TRUCKEE MEADOWS WATER AUTHORITY

STAFF REPORT

TO: Chairman and Board Members
FROM: John Erwin, Natural Resources
DATE: 14 October 2015
SUBJECT: **Presentation, discussion and direction to staff regarding TMWA's 2016-2035 Water Resource Plan**

The attached draft Water Resource Plan will be discussed at the October 21, 2015 TMWA Board of Directors Strategic Planning Workshop. The draft plan was previously presented at a noticed public meeting of TMWA's Standing Advisory Committee (SAC) on October 6 and will again be discussed at the SAC meeting scheduled for November 3.

By way of information a series of open house meetings have been scheduled so that the public can comment and discuss the draft 2016-2035 Water Resource Plan. The open house meetings are scheduled and located as follows:

1. **Date:** Monday, November 9, 2015
   Time: 5:30-7:00 p.m.
   Location: Spanish Springs Library at Lazy 5 Regional Park
   7100 Pyramid Lake Hwy, Spanish Springs

2. **Date:** Monday, November 16, 2015
   Time: 5:30-7:00 p.m.
   Location: Truckee Meadows Water Authority
   1355 Capital Blvd., Reno

3. **Date:** Tuesday, November 17, 2015
   Time: 5:30-7:00 p.m.
   Location: O'Brien Middle School
   10500 Stead Blvd., Reno

4. **Date:** Wednesday, November 18, 2015
   Time: 5:30-7:00 p.m.
   Location: South Valleys Library
   15650 Wedge Parkway, Reno

TRUCKEE MEADOWS WATER AUTHORITY

2016-2035

DRAFT

WATER RESOURCE PLAN

KEY FINDINGS AND RECOMMENDATIONS

1.1 2016-2035 Water Resource Plan ("2035WRP")

Findings:

Truckee Meadows Water Authority's ("TMWA's") prior water resource plans: (1) laid the foundation for an understanding of the region's water supply system; (2) summarized the history of municipal water supply in the Truckee Meadows up to and including the formation of TMWA; (3) presented legislative directives that modified regional water resource planning for the Truckee Meadows and led to the creation of the Western Regional Water Commission ("WRWC"); (4) analyzed economic influences at the local level that affect the growth activity and patterns for the Truckee Meadows resulting in a need to examine current population trends and their potential impact on future water demands and resource requirements; (5) confirmed the use of Truckee River flows during the historical 1987-1994 drought period as the basis for prudent water supply planning for the Truckee Meadows; and (6) provided ongoing analysis of future water supply options to meet the region's economic development needs. This 2035WRP continues the Board's previous direction to review conditions and influences affecting water supplies and local growth trends and what those influences may have on Truckee Meadows water resources and TMWA's plans and/or management strategies in the context of completion of the merger of the former Washoe County water utilities into TMWA in December 2014; completion of all conditions precedent to implement the Truckee River Operating Agreement ("TROA"); and current hydrologic conditions.

Recommendation:

Continue monitoring, reviewing and revising where necessary its water resource management strategies through its planning efforts, as presented in documents such as this 2035WRP, in response to current and future conditions including but not limited to changing conditions in meteorology, hydrology, community development, institutional/regulatory constraints, customer demands, or other factors affecting TMWA's water resource availability and delivery systems.

1.2 Consolidation of TMWA and WDWR Water Operations

Findings:

In response to the WRWC legislative directive to evaluate the potential consolidation of water purveyors in the Truckee Meadows, staffs of TMWA and Washoe County Department of Water Resources ("WDWR") successfully merged the former Washoe County water utilities and the South Truckee Meadows General Improvement District ("STMGID") into TMWA on December 31, 2014.

Recommendation:

No further action required on this item.

1.3 Truckee River Operating Agreement

***Findings*:**

The Truckee River Operating Agreement ("TROA") was signed by the five Mandatory Signatory Parties on September 6, 2008 whereby TMWA, the Pyramid Lake Paiute Tribe ("PLPT"), the United States, California and Nevada set the stage for resolving river operation uncertainties; the parties are moving together to implement and make TROA effective. In August 2015, the cities of Reno and Sparks, Washoe County, and PLPT executed an agreement satisfying the last condition required before TROA could be implemented. Actions taken subsequently by the TROA Mandatory Signatory Parties to dismiss two pending litigations were completed, paving the way to implement TROA. In essence, all conditions precedent to implement TROA were completed in the fall of 2015. When implemented, TROA's framework provides flexibility for river operations to allow parties to store water they previously could not store, significantly enhances TMWA's drought reserves, allows the exchange of water to optimize the use of Truckee River supplies without injuring the water rights on which the parties rely, and resolves future regulatory uncertainties surrounding the use of the Truckee River.

Recommendation:

Continue to participate in any pending litigation or appeal that challenge the implementation of TROA.

2.1 Sustainability of Source Water Supplies - Climate Variability

Findings:

Climate change and meteorological droughts are the most significant variables with potential to change the quantity and quality of raw water supplies, particularly surface water supplies. While the weather pattern consistently provides precipitation during the winter and spring months, the type of precipitation (snow versus rain), amount of precipitation, water content of snow, and speed of snowmelt are variable from year to year. TMWA manages the uncertainty of its raw water sources through storage in upstream reservoirs, conjunctive use of surface and groundwater supplies, and continual assessment of threats to water supply reliability from weather. Studies by Desert Research Institute ("DRI") and University of Nevada, Reno ("UNR") indicate the potential for climate change to alter the timing, type of, and quantity of precipitation needs continued monitoring and study, but it is inconclusive at this time as to the magnitude that climate change will have on the region and its water resources over a long-term planning horizon. Over the past several years the use of tree ring studies have been found useful in understanding the climate history of Lake Tahoe, Truckee River, and Carson River watersheds. Through such studies a better understanding of the cycles of dry and wet years has been developed along with analyses of frequencies of occurrence, durations and magnitudes. However, the current body of research on tree ring chronologies have not been specific in the Truckee and Carson River watersheds, thus there is limited direct data on historic flows that can be used in planning.

Recommendation:

Continue to consider, when available, new findings from climate change research for the greater Truckee Meadows region and engage UNR, DRI and/or other researchers to develop tree ring chronologies of the Truckee and Carson River watersheds for use in water resource planning and management during droughts and periods of drought recovery.

2.2 Sustainability of Source Water Supplies – Drought Periods

Findings:

The region is in its fourth consecutive, low-precipitation year. The meteorologic drought, begun in 2012, created hydrologic drought impacts in 2014 and 2015 which required TMWA to release some of its upstream drought reserves for the first time since 1992. As defined in TROA, the region has been in a Drought Situation (i.e., the level of Lake Tahoe is projected to be below elevation 6223.5 feet on November 15 of a given year per TROA) since 2014. Unfortunately, it cannot be known with certainty the duration of the current drought. In addition, analysis has shown that under TROA operations water supplies and drought reserves accumulate to TMWA's benefit under the 1987 to 1994 drought; in addition, even under a hypothetical drought hydrology which repeated 2015 hydrology at 2015 demands for 10-years, TMWA would grow its reserves.

Recommendation:

Continue to monitor TMWA's ability to meet current and future demands through the 1987 to 1994 drought period, the worst drought period of record, and based on factors such as demand growth, conservation improvements, hydrologic cycles, climate changes, etc., update the Board when future conditions change that require changes to the planning criteria or supply operation.

2.3 Sustainability of Source Water Supplies - Surface Water Contamination

Findings:

While there is a risk to surface water reliability from turbidity and toxic spill events, research conducted in 1996 and again in 2007 by UNR on behalf of TMWA has shown no recorded river contamination event from rail or highway transportation. The recent study also suggests that the area of highest risk is downstream of TMWA's treatment facilities in the City of Sparks where there is a rail yard and a large number of warehouses and shipping companies that load/unload trucks and rail cars. TMWA's Source Water Protection Program (including its Wellhead Protection Plan ("WHPP")) is designed to preserve and enhance available water supplies and to address known and potential threats to water quality. TMWA has sufficient well capacity and distribution system storage to meet reduced customer demands during a water quality emergency, and has emergency plans in place in the event of extended off-river emergencies. With the merger of WDWR and STMGID water systems into TMWA, system integration improvements will be implemented that are beneficial in terms of increasing the supply and/or quality of water supplies at minimum economic costs to ensure the delivery of water through the 20-year planning horizon and beyond.

Recommendation:

Continue to: (1) implement its source water protection strategies in cooperation with local entities; (2) maintain, as a minimum, the ability to meet daily indoor water use with its wells; and (3), for river outages lasting up to 7 days during the summer, maintain the ability to meet average daily water demands using its wells, treated water storage, and enhanced conservation measures.

2.4 Sustainability of Source Water Supplies - Groundwater Contamination

Findings:

TMWA works closely with the Central Truckee Meadows Remediation District ("CTMRD") to characterize tetrachloroethylene ("PCE")-contaminated groundwater and remove PCE contamination at affected wells. TMWA is also working with the CTMRD to remove PCE contamination at the source, before groundwater can be impacted. A more ubiquitous contaminant, nitrate, has been impacting groundwater in several basins. A 2007 report by the WDWR funded by the Regional Water Planning Commission ("RWPC") titled, *Septic Nitrate Baseline Data and Risk Assessment Study for Washoe County, Phase I: Prioritization of Study Areas and Assessment of Data Needs*, used available data to identify potential areas of septic nitrate contamination and identify data gaps. The report identified approximately 18,300 septic systems in Washoe County, and at least sixteen areas that have septic densities high enough to impact potable water supplies. Of these, it was determined that five study areas (Spanish Springs, Cold Springs, Washoe Valley, Heppner, and Golden Valley) had sufficient evidence linking water quality degradation to septic systems and required management action. Nine additional areas (Mt. Rose, Ambrose, Hidden Valley, Huffaker, Verdi, Geiger, Island 18, Mogul, and Pleasant Valley) are currently being studied. Two municipal wells in Spanish Springs Valley have already been shut down due to septic nitrate contamination. TMWA has sufficient well capacity and distribution storage to continue to provide safe drinking water in Spanish Springs, as well as remaining areas of concern. However, until areas of high septic density are converted to sewer, the flow of nitrate-contaminated effluent to drinking water aquifers will continue and concentrations may continue to increase.

Recommendation:

Continue to: (1) provide safe drinking water in all areas affected by PCE and septic effluent; (2) investigate the impact to groundwater from PCE and septic effluent; (3) work closely with local jurisdictions to find resources and strategies to convert residences and businesses on septic to sewer; and (4) utilize artificial recharge as a remedial strategy to keep contaminated water away from production wells.

2.5 Sustainability of Source Water Supplies - Groundwater Management

Findings:

Long-term water level declines in East Lemmon Valley and South Truckee Meadows due to reduced natural recharge resulting from low-precipitation and increased pumping by all users have made groundwater production more expensive and impacts to domestic well owners more likely in these areas. TMWA's current strategy to reduce impacts to groundwater levels relies on: (1) strategic and coordinated timing of its pumping; (2) passive groundwater recharge by increasing the duration and location of deliveries of surface water as often as possible to allow wells to rest and water levels to recover; and (3) active groundwater recharge to enhance groundwater supplies and drive water level recovery.

Recommendation:

Continue to: (1) reduce impacts to groundwater by pumping municipal wells strategically; (2) allow water levels to recover through passive groundwater recharge; and (3) force water level recovery through active groundwater recharge. Increasing the breadth and scope of all three of these activities in areas formerly served by WDWR will help groundwater levels recover in areas most affected by groundwater level declines.

2.6 Sustainability of Source Water Supplies – Aquifer Storage & Recovery

Findings:

Since its inception, TMWA's aquifer storage and recovery ("ASR") program has improved or stabilized groundwater levels in and around the injection sites thereby preserving TMWA's ability to utilize its groundwater resources to meet summer peaking and/or drought situation pumping requirements without degrading groundwater quality in the process. ASR is one element of TMWA's integrated management strategy to augment drought reserve supplies for later use during a Drought Situation. ASR can increase the natural supply of groundwater by storing surface water underground when excess supply and treatment capacity exist, and by mitigating groundwater contamination. TMWA has equipped its production wells to allow for treated water to flow back into the wells under pressure during winter time operations. Through June 2015, TMWA has replenished groundwater reserves in the region (Truckee Meadows, Spanish Springs and Lemmon Valley) with over 33,500 acre feet ("AF") of treated surface water.

Recommendation:

Continue and expand the injection of treated surface water into groundwater aquifers to: (1) augment groundwater supplies which provide additional drought and peak-demand capacity; (2) reduce or eliminate water quality concerns; and (3) stabilize and increase groundwater levels. Increasing the breadth and scope of all three of these activities throughout the service area will help groundwater levels recover and may help reduce the impact from septic, industrial, and naturally-occurring contaminants.

3.1 Water Rights Availability

Findings:

TMWA's planning area grew as a result of the 2014 merger of the water systems formerly owned or operated by Washoe County. Because the majority of the water distribution system in the Truckee Meadows, Spanish Springs, Lemmon Valley and a portion of Pleasant Valley is integrated, this planning area can take advantage of Truckee River resources and the benefits of TROA. This planning area is referred to as the Truckee Resource Area ("TRA"). The remote, satellite systems in Washoe Valley and east of the Truckee Meadows in the Truckee Canyon Segment must rely solely on groundwater for their water supply. These systems are referred to as the non-Truckee Resource Area ("non-TRA") [1]. The non-TRA systems have sufficient resources to meet the need within the development (or subdivision) and TMWA does not anticipate significant expansion of the systems beyond those boundaries. Within the TRA, a review

[1] Truckee Resource Area ("TRA") means the portion of TMWA's retail and wholesale service areas within which TMWA is able to accept for dedication any Truckee River water source/right for the delivery of Truckee River water to a Service Property.

of available Truckee River water rights shows a sufficient number (potentially over 45,000 AF) of water rights exist to meet future-average-year-TMWA-water-service demands through the 2016 to 2035 planning horizon. However, acquiring and transferring many of these water rights, which are fractionated and have ownership problems, will require additional time and expense before the right can be put to use. Over the past decades, demands for Truckee Meadows water rights have increased in response to a highly competitive development market, difficulties in finding willing sellers of significant quantities of water rights, and competing environmental and lower river uses of water rights for such things as Fernley's water supply or enhancing water quality both in the Lower Truckee River and groundwater aquifers. Since the number of Truckee Meadows water rights is limited, close coordination of the various river interests must occur to avoid undo stress on the water rights market. Additionally, the North Valleys Importation Project's ("NVIP") 8,000 AF of Honey Lake groundwater resource is available to meet future demands in the North Valleys.

Recommendation:

Continue to accept the dedication of Truckee River water rights in the growth prone Truckee Meadows, Spanish Springs and upper, west Pleasant Valley which water rights are sufficient to support both TROA implementation and increased future development needs within TRA; recognize NVIP is available to meet future demands in the North Valleys, and unless other resources are available in the non-TRA systems, these systems are limited to the resources dedicated for the development within the system's service area.

3.2 Current Water Resources

Findings:

TMWA has over 136,000 AF of decreed, storage, and irrigation rights to generate water supplies for customer demands. Under TROA, TMWA uses its Privately Owned Stored Water ("POSW") and a portion of its unexercised water rights to generate sufficient upstream drought reserves to meet projected drought-year demands over the planning horizon. To ensure an adequate supply of water for all customers, TMWA's Rule 7 requires that applicants for any new water service dedicate sufficient water rights to meet the demand of their development. Applicants for new service can buy water rights on the open market and dedicate sufficient, acceptable water rights to TMWA or, if the applicant chooses to acquire from TMWA, the applicant pays for a will-serve commitment based on TMWA's costs incurred to acquire and process the necessary water rights.

Recommendation:

Continue to acquire water rights to meet future water demands pursuant to its Rule 7.

3.3 Conjunctive Management of Water Resources

***Findings*:**

TMWA's 2035 water use projection of 101,000 AF for the combined TRA and non-TRA can be satisfied with TMWA's current resources with continued dedication of river rights. Ultimately, within the TRA, TROA allows TMWA to meet a demand of 119,000 AF based on the historic drought from 1987 to 1994; this 8-year drought was the most severe on record. Additionally, as a result of the merger, TMWA has over 20,000 AF of groundwater rights committed to areas within the TRA which are not included in the TROA resource pool and to the non-TRA satellite systems. As it pertains to TROA and future demands within the TRA, use of a more stringent drought cycle design, without data to support it, ultimately reduces the use of available resources in the long-term and burdens the region with the cost requirement to replace the constrained resource.

Recommendation:

Continue to: (1) rely on its pool of resources to meet current demands; (2) recognize TROA can provide drought-year operational benefits in excess of current drought-year reserves thereby supporting future demands; and (3) pending the outcome of the 2015/2016 winter and subsequent 2016 runoff projections, continue to base its planning on the worst drought cycle of hydrologic record for the Truckee River.

4.1 Population Projection

Findings:

TMWA's population forecast estimates total Washoe County population to increase by 95,000 from 450,000 in 2016 to 545,000 in 2035, or 21 percent; the estimated population served by TMWA will increase by 83,000 people from 392,000 in 2016 to 475,000 by 2035, or 21 percent. The population estimates may change over time as the pace of development within the region or its sub-area varies, and as the region moves towards greater intensification of land use. TMWA's forecast results compare favorably to the State Demographer's near-term projections.

Recommendation:

Accept TMWA's population forecast as a reasonable estimate of future population growth to be used by TMWA for planning purposes in its planning areas.

4.2 Water Demand Forecast

Findings:

Water demand-per-service within TMWA's service areas has been decreasing over time resulting in slower total demand growth in TMWA's extended forecast. Based on the review of current growth and economic trends in the region, future water demand is anticipated to grow in the central Truckee Meadows but at a slower pace than historically seen. The water production forecast for a typical year indicates that from 2016 to 2035, production will increase from current estimates for 2016 of approximately 83,000 AF to a projected 2035 demand of approximately 102,000 AF, or about 21,000 AF. The 2035 production is well within the maximum 119,000 AF/yr under TROA operations.

Recommendation:

Accept for planning purposes that the water demand projections are reasonable estimates for use in TWMA's planning areas.

5.1 Water Demand Management

Findings:

TMWA's Water Demand Management Programs include measures to enhance efficient use of water, reduce or eliminate water waste, and save water. Some specifics include change-out of old meters, leak repair, water theft prevention, landscape design/retrofit materials, numerous education materials, Assigned-Day Watering, watering prohibited during the heat of the day, water audits, and Drought Situation responses. Combined, these measures are designed to satisfy the conservation goal agreed to in the 1996 Water Conservation Agreement between RSW, TMWA, PLPT and the United States. Continued levels of spending will be in accordance with that agreement. TMWA works with the WRWC in developing conservation plans for the region, and cooperates with WRWC in implementing its conservation programs. The water conservation activities embodied in this 2035WRP satisfy Article 5(i) of the Joint Powers Authority ("JPA") agreement that formed TMWA and the Nevada Division of Water Resources requirements that public water systems have a water conservation plan as set forth in NRS 540.131 through 540.151.

Recommendation:

Accept the Water Conservation Plan outlined in this 2035WRP.

6.1 Future Water Resources

Findings:

The selection of the next water supply project is strictly a function of a project's yield, ease of implementation, sustainability, and financial feasibility accompanied with existing regional economic conditions and market forces that would or would not favor the development of a future water supply project. It may be that in the future, as new technology becomes available or the political, regulatory or public opinion changes, new projects may be developed or projects previously thought infeasible may become feasible. In addition to the implementation of TROA, the NVIP was completed in 2008 and is available to supply 8,000 AF annually to the North Valleys. TMWA is an active supporter and participant in the TROA process and the implementation of TROA has numerous benefits. In addition to complying with TROA, TMWA will also pursue other resource development projects that do not conflict with TROA requirements and will be necessary in order to meet water demands beyond the 2035 planning horizon.

Recommendation:

The Board continue to investigate, evaluate, and negotiate, where appropriate, other potential water supply projects consistent with and/or in addition to TROA.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AF	Acre-Feet, an acre-foot is equal to 325,851 gallons
AF/yr	Acre-Feet/Year
Airport Authority	Reno-Tahoe Airport Authority
AMSL	Above Mean Sea Level
ASR	Aquifer Storage and Recovery
BAC	biologically activated carbon
BBER	Bureau of Business and Economic Research, University of Nevada Reno
BCC	Washoe County Board of County Commissioners
BDOC	biodegradable dissolved organic carbon
BLM	Bureau of Land Management
Board	Board of Directors for Truckee Meadows Water Authority
CC&Rs	Covenants, conditions and restrictions
cfs	cubic feet per second
Churchill	Churchill County
CIP	Capital Improvement Program
CSWRCB	California State Water Resources Control Board
CTMRD	Central Truckee Meadows Remediation District
CTP	Chalk Bluff Water Treatment Plant
DMPs	Demand-side management programs
DRI	Desert Research Institute
DWSRF	Drinking Water State Revolving Fund
eDMPs	Enhanced demand-side management programs
ELV	East Lemmon Valley
EMC	Enhanced Messaging Campaign
FSA	Future Service Area
Ft	Foot
FY	Fiscal Year
ELV	East Lemmon Valley
EPDTS	Entry Points to the Distribution System
Fallon	City of Fallon

FSR	Fish Springs Ranch
GIS	Geographic Information System
GTP	Glendale Water Treatment Plant
gdp	gross domestic product
gpcd	gallons per capita per day
GMWS	General Metered Water Service Rate Schedule
gpm	gallons per minute
HOAs	Home Owners Associations
ILA	Interlocal Agreement
IPR	Indirect potable reuse
ISA	Interim Storage Agreement, 1994
ITRDB	International Tree-Ring Data Bank
IWP	Intermountain Water Project
JPA	Joint Powers Authority
LDV	Lower Dry Valley
LSC	Lower Smoke Creek
LMB	Local Managing Board
LV	Lemmon Valley
MCL	Maximum contaminant level
mg/l	milligrams per liter or parts per million (ppm)
µg/l	micrograms per liter or parts per billion (ppb)
MF	membrane filtration
MGD	Million Gallons per Day
M&I	Municipal and Industrial
MIS	Metered Irrigation Water Services Rate Schedule
MMWS	Multi-Family Metered Water Service Rate Schedule
MSA	Metropolitan Statistical Area
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NDWR	Nevada Division of Water Resources
NEPA	National Environmental Policy Act
NNWPC	Northern Nevada Water Planning Commission

Non-TRA	non-Truckee Resource Area
NPS	Non-Potable Service
NRS	Nevada Revised Statutes
NTM	North Truckee Meadows
NTU	Nephelometric Turbidity Unit
NVI	North Valleys Initiative
NVIP	North Valley Importation Project
O3	Ozonation
ODPS	Orr Ditch Pump Station
O/M	Operating/Maintenance
PARs	Preliminary Assessments Reports
PCE	tetrachloroethylene, a volatile organic compound
PCSs	Potential Contaminant Sources
PL	Public Law
PLPT	Pyramid Lake Paiute Tribe
POSW	Privately-Owned Stored Water, as defined in Truckee River Agreement
POU	Place of use
PPB	Parts per billion
PSI	Pounds per square inch
PUCN	Public Utilities Commission of Nevada
RAA	Running Annual Average
Red Rock	Red Rock Valley Importation
RMWS	Residential Metered Water Service Rate Schedule
RO	Reverse osmosis
ROD	Record of Decision
RWPC	Regional Water Planning Commission
RSW	City of Reno, City of Sparks, and Washoe County
RWMP	Regional Water Management Plan
RWPC	Regional Water Planning Commission
SB	Senate Bill
SCR	Senate Continuing Resolution

SDP	State Demographer's Projection
SDWA	Safe Drinking Water Act
Settlement	Truckee River Negotiated Settlement
Settlement Act	Truckee-Carson-Pyramid Lake Water Rights Settlement Act
Settlement Agreement	PLPT Fish Springs Ranch Settlement Agreement
Sierra	Sierra Pacific Power Company (NVEnergy)
SMPs	Supply-side management programs
sq. ft.	Square Feet
SSIP	Silver State Importation Project
STM	South Truckee Meadows
STMFP	South Truckee Meadows Facility Plan, August 2002
STMGID	South Truckee Meadows General Improvement District
SSV	Spanish Springs Valley
SVGID	Sun Valley General Improvement District
TCE	Trichloroethylene, a volatile organic solvent
TCID	Truckee-Carson Irrigation District
tds	total dissolved solids
The Fund	Truckee River Fund
TMWA	Truckee Meadows Water Authority
TMWRF	Truckee Meadows Water Reclamation Facility
TMSA	Truckee Meadows Service Area
TRA	Truckee Resource Area
TROA	Truckee River Operating Agreement
TROM	Truckee River Operation Model
TRPA	Tahoe Regional Planning Agency
UDV	Upper Dry Valley
UNR	University of Nevada, Reno
U.S.	United States
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation, or BOR
USGS	United States Geological Survey
USEPA	U.S. Environmental Protection Agency

UV	ultra-violet radiation
VAR	Vector Autoregression Model
Vidler	Vidler Water Company
WCHD	Washoe County Health District
WCWCD	Washoe County Water Conservation District
WDWR	Washoe County Department of Water Resources
WHPP	Wellhead Protection Plan
WLV	West Lemmon Valley
WRP	Water Resource Plan
WRWC	Western Regional Water Commission
WSF	Water Service Facility
2025WRP	2005-2025 Truckee Meadows Water Resource Plan, Truckee Meadows Water Authority, March 2003
2030WRP	2010-2030Truckee Meadows Water Resource Plan, Truckee Meadows Water Authority, December 2003
2035WRP	2016-2035 Truckee Meadows Water Resource Plan

CHAPTER 1 INTRODUCTION

The Truckee Meadows Water Authority ("TMWA") was formed in direct response to a September 2000 announcement by Sierra Pacific Resources ("Sierra") of its intention to sell its water utility business serving water to the greater Reno/Sparks area in Washoe County, Nevada. On October 20, 2000 Reno, Sparks and Washoe County ("RSW") submitted a joint "Proposal to Purchase the Water Utility Assets of Sierra Pacific Resources." RSW indicated intent to form a Joint Powers Authority ("JPA") and to have the JPA in existence upon selection as the successful bidder. On November 13 and 14, 2000, a Cooperative Agreement was executed between RSW forming TMWA[2]. TMWA was officially born by RSW's execution of the "Cooperative Agreement among City of Reno, City of Sparks, and County of Washoe" on December 4, 2000 pursuant to the provisions of Chapter 277 of the Nevada Revised Statutes ("NRS").

The broad underlying principles RSW sought to achieve through TMWA include:

- Assure that water resources are developed and managed to fulfill the present and future water needs of the greater Truckee Meadows community.
- Acquire and manage the water assets for the benefit of the Truckee Meadows community.
- A need for RSW to act together with respect to water supply and water quality.
- Secure additional supplies and effectively manage existing supplies which can best be achieved through the cooperative action of RSW operating through TMWA.

After the successful launch of TMWA, RSW subsequently submitted and was awarded the successful bid to acquire Sierra's water utility business on January 15, 2001. On June 5, 2001 TMWA sold $452.3 million in bonds pledged against its revenues and the sale of Sierra's water utility business with the transfer of title to all diversion, treatment, conveyance, water transmission, wells and distribution related facilities was completed. When TMWA opened for business on June 11, 2001, 127 employees, all former water division employees of Sierra, continued managing and operating the water utility business for the greater Truckee Meadows area, and began the process to meet the business objectives established by the JPA, TMWA's Board of Directors and its management team.

In March 2003 TMWA published, and the Board adopted, TMWA's *2005-2025 Water Resource Plan* ("2025WRP"). That plan presented: a summary of the history of municipal water supply in the Truckee Meadows; the understanding of the region's water supply system; a conjunctive management of surface and groundwater; confirmation of the use of Truckee River flows during the historical 1987-1994 drought period as the basis for TMWA's 9-year drought plan; projected population and water demands; conservation programs and measures to reduce annual water use and minimize water waste; and potential future water resource options.

Subsequent to the Board review of its water resource plan strategies in Fall 2009, the Board adopted its *2010-2030 Water Resource Plan* ("2030WRP") in December 2009. The

[2] The original Cooperative Agreement, in 2000 was subsequently revised in 2005 to change the make-up of the Board from 7 members (3-Reno, 2-Sparks, 1-Washoe County, 1-Unidentified) to its current form (3-Reno, 2-Sparks, 2-Washoe County); and in 2010 to revise the agreement to accommodate potential merger with Washoe County.

2030WRP built on the foundation strategies established in the 2025WRP in addition to responding to then current issues involving:

Chapter 1 Legislative directives to consolidate water purveyors in Washoe County;

Chapter 2 Execution by the five Mandatory Signatory Parties (TMWA, Pyramid Lake Paiute Tribe ("PLPT"), California, Nevada, and the United States ("U.S.")) and seven other parties of the Truckee River Operating Agreement ("TROA") on September 6, 2008;

Chapter 3 Changes in population and demand projections as a direct result of the regional economic malaise from 2007-2009 when the 2030WRP was drafted; and

Chapter 4 Completion of the retrofit of flat-rate, single-family residences that were required to be retrofit as part of the 1989 Negotiated River Settlement.

Continuing with the Board's prior recommendations, this 2016-2035 Water Resource Plan ("2035WRP") reviews, updates, and/or modifies TMWA's water resource planning and management strategies due to a number of key events that have occurred over the past five years which include:

- The merger of Washoe County Community Development-Department of Water Resources ("WDWR") and South Truckee Meadow General Improvement District ("STMGID") water utilities into TMWA was completed December 31, 2014. Combining the three purveyors under one jurisdiction allows for a consistent water management strategy to be implemented across the majority of water consumers and water resources in southern Washoe County. While the merger allows for greater efficiency in water management planning, it also poses additional resource management challenges to ensure adequate supply within the expanded Truckee Resource Area[3] ("TRA").
- A reversal of negative or stagnant economic trends dominating the region since 2007 which altered the economic activity and growth expectations for the Truckee Meadows. The region began experiencing a modest economic resurgence in late 2013 which continues today. This economic shift results in a need to examine the current population trend and its possible effect on water demand and future resource requirements.
- Completion of the remaining conditions precedent to implementing TROA since it was signed by the five Mandatory Signatory Parties in 2008. Favorable California State Water Resources Control Board approvals in 2012, California state court dismissal of an appeal in 2014, and recent Federal court rulings in 2014, are paving the way for implementing TROA. This past August 2015 major milestones related to the Reno, Sparks and Washoe County obligation to supply 6,700 acre feet ("AF") of Truckee River water rights were completed. Filings were made in August and September 2015 to dismiss the last two lawsuits which are the final two elements to "check-off" before TROA is implemented. With TROA in effect, the framework is now in place that provides greater flexibility in river operations, particularly during drought conditions as TMWA's drought storage potential increases, river flows are enhanced for endangered and threatened fish species, and water rights of the signatories and non-signatories to the agreement are protected.

[3] The Truckee Resource Area ("TRA")" is that portion of TMWA's service area within which the utility will accept for dedication, subject to certain conditions, a Truckee River water source/right for the delivery of water to a service property that can be served with Truckee River resources.

- The region is in the fourth year of a meteorologic drought that has produced consecutive lower-than-average snowpack years. The hydrologic drought conditions on the Truckee River began to develop late 2014 - the third year of the meteorologic drought – and had little impact on TMWA's water supplies or drought reserves. The hydrologic drought conditions grew more severe in 2015 due to the lowest snowpack in 106 years of historical record keeping. The lack of precipitation has led to an extended drought period similar to 1991 through 1994 with the more regional impacts occurring in 2015.

Given these events, current water resource planning must consider the potential for prolonged drought years while accommodating for regional growth over the next 20 years. Projected changes in supply and demand will impact TMWA's water facility and capital improvement plans which, in turn, can impact the rates charged to customers, including facility charges. TMWA's 2035WRP is one component of the coordinated planning efforts addressing the water resource, and ultimately the facility challenges facing the utility and the region in order to develop workable strategies that are cost effective while protecting the financial integrity of TMWA. A visual presentation of the cyclical relationships of this integrated planning approach TMWA undertakes periodically is shown below in Figure 1-1. This cycle of review and updating is a continuous process necessary to respond to changing economic and environmental factors that may affect the Truckee Meadows and the surrounding region.

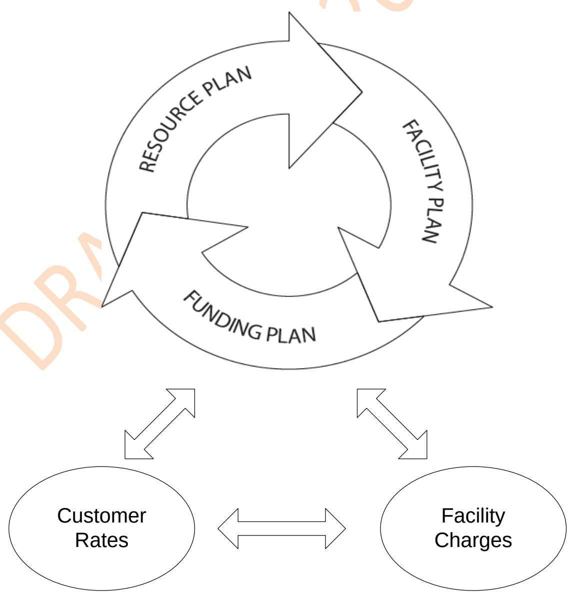


Figure 1-1. TMWA Planning Process

This Introduction to the 2035WRP frames the more significant challenges to water resources currently found within the Truckee Meadows region and sets the context for this water resource plan ("WRP"). This 2035WRP builds upon the information developed and contained in prior WRPs as well as various regional planning efforts. This plan will examine and analyze the water resource options available to TMWA to meet the water demands of its current customers and set a strategy for management given future demand projections.

Legislative Directives

In 2007 the Nevada Legislature adopted Senate Bill ("SB") 487, codified as the Western Regional Water Commission ("WRWC") Act. The Bill was sponsored by the Interim Legislative Subcommittee created in 2005 by Senate Continuing Resolution ("SCR") 26, and enabled the creation of a new regional water entity in Washoe County to be effective April 1, 2008. Pursuant to this legislation, the cities of Reno and Sparks, STMGID, the Sun Valley General Improvement District ("SVGID"), TMWA, and Washoe County, entered into a JPA to create the WRWC. The WRWC is charged with facilitating cooperative resource management efforts among the existing water purveyors in southern Washoe County and to provide for integration of regional water supply and storm water management, subject to the TROA. This includes facilitating planning for the development, management and conservation of regional water supplies, maximizing conjunctive use by public water purveyors (excluding Gerlach and Incline Village),) and facilitating the development of a plan to integrate public purveyor water systems to provide the most effective management and integration of systems. SB487 provided for a change of oversight and restructuring of the prior Regional Water Planning Commission ("RWPC") into the Northern Nevada Water Planning Commission ("NNWPC"). The WRWC began functioning and assumed oversight of the NNWPC in April 2008.

SB487 also created a legislative committee to oversee the WRWC, which met from time to time during the 2008, 2010 and 2012 interim legislative periods to review the WRWC's programs and activities and make a report to the Legislature. During that period, the Committee made the following recommendations for legislation: 2008, requiring coordination of water quality monitoring on the Truckee River and minor language changes in SB487; 2010, providing financial assistance for connecting to public water or sewer systems; and 2012, eliminating the Committee's statutory sunset date of July 1, 2013 and expanding its scope to study statewide water issues. The sunset provision was not removed, and the Committee expired by statutory elimination on July 1, 2013.

The WRWC adopted its first Comprehensive Regional Water Management Plan ("RWMP") for the planning area in January 2011. The RWMP includes the supply of municipal and industrial ("M&I") water, quality of water, sanitary sewerage, treatment of sewage, drainage of storm water and control of floods. The RWMP is in the latter stages of a 5-year review required and expected to be completed in December 2015. An update of the RWMP for the years 2016 to 2035 will be prepared and presented to the WRWC for adoption in the fall of 2016. Since TMWA is a major contributor to the potable water management elements of that plan, adoption by TMWA's Board of this 2035WRP is necessary in order that its findings may be incorporated into the RWMP.

Consolidation of TMWA, WDWR & STMGID

Since TMWA's inception in 2000, serious consideration had been given by TMWA's Board of Directors and Washoe County's Board of Commissioners ("BCC") to the possible integration of some or all functions of TMWA and WDWR. Formal direction was given to the WRWC to incorporate into its 2030 Comprehensive Water Plan an "evaluation and recommendations regarding the consolidation of public purveyors in the planning area, which must include costs and benefits of consolidation, the feasibility of various consolidation options, analysis of water supplies, operations, facilities, human resources, assets, liabilities, bond covenants, and legal and financial impediments to consolidation and methods, if any, for addressing any such impediments." *[Western Regional Water Commission Act, Section 42(9)]*.

In furtherance of this directive, at its September 12, 2008 meeting, the WRWC asked staff from TMWA and WDWR to "conduct a focused financial analysis to assess the feasibility of some form of utility integration using their joint bond counsel and financial advisors…".[4] At the December 2008 WRWC meeting, the Phase One Financial Report was presented which consisted of a bond analysis addressing certain limitations and restrictions resulting from existing debt and what opportunities were available for refunding or refinancing existing debt. This analysis demonstrated that consolidating WDWR into TMWA by defeasing WDWR debt would be financially feasible within a reasonable time-frame, but that the converse – defeasing TMWA's debt – would not be a financially advantageous alternative. Staff of TMWA and WDWR met on numerous occasions to analyze the feasibility of whether the integration/consolidation of certain functions of the two entities was possible and, if so, whether efficiencies and benefits to the community would result. Preliminary assessment reports ("PARs") for System Planning and Engineering were delivered to WRWC at its March 13, 2009 meeting, and Operations and Water Resources at its July 10, 2009 meeting. Each of these PARs analyzed the potential opportunities for improving efficiency, customer service and reliability, as well as reducing long term operating and/or capital costs through some form of integration of WDWR and TMWA. The PARs were prepared by interagency teams of employees who were familiar with the topics and analyzed TMWA and WDWR water systems as one rather than two systems. The findings of the PARs generally indicated that operational and resource management efficiencies may be achieved through consolidation, that rate structures of the two agencies were sufficiently close that migration to one set of customer rates would not result in inequities to either customer base, and that no insurmountable labor issues were anticipated.

To facilitate the consolidation review, the WRWC appointed a Subcommittee on Integration/Consolidation in July 2009, which conducted two meetings with staff to consider certain aspects of consolidation. At its August 6, 2009 the WRWC-Subcommittee meeting concluded that the integration/consolidation process should proceed, and that the full WRWC Board recommend to the governing bodies of both utilities to develop an inter-local agreement ("ILA") to implement integration of the two agencies leading to full consolidation. The respective governing bodies took action in September 2009 to direct TMWA and WDWR staff to proceed with the development of an ILA to advance the integration/consolidation of WDWR water functions into TMWA.

TMWA and Washoe County executed the *Interlocal Agreement Governing the Merger of the Washoe County Department of Water Resources Water Utility into the Truckee Meadows Water Authority* dated January 29, 2010, which provides for the merger of WDWR into TMWA. Due diligence began in earnest in 2010 to further identify and/or clarify any potential legal obligations/constraints, complete financial analyses to determine the costs/benefits to the

[4] The WRWC Act requires analysis of consolidation of all "public purveyors" within the planning area, however, no analysis was conducted of the SVGID as it was generally concluded that this entity functions in a semi-autonomous fashion and that significant efficiencies in operations or resource management are unlikely to be achieved by consolidating their functions with a consolidated TMWA/DWR entity.

respective utility's customers, create an operating model of the combined systems to develop optimum production schedules and estimate related costs, and work out transition issues.

By October 2012, TMWA presented to the TMWA Board the results of its completed due diligence analyses and sought direction as to continue the process. At that time, the various steps to proceed with merger implementation included labor negotiations; transferring system control to TMWA; transfer customer billing information to TMWA; defease WDWR publically issued water debt to be assumable by TMWA; revise various WDWR loan and bond commitments; and other specific tasks identified in the ILA. During the due diligence process, it was identified that the merger of the WDWR system into TMWA would require some resolution with respect to continued operations of the STMGID[5] system. Through 2012, the Washoe County and the STMGID Local Management Board explored various options including merging STMGID as part of WDWR or STMGID becoming a stand-alone utility. The TMWA/WDWR merger was put on hold until these issues could be resolved.

By December 2012, the BCC elected to authorize the STMGID Local Managing Board with the sole responsibility to manage its affairs as a stand-alone entity. In the same month, STMGID submitted a merger term sheet to TMWA for TMWA Board consideration proposing a direct merger of STMGID into TMWA concurrent with the TMWA/WDWR merger. By June 2013, TMWA staff had completed its due diligence of a merger with STMGID with a favorable recommendation to the TMWA board. Throughout 2014, TMWA and WDWR staff members worked long hours to complete all steps necessary and obligations within the various ILAs. On December 31, 2014, both the WDWR and STMGID water systems were successfully merged into and acquired by TMWA.

TMWA's prior water resource plans focused on resource issues facing the utility and its conjunctive use of Truckee River resources and groundwater resources in the pre-merger TRA. Pre-merger, TMWA's planning area was limited to the southern-half of Spanish Springs (hydrographic basin 85), the northern-half of the Truckee Meadows ((hydrographic basin 87), and the west-half of Lemmon Valley (hydrographic basin 92A). Post-merger, TMWA assumes a larger, regional role in resource planning and management. The following graphics illustrate the change in scope of TMWA's responsibility and service areas pre- and post- the merger. The service area grew from about 109 to 156 square miles.

[5] STMGID was a general improvement district created by Washoe County in 1981 for the basic purposes of furnishing storm drainage, sanitary sewer and water facilities. STMGID served approximately 3,700 customers in the south Truckee Meadows. Up until December 2012, the BCC served as the STMGID Board of Trustees, and a Local Managing Board ("LMB") comprised of five residents in the STMGID area acted as an advisory board to the BCC.

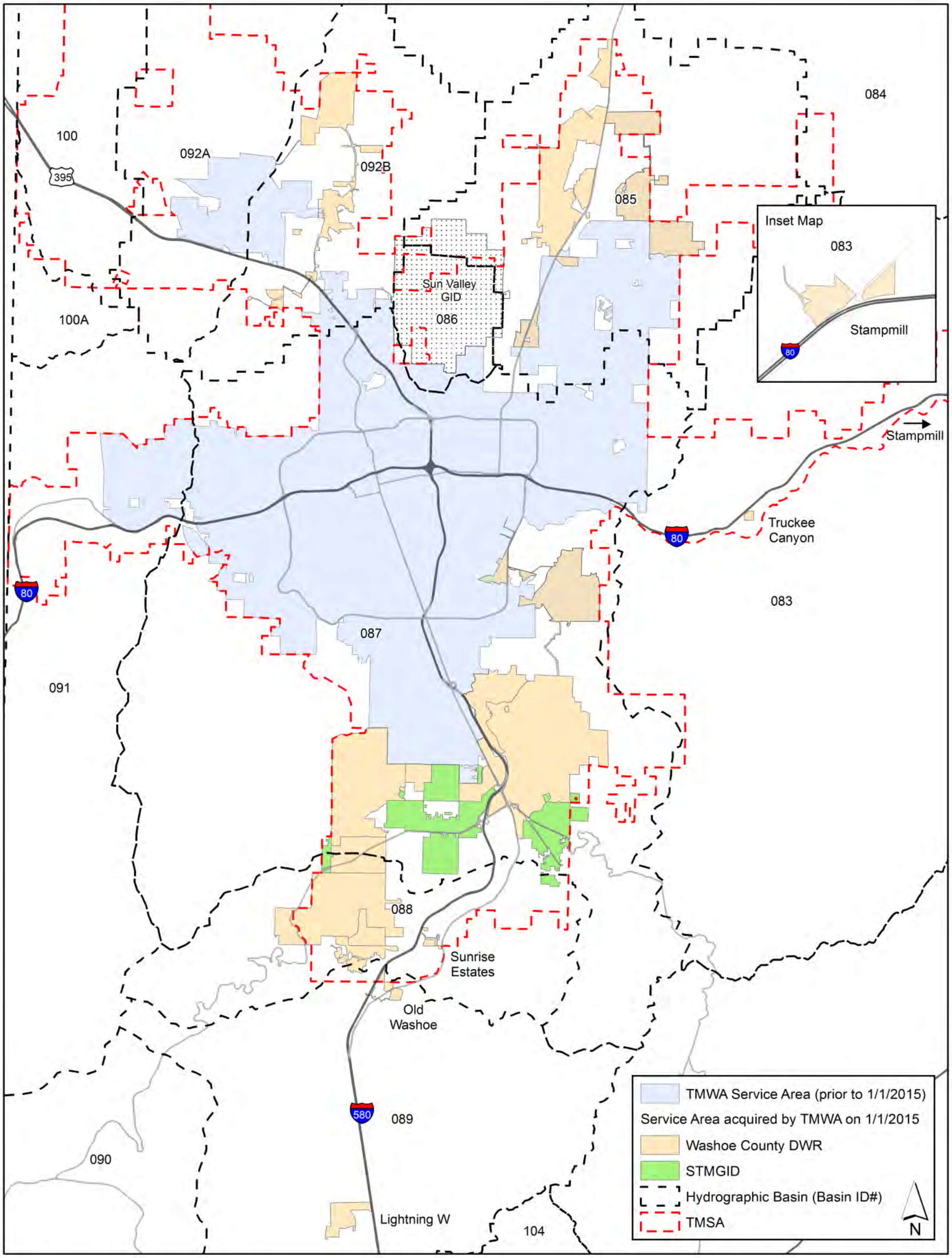


Figure 1-2. Pre-Merger Service Areas

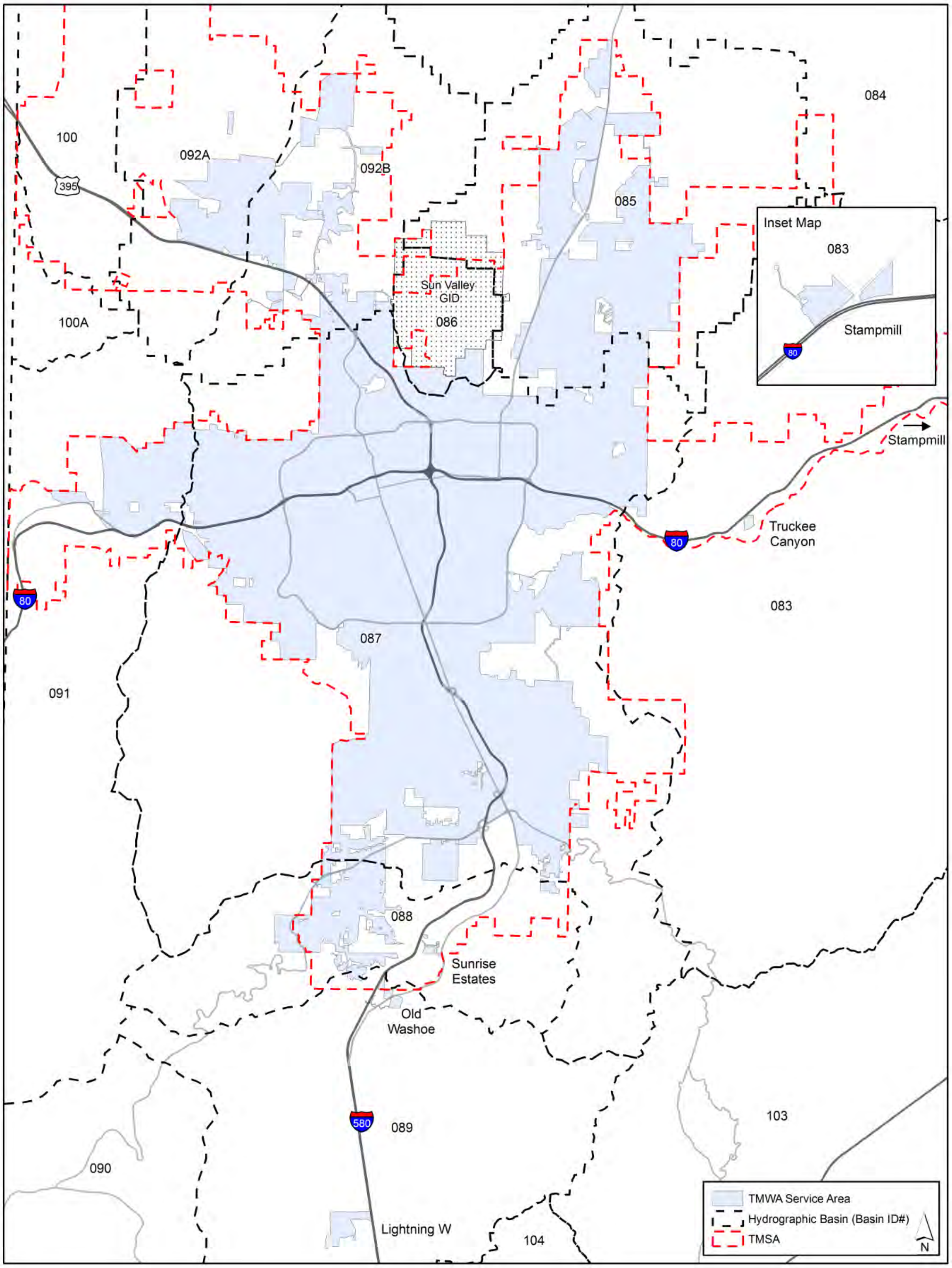


Figure 1-3. Post-Merger Service Area

Due to the expansion of TMWA's service area, TMWA evaluation of water resources and facilities expanded to include all of Lemmon Valley, all of Spanish Springs, all of Truckee Meadows[6], Pleasant Valley (hydrographic basin 88), and in those areas in Washoe Valley (hydrographic basin 89) and the Tracy Segment (hydrographic basin 83) where small, satellite systems are located. The distribution systems located in hydrographic basins 83, 85, 86, 87, 88 (west portion), 91 and 92 are grouped in the TRA category since the integration of systems between these basins affords customers/development access to Truckee River resources (mainstem and tributary water rights) and the benefits of TROA's drought reserves. Table 1-1 highlights resources, customers and demands in the various planning basins included under the TRA designation.

Table 1-1. Summary of TMWA's Customers, Resources and Usage in TRA and non-TRA Planning Basins

		TRA				non-TRA			
Description	TOTALS	Spanish Springs	Truckee Meadows[1]	Pleasant Valley-West	Lemmon Valley	Tracy Segment	Pleasant Valley-East	Washoe Valley	Honey Lake
		85	87	88	92A & 92B	83	88	89	97
a	b	c	d	e	f	g	h	i	j
A. Service Connections									
1. Residential-single family	103,295	15,758	77,613	1,221	8,479	43	54	127	
2. Residential-multi-family	5,013	108	4,714		191				
3. Commercial/Industrial	6,793	280	6,194	12	291	10		6	
4. Irrigation	3,178	182	2,750	60	174	5		7	
5. Wholesale	1		1						
6. Total Connections	118,280	16,328	91,272	1,293	9,135	58	54	140	0
B. Rights (acre feet)									
1. Ground water-in basin	41,620	5,900	28,237	3,457	2,678	315	432	601	
2. Ground water-importation [2]	8,000								8,000
3. Surface water-converted ag rights[3]	69,717		69,717						
4. Surface water-decree[3], creek[4]	44,843		44,843						
5. Surface water-storage	22,250		22,250						
6. Total Resources	186,430	5,900	165,046	3,457	2,678	315	432	671	8,000
C. Sources (acre feet)									
1. Ground water-in basin extraction	21,233	1,438	16,869	1,708	988	45	34	151	
2. Ground water-importation	276								276
3. Surface water-retail	57,640		57,640						
4. Surface water-POSW	4,900		4,900						
5. Total Sources CYE2014	84,049	1,438	79,409	1,708	988	45	34	151	276

[1] Includes Basin 86 -Sun Valley and Basin 91 - Truckee Canyon (Verdi).
[2] Honey Lake water rights/resources are available to the North Valleys via the Vidler Pipeline.
[3] Converted ag and decree rights are used throughout the TRA.
[4] Converted creek ag rights are available for use in Basins 87 (southwest) and 88 (west portion).

[6] Includes Basin 86-Sun Valley and Basin 91-Truckee Canyon (Verdi) as TMWA does not have facilities nor groundwater resources in those areas.

The remote, i.e., satellite, systems TMWA now manages as a result of the merger are found in basins: 83 (Truckee Segment), 88-East (the area east of I-580 in Pleasant Valley), 89 (Washoe Valley) and 97 (Honey Lake)[7]. These systems are grouped in the non-Truckee Resource Area ("non-TRA") category because the systems were developed as standalone subdivisions, which upon recordation of a final map required sufficient resources to meet the full build-out requirements of the development. At this time, the resources to serve these developments are fully committed and cannot be expanded beyond the defined development area without additional investment in facilities and viable resources. For purposes of this plan, it is assumed that each of the satellite systems has sufficient resources and facilities dedicated to meet the build-out of the development over the planning horizon, and it is not foreseen that Truckee River resources are or will be available to these systems in the near-term. A brief summary of these systems and the basin in which they are located is presented in Table 1-2.

Table 1-2. Summary of Satellite Systems Resources and Customers

	Description	Start year	Lots & customer type	Dedicated water rights (acre feet)	2014 Production
	-------------------a---------------------	---b---	----c----	----d----	----e----
1	Basin 83: Truckee Segment				
2	Truckee Canyon Water System	2000	10-commercial 2-irrigation	200	18
3	Stampmill Estates	1994	2-commercial 43- residential	115	27
4	Basin 88: Pleasant Valley-East[a]				
5	Sunrise Estates	1978	54-residential	432	34
6	Basin 89: Washoe Valley				
7	Lightning W Estates	1997	2-commercial 2-irrigation 62-residential	443	98
8	Old Washoe Estates	1978	4-commercial 5-irrigation 65-residential	158	53
9	Basin 97: Honey Lake	2007	na	na	na

The TRA includes the growth prone areas of Lemmon Valley, Pleasant Valley (west portion), Spanish Springs, and Truckee Meadows. For this plan, the discussion of water resources in the chapters that follow will frame issues for each hydrographic basin but will be aggregated under the TRA classification and describes how TROA meets and exceeds future demand needs in the TRA while accruing more drought reserves than previously available to TMWA over the planning horizon.

[7] Honey Lake is unique in that there are no customers and related distribution facilities in the basin, just well production and transmission facilities, and is grouped in the non-TRA for convenience.

Trends After 2007 Economic Downturn

Following significant economic activity, between 2002 and 2006, the median price of housing approximately doubled within Washoe County. The annual median price for residential homes peaked in 2006 at $345,000. Some of the reasons cited for this rapid price increase in housing related to (a) relatively low home prices compared to California and other western markets; (b) historically low mortgage rates and easy access to mortgage loans in existence during that time; (c) high consumer confidence and spending at the national level; (d) a strong national economy; (e) an influx of national home builders to the region selling new homes at higher than average prices; (f) a surge in immigration and demand for new housing in the region; (g) a stable and favorable business climate compared to other regions in the west; and (h) increasing costs of raw materials for new construction brought about by high demands. However, due to artificially-low interest rates and subprime lending practices, eventually mortgage rates adjusted and the price trend reversed itself. By 2011, median home prices had plummeted 57 percent from $345,000 to $149,000, a level below that of 2001. By 2014 however the median home price was estimated to be $230,000, indicating home buying was on the rise. Figure 1-4 shows the changes in the median housing price for Washoe County between 2001 and 2014.

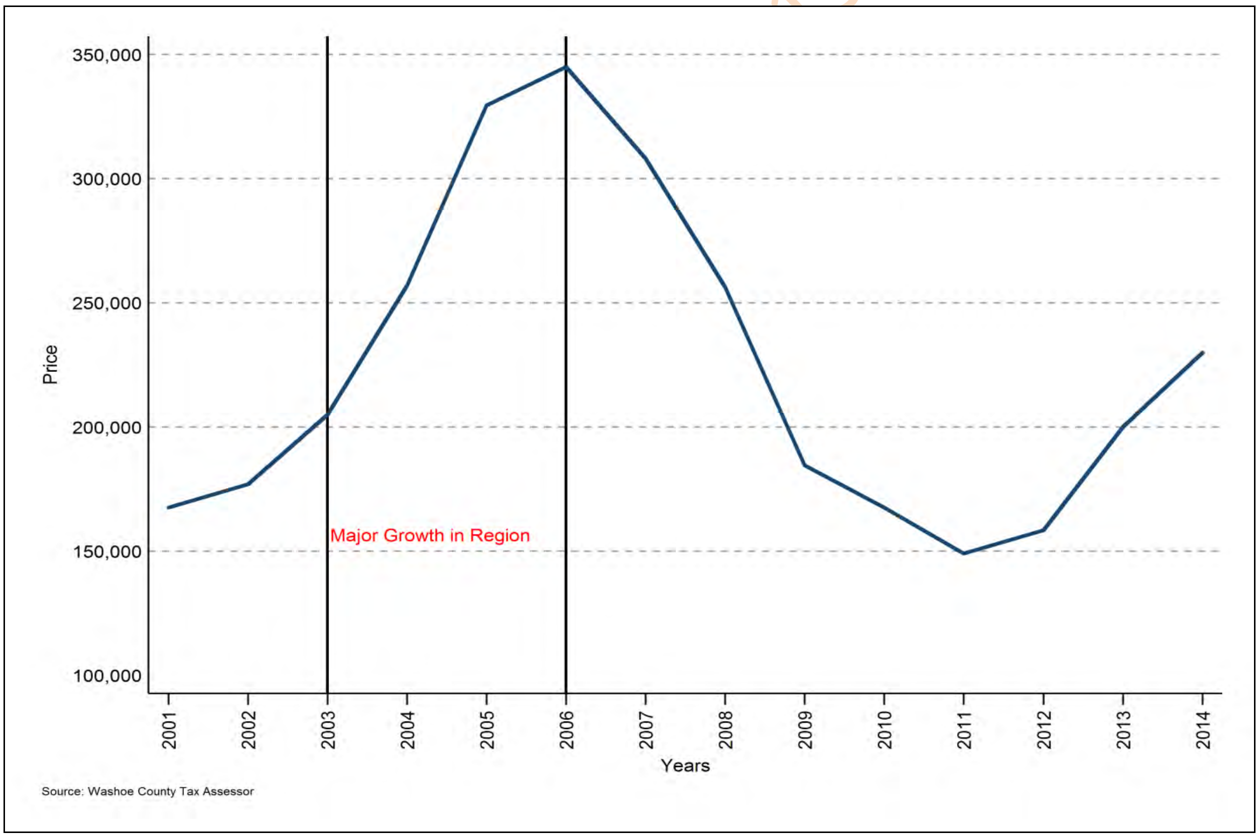


Figure 1-4. Median Housing Prices in Washoe County 2001 -2014

The ensuing credit crisis within the financial market signaled the start of a recession nation-wide. Economic conditions within the Reno MSA[8] had a significant downturn after the housing bubble crash of 2007/8. During the peak of the housing boom, the surge of immigration of people initially seeking lower home prices, relative to the national average, found increasing mortgage payments and little job opportunity after the decline. Declining income levels, a rapidly-contracting construction industry, and poor employment conditions in general, led to a dramatic drop in the number of employed persons within the Reno MSA. In 2006, approximately 223,000 people were employed; however by 2011 employment numbers had decreased to 189,000. The result was an unemployment rate that had jumped over 200 percent from a record low of 3.8 percent in 2006 to 12.6 percent in 2011.

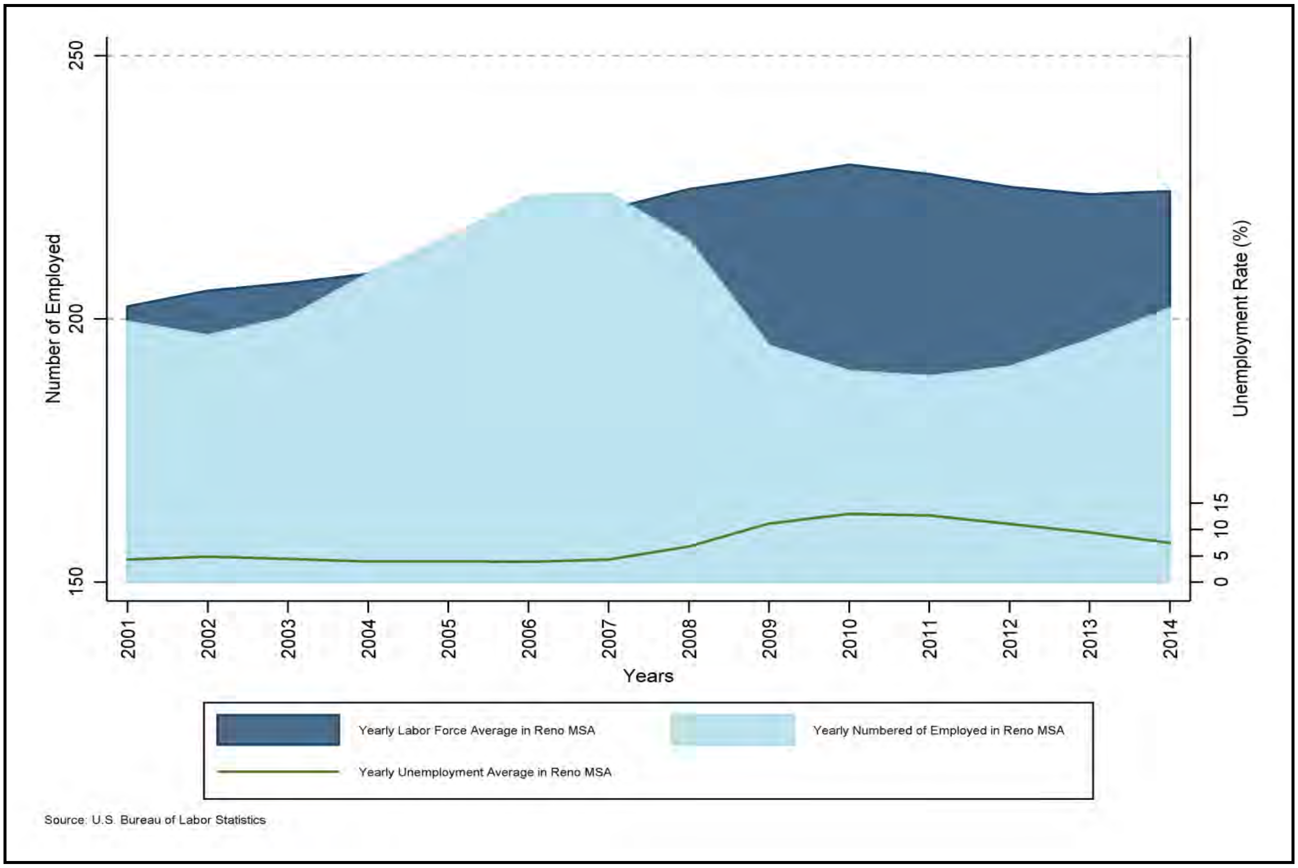


Figure 1-5. Employment Statistics in Reno MSA 2001 -2014

By 2012, indicators began to show signs of an economic recovery. Between 2010 and 2014 employment numbers rose 6 percent, and subsequently the rate of unemployment dropped from a unprecedented high of 13 percent in 2011 to 7.4 percent by 2014 (a rate only slightly higher than the average of 6.1 percent over the last 25 years). This increase in employment slowly began to raise the income levels within the Reno MSA. By 2012, per capita income had rebounded to $45,000 from $41,000 in 2010 (a gain of 9.7 percent), with the trend flattening over the next year.

[8] Reno Metropolitan Statistical Area ("MSA") includes employment from Washoe and Storey Counties.

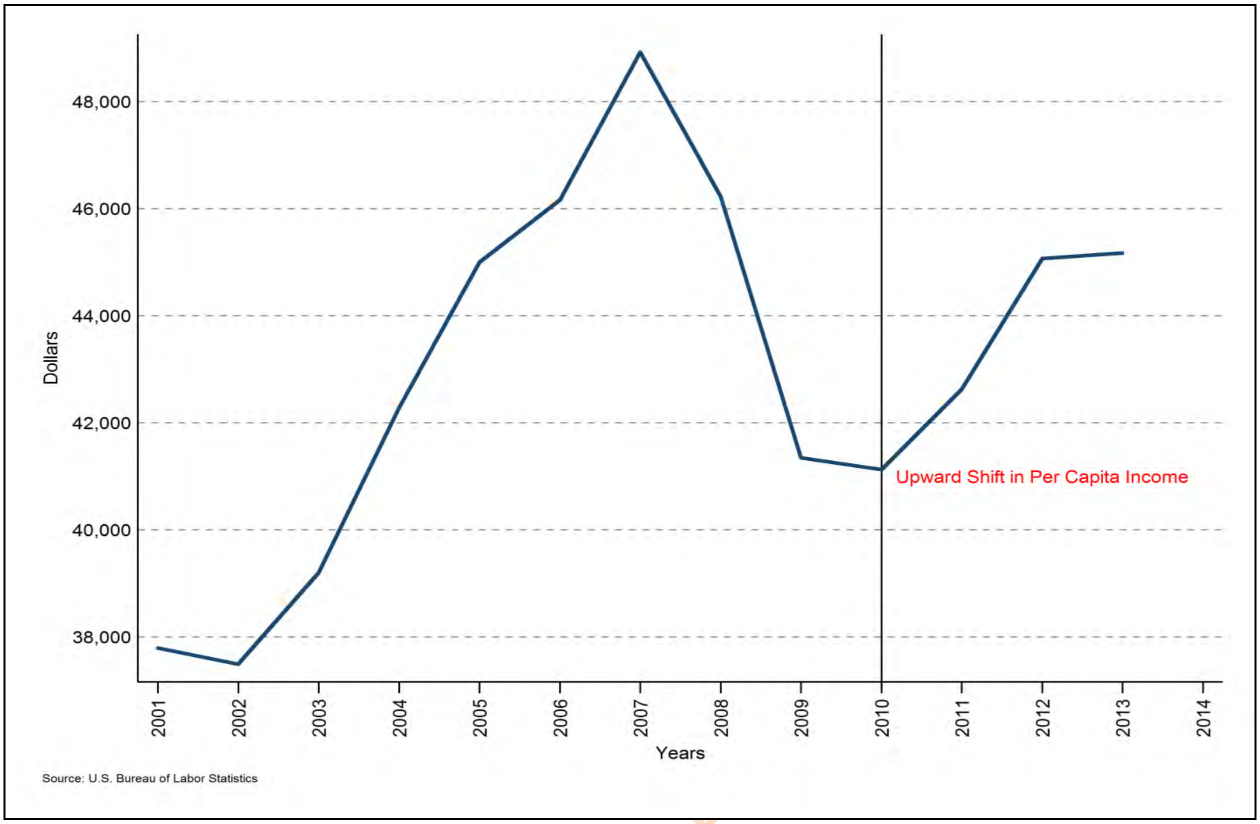


Figure 1-6. Per Capita Income Levels in Reno MSA 2001 -2013

Lagging behind the increase in level of income was home buying, which also exhibited a positive trend. Between 2011 and 2014 homeownership saw upward momentum as housing prices increased 37 percent during that period (see Figure 1-6). New residential housing hit a 10-year low in 2011 with only 538 housing permits issued. By 2014, housing permits issued had increased 4-fold to 2,192. Prior to 2003, the median number of will-serve commitments issued by TMWA was 1,300 acre feet/year ("AF/yr"). As the region experienced eight years' worth of development in a four year period (2002 to 2005), commitments more than doubled to 2,800 AF. Following the precipitous drop in new development activity beginning in late 2006, will-serve commitments reached a low point in 2010 (a level not seen since 1958) of 117 AF. Subsequently, as development began a modest rebound, will-serve commitments began to increase (see Figure 1-7).

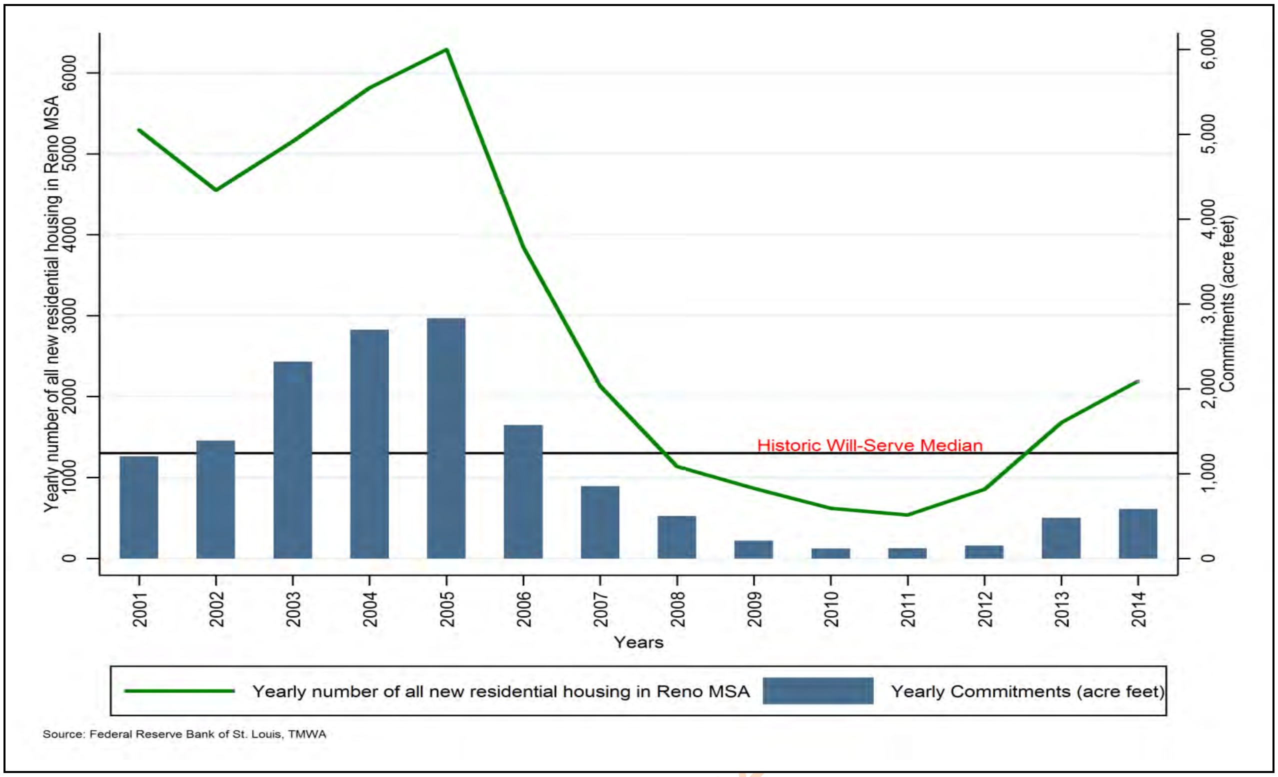


Figure 1-7. New Housing Permits and Annual Will-Serve Commitments 2001 -2014

Moving forward, based on the historic growth, the announcement of Tesla battery plant and other new projects, growth is likely to continue to be positive. It is projected the Reno MSA will see a 4.7 percent increase in employment between 2015 and 2019.[9] Given the relationship between economic growth, new housing development and home prices, as well as the price of water, it is expected that the price of water rights will increase - though at a much slower rate than previously experienced. Chapter 4 considers these trends and changes in employment leading to the development of revised population, dwelling unit and customer demand estimates for this 2035WRP.

Depending on the use of the land, commercial versus residential, and the resulting densities assigned to the land, the amount of water resources needed to meet this demand will vary. Analysis in Chapter 3 discusses the availability of Truckee River mainstem rights for future dedication to TMWA to support future will-serve commitments.

[9] Estimate based on report by the Economic Development Authority of Western Nevada http://edawn.org/.

TROA Implementation

Pursuant to the *Truckee-Carson-Pyramid Lake Water Rights Settlement Act*, Public Law No. 101-618 (Nov. 16, 1990), Title II, 104 Stat. 3289 (the "Settlement Act"), Congress directed the Secretary of the Interior to negotiate an operating agreement with Nevada and California (and other parties) which, among other things, would provide for a more flexible and coordinated operation of Lake Tahoe, Boca Reservoir, Prosser Creek Reservoir, Martis Reservoir and Stampede Reservoir, and if owners of affected storage rights agreed, Donner and Independence Lake, while at the same time satisfying the exercise of water rights in conformance with the Orr Ditch Decree. TROA is that operating agreement.

TROA provides for modified river and reservoir operations that result in multiple benefits for water users, including benefits related to endangered fish species (spawning fish flows), recreation (minimum water levels in reservoirs), and significant additional drought storage for TMWA. Implementation of TROA solidifies the interstate allocation of water between Nevada and California as provided for in the Settlement Act.

On September 6, 2008, TROA was signed by the five Mandatory Signatory Parties: PLPT, the U.S., California, Nevada and TMWA. The parties have completed all requirements to implement and make TROA effective. Once TROA becomes effective, a framework will be established which provides greater flexibility for river operations allowing parties to exchange water to accommodate emerging issues without injuring the water rights on which they rely, and perhaps avoid future regulatory uncertainties surrounding the use of the Truckee River. The following describes the various conditions of consequence precedent to implementing TROA that were completed since signing TROA in 2008, thus allowing TROA to be implemented:

- Publication of TROA in the Federal Register (December 5, 2008) and its promulgation as a regulation (final on January 5, 2009). Truckee-Carson Irrigation District ("TCID"), Churchill County and the City of Fallon have initiated litigation in the U.S. District Court challenging the regulation, including a challenge to the adequacy of the Final Environmental Impact Statement for the Operating Agreement.

- A motion to modify the Orr Ditch Decree was submitted to the Court in *United States v. Orr* Water *Ditch Company, et al*. for approval of modifications to the Orr Ditch Decree on November 17, 2008. On September 30, 2014, the Court entered an Order granting the Amended Motion to Modify, and an Order which amends the Orr Ditch Decree as requested in the Amended Motion.

- The U.S. and TMWA submitted a joint motion to the court in *United States v. Truckee River General Electric Company* to modify the Truckee River General Electric Decree on November 20, 2008. The Court entered an order modifying the Decree on December 22, 2008.

- On October 29, 2012, the California State Water Resources Control Board ("CSWRCB") issued Decision 1651 approving the petitions to change the water rights (petitions originally filed in 2004) for Boca Reservoir, Prosser Creek Reservoir, Stampede Reservoir, and Independence Lake. CSWRCB is awaiting confirmation that all items are complete before it issues final permits.

- Approval of changes to water rights in Nevada to allow TMWA to hold the consumptive use component of certain of its irrigation water rights in storage was approved by the Nevada State Engineer Order No. 6035 on March 19, 2010. On March 31, 2014, the Orr Ditch Court affirmed the State Engineer's decision.

- On September 30, 2014, the Orr Ditch Court made the determination that the Truckee River is fully appropriated and closed to new appropriations affirming the Nevada State Engineer's Ruling No. 4683 is final.
- In the fall of 2014 the PLPT filed the application and received the permit needed to allow water under Ruling No. 4683 to be stored in Truckee River reservoirs.
- Provision of 6,700 AF of water rights for water quality purposes under Section 1.E.4 of TROA was satisfied by RSW in August 2015.
- The last conditions, coincident with the provision of the 6,700 AF by RSW, were the final filings by PLPT and the State of California in California state court to dismiss the PLPT v. State of California case, and by the Mandatory Signatory Parties to TROA agreeing that there has been a final resolution of that certain action entitled U.S. v. TCID were completed.

Further discussion on the benefits of TROA is found in Chapter 3. Suffice to say, all conditions necessary for the implementation of TROA have been satisfied. The pendency of court challenges to actions required for TROA to enter into effect will not delay its entry into effect.

Water Resources During Drought Periods

The annual flow of water from the Truckee River system is dependent on the amount or size of the preceding years' snowpack which can be highly variable from year-to-year. Simply stated, the larger the snowpack the greater the Truckee River flows; conversely, the smaller the snowpack the smaller the Truckee River flows. Figure 1-8 illustrates this variability by comparing annual snowpack accumulations for the Truckee River Basin.

Beginning in 2012, snowpack accumulations have been near or below 50 percent of average. This 2035WRP comes as the region experienced its fourth consecutive year of exceptionally low-precipitation. Drought Situations[10] exist when there is inadequate natural flow in the Truckee River and there is not enough stored water in Lake Tahoe and/or Boca Reservoir to maintain required rates of flow to meet Floriston Rates, or the elevation of Lake Tahoe is projected to be less than half-a-foot above its natural rim on or before November 15 each year. Truckee River discharge data (1909 through present) and various tree-ring research efforts show drought periods can vary from a few years to as many as 8 to 10 years in duration.

[10] Pursuant to TROA: "**Drought Situation** means a situation under which it is determined by April 15, based on procedures set forth in Section 3.D, either there will not be sufficient **Floriston Rate Water** to maintain **Floriston Rates** through October 31, or the projected amount of **Lake Tahoe Floriston Rate Water** in Lake Tahoe, and including **Lake Tahoe Floriston Rate Water** in other **Truckee River Reservoirs** as if it were in Lake Tahoe, on or before the following November 15 will be equivalent to an elevation less than 6,223.5 feet Lake Tahoe Datum."

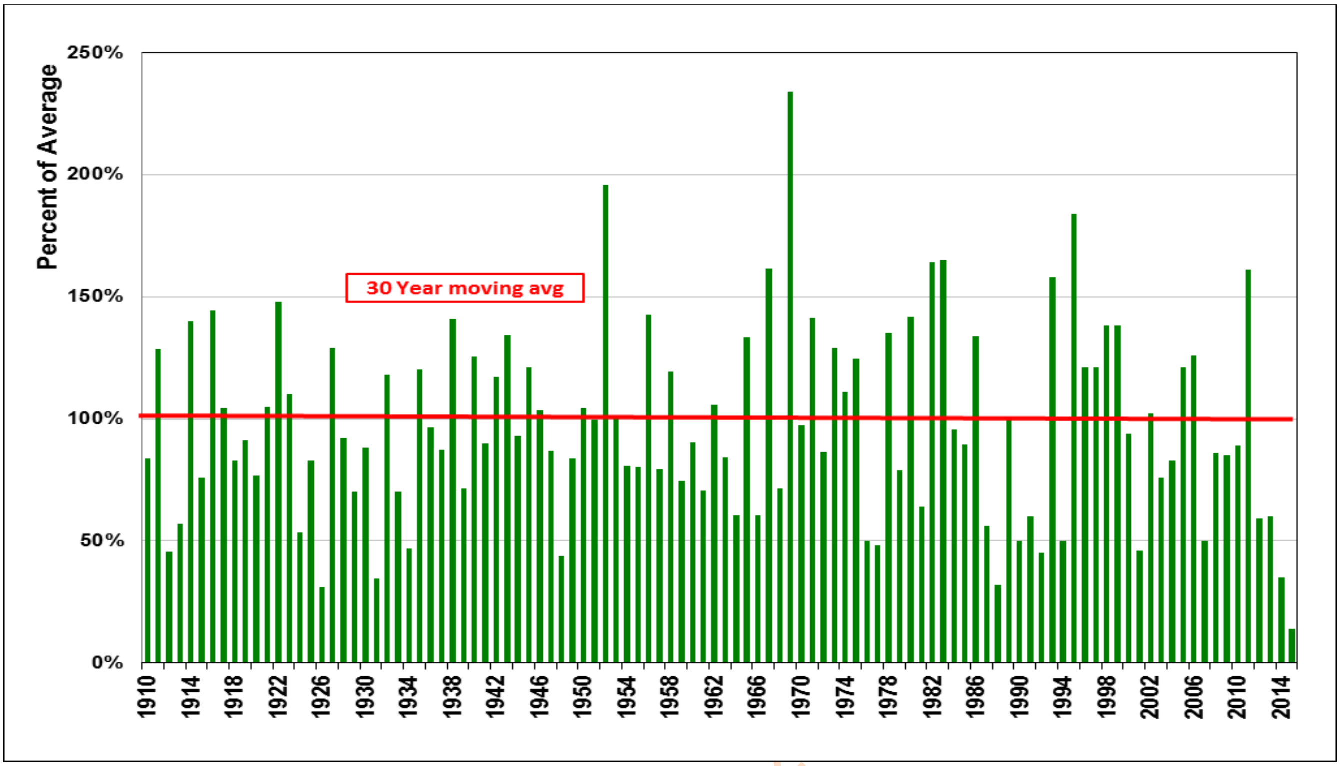


Figure 1-8. Snowpack Percent of 30-Year Moving Average

During the various drought periods, TMWA's drought reserves may not be impacted; Privately Owned Stored Water ("POSW") or drought reserves are only used to meet customer demand when the more critical dry years within the drought period are experienced. Based on past history it is not until at least the third dry or drought year in a row that upstream reserves may have to be used. In the 1987 through 1994 drought of record, only in the summer of 1991 and 1992 were upstream reserves required to meet demands. It is important to also note that the use of reserves has only occurred between the months of June and October, primarily during the irrigation season. In those years where Floriston Rates were not met through the irrigation season, by November flows in the Truckee River were once again sufficient enough to meet wintertime production needs. TMWA's current water planning is based on the hydrology of 1987-1994, the worst drought on record. In the current drought period, drought reserves were required to meet TMWA customer demands in both 2014 and more so in 2015. Although 2015 was the driest in the last 100 years with the lowest snowpack in recorded history, it cannot be stated with any certainty as to what the duration or direction the current drought period will take. This topic is discussed further in Chapters 2 and 3.

The core of TMWA's water supply for customers in the TRA is derived from the Truckee River. Consecutive years of low-precipitation in the Lake Tahoe and Truckee River basins produce dry conditions and drought periods in the TRA. The length of a drought period is solely a function of climatic/meteorological conditions, hydrologic drought conditions, and trends over a period of years. Determining a safe annual yield of available water resources during extended drought situations is the crux of this, and prior, water resource plans.

Summary

Water resource planning for the Truckee Meadows has become increasingly more complex in recent years and will continue to be more challenging as TMWA seeks to accommodate the region's current and future water supply needs. However, with the recent implementation of TROA, TMWA is better equipped to mitigate drought situations and expand its ability to generate larger volumes of upstream reserves. For example, in 2015, the lowest recorded snowpack and precipitation year of record, TMWA estimates it would have been able to add an additional 9,000 to 12,000 AF of reserves to its existing 27,000 AF of POSW it had accumulated by May 2015 (Chapter 3 discusses this further).

This chapter introduced some of the key issues facing the current and future development of water resources for the Truckee Meadows. The following chapters will take up other issues related to climate, source water reliability and sustainability, water right availability, water resource integration and conjunctive management of resources, demand-side management, and future supply opportunities. This 2035WRP relies and builds upon the information developed and contained in prior TMWA and various regional planning efforts. This 2035WRP plan will examine and analyze the water resource options available to TMWA to meet the water demands of its current and future customers. The plan outline is set forth as follows:

- "Key Findings and Recommendations" summarizes the significant findings of the 2035WRP and makes recommendations for further Board actions.
- Chapter 1, "Introduction", presents some of the key past and current trends and challenges that have shaped or are projected to shape the future of the greater Truckee Meadows region and the availability of water resources.
- Chapter 2, "Source Water Reliability", presents discussion of quality of surface and ground sources, source/loss risk analysis, and protection/response plans.
- Chapter 3, "Integrated Management of Water Resources", describes what water rights are currently available or used by TMWA and how those resources are conjunctively managed to annually produce a sufficient amount of water to meet TMWA's water service demands in non-drought and drought-situation years
- Chapter 4, "Population and Water Demand Projections", presents forecasts of population and water demands for the planning horizon.
- Chapter 5, "Water Conservation Plan", describes several conservation programs and measures that TMWA employs to reduce annual water use and minimize water waste in both non-drought and drought-situation years.
- Chapter 6, "Future Water Resources", identifies potential future water resources.
- Chapter 7, "Summary", compiles the issues outlined in the plan with some suggested direction for the future of water resources for the greater Truckee Meadows region.

CHAPTER 2 SOURCE WATER RELIABILITY

This chapter explores the reliability of TMWA's primary water sources in terms of both quantity and quality for municipal purposes. Key concerns with ensuring a perpetual and adequate water supply are weather variability and hydrologic droughts. The discussion explores weather related factors, such as climate change and drought periods, that can affect the availability of TMWA's water resources, and water quality issues that can affect long-term sustainability. The most imminent threats to the reliability of the water supply are weather and source contamination, both of which may affect the quantity and quality of available water supplies.

Weather Variability

Nevada is part of the Great Basin and for the most part is classified as a high desert climate. Few places in Nevada are as fortunate as the Truckee Meadows which has a river running through it, but that does not change the fact it is a desert with annual average rainfall of 7.5 inches per year. In essence, the region is in perpetual dry conditions interrupted by higher-than-average precipitation years, which make it difficult to delineate the beginning or end of a drought period including its duration.

Weather, particularly precipitation in the form of snowpack, is the primary determinant in establishing drought conditions and the availability of surface and groundwater supplies in the various hydrographic basins where TMWA provides service. Precipitation replenishes the reservoirs and aquifers from which water is extracted. While the weather pattern consistently provides precipitation during the winter and spring months, the type of precipitation (snow versus rain) and timing of snowmelt runoff can vary greatly from year to year. Simply stated, a larger snowpack produces greater Truckee River flows; conversely, the smaller the snowpack the smaller the flow in the Truckee River. Figure 2-1 compares annual snowpack accumulations to annual Truckee River flows.

TMWA manages for uncertainty of its water supply, in terms of the overall quantity and the timing of its delivery, through storage of water in upstream reservoirs and injection of treated surface water through its network of wells into aquifers in Lemmon Valley, Spanish Springs and Truckee Meadows. When river flows are available, TMWA manages its surface water resources through conjunctive use with groundwater supplies. This conjunctive use management maximizes use of surface water when it's available, thereby reducing groundwater pumping. This approach allows TMWA to meet demands with surface water, and to rest and recharge specific wells when enough surface water is available. TMWA continually assesses the potential reduction to source water supplies due to variability of weather conditions.

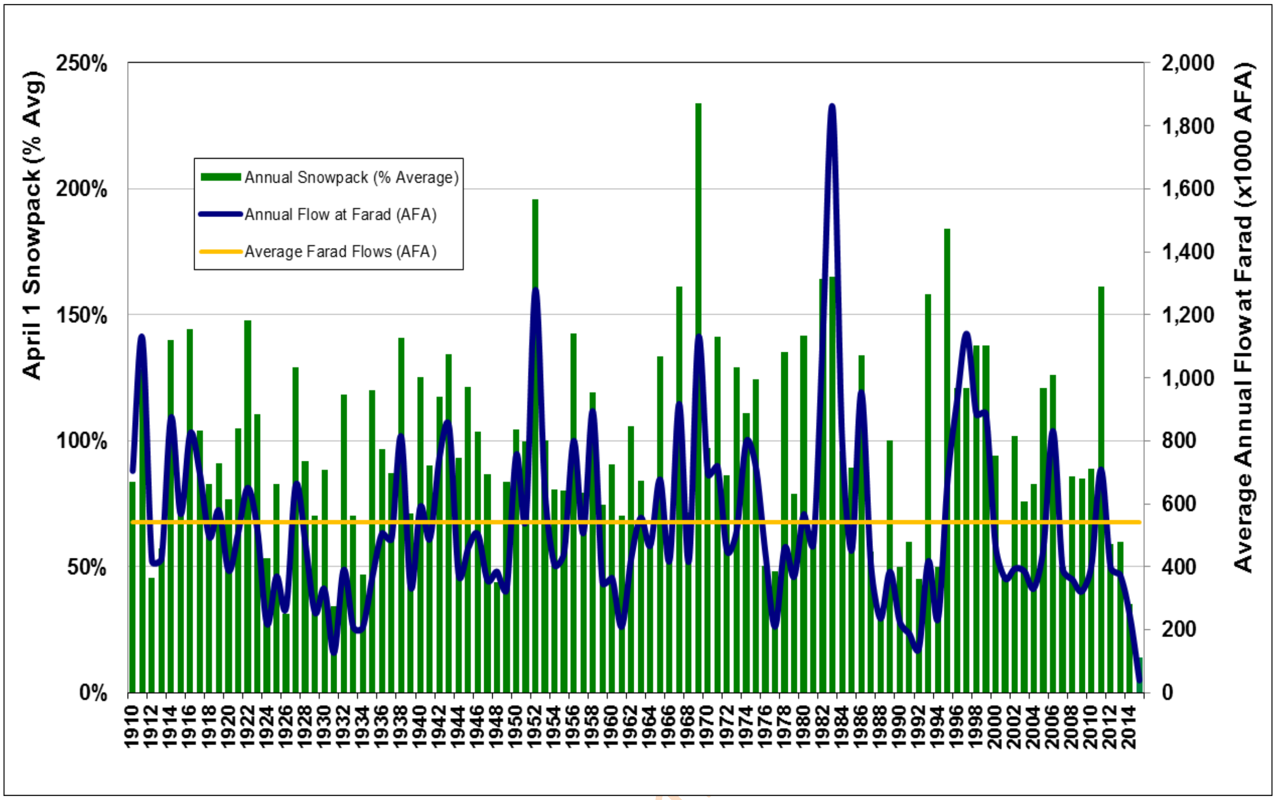


Figure 2-1. Annual Snowpack Percent vs Average and Annual Truckee River Flow at Floriston

Shortages in water resources due to seasonal weather variability can produce adverse environmental and economic conditions such as degradation of the land and the associated biologic ecosystem (i.e., stress to plants, animals, and habitat). Recent changes in the climate have been suggested as the culprit for the high degree of weather variability and deserve more attention as to the impacts to regional water resources. However, studies on the historic hydroclimatic conditions in the region reveal long periods with either extremely wet or dry conditions are common cyclical events when viewed from a much longer timeframe. In order to effectively manage for source water reliability given the uncertainty surrounding annual precipitation, such events and the frequency of their occurrence merit a close investigation.

For a better understanding of how water resources can be impacted from extreme variability in the Truckee River Basin's weather patterns, TMWA partnered with the Desert Research Institute ("DRI") in 2006 and 2009 to research the possibility of climate change and global warming affecting the Truckee Meadows' water supplies (see Appendix 2-1). The results of that research indicated, at the time the study was done, that historic hydrological records are the best data available for future planning and scientific evidence remains inconclusive as to the effect of climate change on drought conditions within the Truckee Meadows. Since there is a high variability in regional climate data, it has proven difficult to definitively detect long-term climate trends, i.e., some studies project the region becoming wetter while others project a progressively drier environment over time. Given this "noise" in the data and a divergence in the predictions under various climate change models, the 2009 research concluded that continued investigation on this topic is warranted.

In 2015, TMWA partnered with the University of Nevada, Reno ("UNR") to investigate recent advances in the research of climate change (see Appendix 2-2). The preliminary report indicates that, despite the advancements on climate change research, the debate regarding variation in weather patterns, greenhouse gas emissions, and extreme drought is still ongoing. In many cases simulated climatic projections do not line up with observational data over time. However, it is better established that from a century's worth of hydrologic records that the high variability in local seasonal river flows is driven, in large part, by oceanic and atmospheric oscillations. Moreover, to adequately evaluate current changes to the availability of water resources as well as the likelihood of future extreme hydrologic conditions, one must take a much broader perspective that incorporates long-term trends into projections. This approach requires hydroclimatic data that extends far beyond modern records. In particular, tree-ring sampling can be used to extend hydroclimatic records many centuries beyond modern records providing insight into long-term changes in the region's hydrologic conditions.

This point is underscored by the fact that the Lake Tahoe Basin has endured hydroclimatic episodes that persisted for much longer than experienced in modern times. For example, analysis conducted in 2011 on submerged trees in Fallen Leaf Lake revealed a drought that persisted for two centuries (between 1100 and 1200 A.D.). While mega-drought episodes in the area are rare, shorter periods of wet and dry are more common in the region. Figure 2-2 is a map showing the two basins (Truckee indicated by the lime polygon and Carson indicated by the purple polygon) and the location of the tree-ring chronologies (green dots) analyzed in the 2015 report[11]. The report reviewed a variety of tree-ring chronologies that analyzed tree-ring datasets covering multiple watersheds throughout California and Nevada. Further analysis of the data delineated those datasets where correlation within the tree-ring chronology exists between the Truckee and Carson River Basins and regions in the sample in order to construct a workable tree-ring chronology. The tree-ring samples provide an extension to the dataset on the hydrologic conditions of those watersheds as far back 1500 A.D.

The report finds evidence of many occurrences over the past 500 years of wet and dry periods that persisted for multiple years. Of the 211 wet and dry episodes during this period, the average lasted for 2.4 years, with the longest episodes being a 9-year wet period in the early 1980s (1978-1986), and two 8-year droughts in 1841-1848 and 1924-1931. These findings point to different hydrologic patterns emerging in the new millennium when compared to the entire length of record. For example, in the last century this region has experienced three of the strongest wet periods (out of a total of six) and two of the strongest dry periods (out of a total of four) out of the top 10 wet and dry cycles of the past 500 years. However, given the wide range in the spatial locations of the chronologies, the report recommends collecting more tree-ring data from sites located in the Truckee and Carson River watersheds to improve the quality of long-term hydroclimatic picture within TMWA's service area.

[11] Tree-ring chronology data was provided by the Contributors of the International Tree-Ring Data Bank.

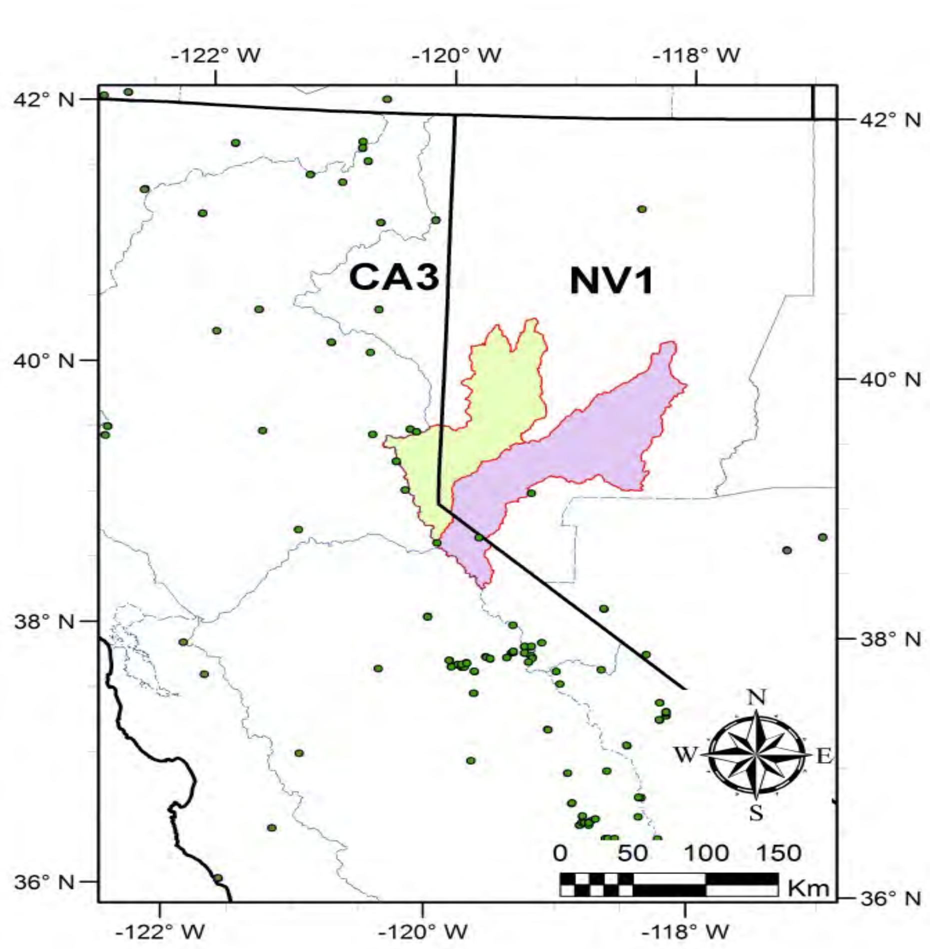


Figure 2-2. Location of Tree-ring Chronologies Used in the 2015 Report

The 2015 report provides evidence that the highly cyclical nature of both wet and dry episodes is not a new phenomenon. However, given that half of the strongest 10 episodes occurred in the last century, it would suggest variations in weather extremes are becoming stronger and more frequent. This high degree of variability between wet and dry weather patterns, coupled with a high degree of uncertainty regarding the duration of either event, makes managing for water source reliability particularly challenging. Management becomes a delicate balance between selling enough water in wet years to keep costs of service low, and ensuring adequate conservation of storage is achieved during periods of drought. In order to confidently manage for both potential conditions, TMWA ensures its reserves are such that they can meet service demands for extended periods of drought, meanwhile assessing snowpack and river flows annually in order to reevaluate management strategies should conditions worsen or improve. This continual reassessment of source water supplies and management tactics is the best defense against reservoir depletion as well as unnecessary economic stress to both the utility and customer base.

The winter snowpack is the primary source of water for TMWA's customers and allows replenishment of TMWA's upstream reservoirs. As the snowpack grows over the course of the winter, water is stored until the spring stream flow runoff period. In high-snowpack-years, this melting can provide stream flows well into the summer months. Given prolonged drought periods can occur in the region, DRI has been conducting cloud seeding in the Lake Tahoe and Truckee River Basins for more than 25 years. The purpose of cloud seeding technology is to enhance snowfall from storm events thereby increasing the overall snowpack in the Tahoe and Truckee Basins. DRI's cloud seeding program consists of three phases; 1) prepping the cloud seeding generators to distribute the seed when the proper storm presents itself; 2) applying seeding to the clouds of wintertime storms; and 3) analyzing the subsequent weather data during the cloud seeding periods to determine effectiveness. DRI's study estimates cloud seeding increases the precipitation rate by approximately 0.01 inches per hour. During the prior 18 seasons it has been estimated that the DRI state program yielded snow water increases ranging from 8,000 to 30,000 AF/yr, with an annual average of about 18,250 AF. For the 2014/15 winter season it was estimated the cloud seeding program increased the snow water by approximately 11,513 AF (See Appendix 2-3 for the complete report). However, while it cannot be estimated how much of the additional snowfall increases streamflow, groundwater recharge, or reservoir storage that would directly benefit TMWA and its customers, any increase in the snowpack can have a positive effect on the region's water supply.

Droughts

The State of Nevada defines drought as follows:

> "Drought is a complex physical and social phenomenon of widespread significance. Drought is not usually a statewide phenomenon; differing situations in the state make drought local or regional in focus. Despite all the problems droughts have caused, drought has proven difficult to define. There is no universally accepted definition because drought, unlike flood, is not a distinct event and drought is often the result of many complex factors acting on and interacting within the environment. Complicating the problem of a drought definition is the fact that drought often has neither a distinct beginning nor end. It is recognizable only after a period of time and, because a drought may be interrupted by short spells of one or more wet months, its termination is difficult to recognize. The most commonly used drought definitions are based on: 1) meteorological and/or climatological conditions, 2) agricultural problems, 3) hydrological conditions, 4) economic considerations and 5) induced drought problems. Each type of drought will vary in severity, but all are closely related and caused by lack of precipitation."[12]

The State of Nevada Drought Plan sets forth the State's definition for each of the five types of droughts. The role of a water purveyor is to secure reliable water resources to meet its customers' requirements, including mitigating the risks that droughts can impose on water

[12] State of Nevada Drought Plan, a report prepared in 2012 by the Drought Response Committee comprised of the State Climate Office, Division of Water Resources, and Division of Emergency Management under direction of the Governor. See Appendix 2-4 for full report.

resources. TMWA monitors meteorological[13], hydrological[14] and induced[15] droughts as these have direct effects on availability of surface water to water right holders along the Truckee River and availability of groundwater in hydrogeographic basins during low-precipitation years. TMWA's focus in water resource planning and management is in direct response to hydrologic and induced drought conditions. Depleted reservoir storage, both upstream and subsurface, has a direct impact on TMWA's water supplies during drought periods. Consecutive (three or more) years of low-precipitation in the Lake Tahoe and Truckee River Basins are likely to negatively impact the storage in both Lake Tahoe and Boca Reservoir. Three exceptionally dry years in a row (2012 to 2014) reduced upstream reservoir storage to a point where there was no water left to release into the Truckee River except for TMWA's drought reserves. The length of a drought period is solely a function of meteorological conditions over a period of years.

A good indicator of an impending dry-year water supply is snowpack accumulation. Measured on April 1 of each year, the water content of the snowpack is used to forecast the amount of water that will run off each spring to help fill upstream reservoirs and provide river flows through the year. Figure 2-3 shows snowpack for the Truckee River basin over the past 30 years.

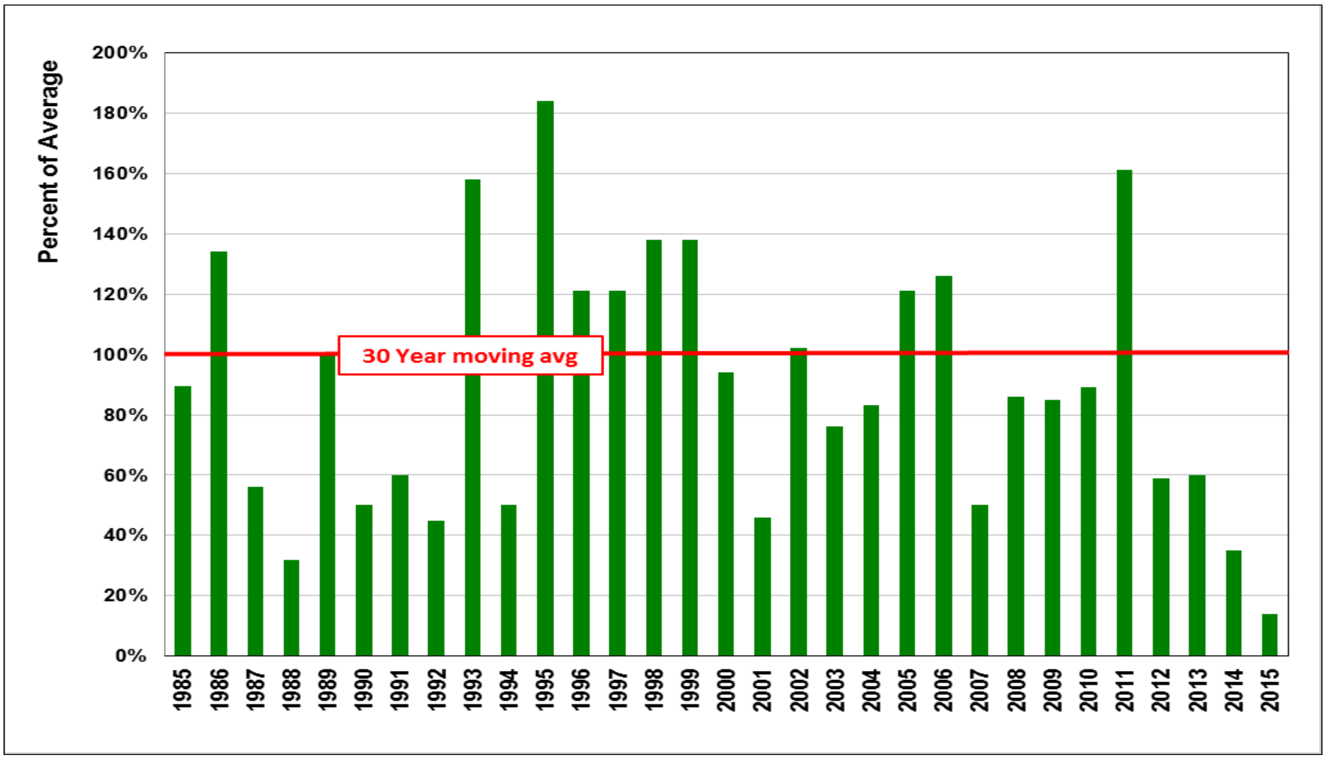


Figure 2-3. 1985 to 2015 April 1 Snowpack for the Truckee River Basin

[13] Meteorological drought is often defined by a period of well-below-normal precipitation. The commonly used definition of meteorological drought is an interval of time, generally of the order of months or years, during which the actual moisture supply at a given place consistently falls short of climatically appropriate moisture supply.
[14] Hydrologic drought refers to periods of below-normal streamflow and/or depleted reservoir storage.
[15] Induced drought is a condition of shortage which results from over-drafting of the normal water supply. The condition is aggravated by negative precipitation experience and below normal streamflow or aquifer recharge. An induced drought is brought about by introducing agricultural, recreational, industrial or residential consumptions into an area which cannot naturally support them.

The risk of continued drought conditions increases in lower-than-average-snowpack years. Although the focus of TMWA's supplies are Truckee River based, annual snowpack and precipitation accumulations in all basins where TMWA has resources is vitally important to support natural recharge to aquifers in those basins. Without consistent, sufficient precipitation in these basins, over-draft conditions may develop since domestic well owners and municipal providers must pump water year-in, year-out to meet demands. Issues affecting groundwater resources are discussed later in this chapter.

Since 1980, there have been four periods of varying degrees of hydrologic drought within the Truckee River system: 1987-1994 (8 years); 2001 to 2004 (4 years); 2007 to 2010 (4 years) and the current period of 2012-2015 (4 years). The past 30 years includes the 1987 to 1994 drought period which is considered the worst drought of record over the 106 years of recorded flows of the Truckee River. The severity of each drought's impact during those periods listed in the table is revealed by the quantity of upstream drought reserves (or POSW) that TMWA had to release during a particular year to meet customer demands.

Table 2-1. Loss of Floriston Rate and Use of POSW During Drought Periods Since 1980

	Year	Date Floriston not Met	Use of POSW	Year	Date Floriston not Met	Use of POSW	Year	Date Floriston not Met	Use of POSW	Year	Date Floriston not Met	Use of POSW
	-a-	---b---	---c---	-d-	---e---	---f---	-g-	---h---	---i---	-j-	---k---	---l---
1	1987		0	2000		0	2007		0	2012		0
2	1988	Aug 20	0	2001		0	2008	Nov 23	0	2013		0
3	1989		0	2002	Nov 28	0	2009	Oct 17	0	2014	Jul 29	4900
4	1990	Aug 26	0	2003	Dec 8	0	2010		0	2015	Apr 7	10,000
5	1991	Jul 26	3,100	2004	Sep 23	0						
6	1992	Jun 5	9,000			0						
7	1993	Sep 26	0									
8	1994		0									

Figure 2-4 compares the four most recent drought periods. The similarity between drought periods is evident with differences appearing in the length of the drought period and its impact on the level of Lake Tahoe.

1987 to 1994 Drought Period. During the 1987/1988 winter, it became apparent that runoff from the snowpack would be significantly below normal. By August 20 of 1988, the Floriston Rates could not be met and POSW was needed by late August to meet customer demands. By the end of August, emergency steps were taken by local government to curb water use to maintain carryover storage for 1989. Outside water use was limited to one-day-a-week in late August. A comparison of water use during the months of August through October 1987 to water use during the same period in 1988, revealed that drought actions reduced production by about 3,400 AF, or about 15 percent reduction. Precipitation through the 1988/1989 winter produced a 100 percent of average snowpack for the Truckee River Basin. Floriston rates were met throughout the 1989 irrigation season. Water supply conditions returned to below average in 1990. Local irrigation ditches were cut-off in late August due to low flows in the Truckee River. Lake Tahoe dropped below its natural rim in September 1990, resulting in no flow into the Truckee River. The winter of 1990/1991 was one of the lowest precipitation periods on record prior to March of 1991. Even with the unusually heavy March precipitation, the snowpack in the Truckee River Basin only measured 60 percent of average on April 1, 1991. Local irrigation ditches were cut-off July 26 when Floriston Rates could not be met.

During 1992, Floriston Rates could not be met after June 5 the earliest date on U.S. District Court Water Master's records up to that date; it was the worst year of the drought period with snowpack less than 50 percent of average and no outflow from Lake Tahoe. After utilizing 9,000 AF of Independence Lake water (POSW), 8,500 AF remained in drought storage at the end of 1992. The net depletion of Independence Lake was 6,000 AF during 1992. The snowpack in 1993 was over 150 percent of average. As a result of the heavy snowpack during the 1992/1993 winter, the elevation of Lake Tahoe increased significantly rising above its natural outlet elevation. Although 1993 was a significant improvement over 1991 and 1992, it was not enough to enable Tahoe to sustain Floriston rates. Floriston Rates were only met until September 26, 1993.

The 1994 snowpack in the Truckee Basin was just 50 percent of average on April 1. The elevation of Lake Tahoe stayed below its natural rim from the fall of 1993 through all of 1994. No releases were able to be made from Lake Tahoe in 1994.

The abundant snowfall of 1995 and subsequent runoff brought the elevation of Lake Tahoe back above its natural outlet elevation. Tahoe rose 6 feet in 1995, ending up four feet above its rim in July 2015. The significantly, above average 1995 snowpack year was reinforced by above-average snowfall in 1996 which effectively ended the 1987 to 1994 drought period. Total natural flows during the 1987 to 1994 water years were 83 percent of the total natural flows from 1929 to 1936 water years and thus, more severe than the previous design drought period of 1928 to 1935.

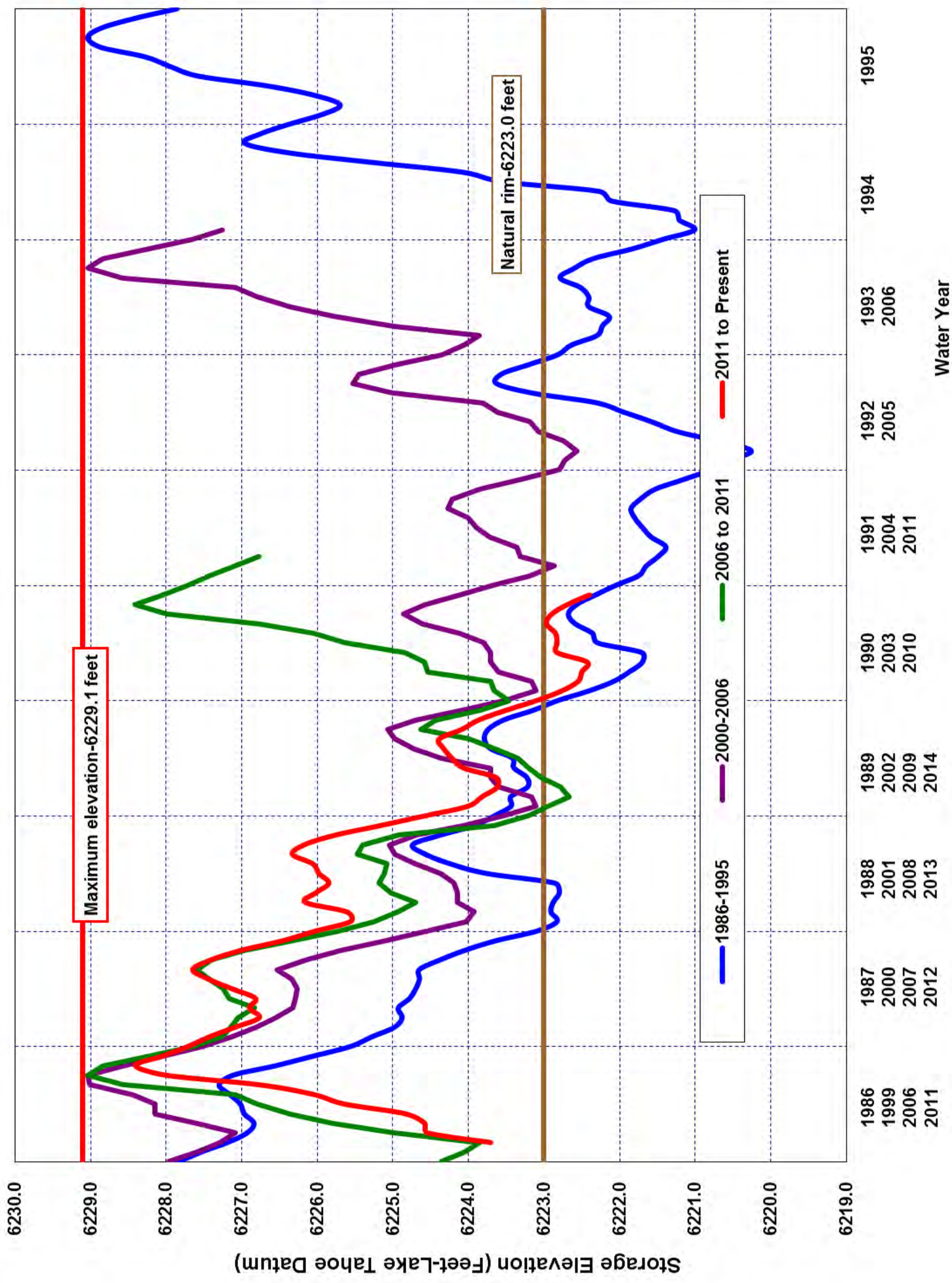


Figure 2-4. Lake Tahoe Elevations During Drought Periods

2000 to 2004 Drought Period. Reservoirs were full leading into the 2000/2001 snow season, but snowpack within the Truckee River Basin was below average in 2000 and continued that pattern again in 2001. While there was an improvement over 2001 in the amount of snowpack and runoff in 2002-2004, it was not enough to end the start of another drought period. Although TMWA did not need to utilize any POSW to meet customer demands during this drought period, the reduced water availability made it difficult to sustain the required Floriston Rates in December 2002 and again from late 2003 into early 2004. In September 2004 Floriston Rate storage was exhausted and normal-river flows were not met again until the end of February 2005 which ended up being a 125 percent of average snowpack year in the Truckee River Basin. Due to heavy precipitation and flooding in late December 2005/early January 2006 the elevation of Lake Tahoe rose significantly. In fact, almost 11 inches of precipitation was recorded at the United States Geological Survey ("USGS") Farad gauging station over a two week period (Dec 21, 2005 to Jan 3, 2006). An above average snowpack was recorded again (126 percent of average) in the Truckee River Basin in 2006. Lake Tahoe and all Truckee River Basin reservoirs filled as a result of the streamflow runoff that was produced the following spring. Those two consecutive above average snowpack years (2005 and 2006 respectively) effectively ended the 5-year drought period.

2007 to 2010 Drought Period. Although the phenomenal snowpack of 2006 refilled Lake Tahoe, the 2007 snowpack was 50 percent of average and turned out to be the start of another drought period. Snowpack in the Truckee Basin was 51, 86, 85, and 89 percent of average for the years 2007, 2008, 2009, and 2010, respectively. Lake Tahoe dropped below its natural rim in October 2008 but the snowpack of 2009 was a slight recovery year and did not impact TMWA reserves in 2009 or 2010. The 161 percent of average snowpack in 2011 was sufficient to nearly fill Lake Tahoe and end this brief drought period. TMWA's drought reserves were not impacted and were not required for use during this drought period.

2012 to Present Drought Period. This drought period followed on the heels of the 2007 to 2011 drought period recovery. Snowpack in the Truckee Basin was 59, 60, 35, and 13 percent of average for the years 2012, 2013, 2014, and 2015, respectively. The snowpack and runoff of 2015 ranked it as the worst year on record. Not since recordings began have there been four consecutive low-runoff years as severe as these four. On July 29, 2014 Floriston Rate water supplies were exhausted and TMWA had to release its drought reserves—POSW-- in August through September. The total amount of upstream reserve TMWA required in 2014 was 4,900 AF.

Due to the severe lack of the 2015 snowpack, Floriston Rate water supplies were exhausted on April 19, 2015. As natural river flows slowly diminished through May and June, the only ditch and diversions operating were TMWA's Highland Ditch that supplies the Chalk Bluff Water Treatment Plant ("CTP") and the Glendale Water Treatment Plant ("GTP") diversion. TMWA began releasing upstream reserves on June 18 and continued to do so through the month of October. TMWA began the summer season with approximately 29,000 AF in upstream storage and released approximately 10,000 AF to meet customer demands.

In all drought periods described above, it took at least three consecutive, low-snowpack years for Lake Tahoe to fall to its rim prior to November. By definition, the region continues in a Drought Situation and TMWA anticipates starting the 2016 irrigation season with approximately 22,000 AF of upstream storage. Should the 2015/2016 winter produce below average precipitation for a fifth year, the region will be in a Drought Situation which will impact TMWA's upstream reserves and could present an operational challenge for TMWA during Summer 2017 if the low-precipitation trend continues through the winter of 2016. As of this writing, it cannot be known with certainty whether the snow season of 2015/2016 will be a low or recovery snowpack year.

Important observations to be drawn from reviewing the historical Truckee River hydrology and drought periods include:

- Truckee River supplies are available the majority of the year under meteorologic and hydrologic drought situations.
- Donner and Independence Lakes typically fill each spring under meteorologic and hydrologic drought situations.
- Drought periods vary in duration, from a few years up to 8 years based on recorded history.
- Truckee River water sources used to provide Floriston Rates diminish early in the late spring and/or summer of extreme, low-precipitation years.
- Water levels in the reservoirs, particularly Lake Tahoe, are depleted gradually over 3 to 4 years, but can refill rapidly ending a hydrologic drought period.
- "Recovery" or high-precipitation years may not end a drought period but do interrupt the drought period, helping replenish reserves and/or producing sufficient Truckee River flows for the following year and negating the need to use upstream reserves.
- Use of upstream reserves may not be necessary in every drought period; only in the extreme, low-snowpack years of a drought period does TMWA use its upstream reserves.

Climate change and drought are the most significant weather variables with potential to change the quantity and quality of the water supply. Studies completed by DRI indicate that while the potential for climate change to alter the timing, type of, and quantity of precipitation is possible, continued monitoring of meteorologic trends is required. Drought periods on the other hand have established historical patterns, with the most severe drought on record lasting eight years. TMWA plans for drought periods by utilizing a combination of natural river flows, groundwater pumping, POSW releases, and extraction of accumulated groundwater injections. Chapter 3 discusses the conjunctive management by TMWA of its available water resources -- annual river supplies, POSW in upstream lakes and reservoirs, credit water stored in Boca and Stampede Reservoirs under TROA operations, additional groundwater pumping, and artificial recharge – in order to meet customer demands through the worst drought on record.

Source Water Contamination

This section begins with an overview of TMWA's water quality and identified potential risks of water supply contamination, and summarizes TMWA's Source Water Protection Program.

As detailed within the *2015 Water Quality Reports*, which can be found on TMWA.com, TMWA continues to provide high quality water that meets and exceeds all U.S. Safe Drinking Water Act ("SDWA") standards. In addition, TMWA's water meets and, in most cases is significantly better than, all U.S. Environmental Protection Agency ("USEPA") and Nevada State Health standards. On average, more than 1,200 laboratory tests are performed each month on over 210 samples taken from various locations in Reno, Sparks and Washoe County to ensure that TMWA's water meets all standards. In addition, TMWA takes samples from numerous locations in the distribution system on a monthly basis to continually demonstrate full compliance with the arsenic standard put into effect in January 2006 by the USEPA.

TMWA Source Water Quality Assurance Program

TMWA's water quality goal is the delivery of high quality potable water to its customers at a reasonable price. In order to achieve and maintain this goal, TMWA utilizes a water quality assurance program. TMWA utilizes the following components in its water quality assurance program:

- Protection of Source Water Quality: TMWA has a fully integrated and coordinated source water quality program designed to protect or improve the quality of TMWA's surface water and groundwater supplies.
- Potable Water Treatment: TMWA utilizes modern treatment facilities for its raw-surface-water and groundwater supplies and complies with all Federal and State drinking water regulations.
- Maintenance of Distribution System Water Quality: TMWA utilizes a highly skilled staff of scientists, engineers and operators who continually monitor water quality in the distribution system.
- Cross Connection Control: TMWA has an extensive and fully engaged backflow prevention and cross-connection control program. The purpose of the program is to prevent backflow of pollutants or contaminants from customer plumbing systems into TMWA's distribution system.

The water quality of the Truckee River is normally excellent. Surface water is of exceptional quality because base flows originate from Sierra Nevada Mountain snowpack runoff and seepage or spring flow. Typical water quality data are shown in Table 2-2. Mineral concentrations are very low, and turbidity levels are typically less than two nephelometric turbidity units ("NTU"). However, water in the Truckee River can have higher turbidity because of storm runoff and/or algae growth associated with low flows and warm temperatures in summer.

Table 2-2. Typical Mineral Concentrations of Surface Water

Constituent	Minimum	Average	Maximum
Total dissolved solids, mg/l	34	86	132
Total suspended solids, mg/l	1	13	20,000*
PH	6.8	7.7	9.6
Temperature, C	0.5	0.0	20.0

* High turbidity events only, such as the July 1992 flash flood on Gray Creek.

The reliability of this source is governed by the ability of TMWA's surface-water-treatment facilities to treat Truckee River water during possible events of high turbidity or chemical or biological contamination. Three types of contamination events are identified:

1. Turbidity events[16] – normally low frequency events that are usually flushed by river flows within hours.
2. Non-persistent toxic spills – spills of substances that would be flushed by river flows, usually within an 8 hour period.
3. Persistent toxic spills - spills lasting more than 2-4 days that do not flush through the river channel.

Higher than average turbidity events can occur in the Truckee River during periods of floods, storm runoff and/or algae growth associated with low flows and warm temperatures in summer. Turbidity at conventional filtration plants is removed through chemical stabilization (coagulation and flocculation), followed by sedimentation and filtration. All surface water is treated at the CTP or the GTP before distribution. The modern treatment facilities at CTP and GTP have greatly reduced the water supply risks associated with turbidity events. Both CTP and GTP are designed to operate during intermittent turbidity events as high as 4,100 NTU lasting 5-10 days, but it is typically more practical to shut the plants down and let the most turbid water pass by to avoid significant clean-up efforts and costs at the treatment plants. Should a turbidity event that exceeds TMWA's ability to treat the water to required standards occur, it is possible to operate the system with only wells to supply an average day demand, more than sufficient to meet current indoor or winter daily demands of approximately 35-39 million gallons per day ("MGD").

Few toxic spills have occurred on the Truckee River and none were of major proportion. The most recent event was a sewage spill near Squaw Valley, California which occurred in the spring of 2015. The spill was diluted 1000:1 by the flow within the Truckee River; no noticeable impact was seen at either CTP or GTP. Major toxic spills that would render the Truckee River unusable have not been recorded. However, toxic spills into rivers throughout the United States do occur, such as the recent Gold King mine spill into the Animas River in Colorado. Some of the toxic spills have rendered water supplies unusable for an extended period of time. In the

[16] The term "turbid" or "turbidity" is applied to waters containing suspended matter that interferes with the passage of light through water.

event of an incident on the Truckee River, the contaminant might be diluted and washed downstream within a day depending on the flow rate in the river at the time. TMWA might be able increase river flows through release of its stored water. These steps are likely to mitigate any contaminant that does not readily absorb into the river bed.

Past resource plans and a review of United States Department of Transportation data, resulted in the identification of several types of hazardous materials which are commonly carried through the Truckee River Watershed. They include:

Ammonia perchlorate	Hydrogen sulfide	White phosphorous
Anhydrous Ammonia	Nitro cellulose (wet)	Propargyl alcohol
Chlorine	Propane	Sulfuric Acid
Cyanide	Petroleum naphtha	Sodium hydroxide
Hydrochloric acid	Phosphoric acid	

These chemicals represent ingredients used in the formation of products ranging from rocket fuel to pesticides. Although most are extremely toxic it is likely that they would be flushed past TMWA's treatment plant intakes within one day. Chemicals that would likely adhere to the river bed include manufactured pesticides, herbicides, and fungicides. Each chemical would require a specific response depending on location, duration and other factors of the water quality emergency. In the event of a spill, it is possible to operate off of distribution storage and wells while the water quality emergency is being assessed.

In 2007 research was completed at the University of Nevada, Reno on behalf of TMWA (see Appendix 2-5) to quantify the risk of a spill to the Truckee River using data that was previously not available. The analysis has shown no recorded contamination event from rail or highway transportation. The data also suggests that accidents tend to occur more frequently during the loading and unloading of trucks and rail cars. This suggests that the area of highest risk is downstream of TMWA's treatment facilities in the City of Sparks where there is a rail yard and a large number of warehouses and shipping companies.

Also completed by the University of Nevada, Reno in 2008 was a risk analysis and assessment accompanied by the development of a contaminant transport model of the Truckee River from Tahoe City to the GTP. The results of this research are provided in Appendix 2-6 and include travel times for various classes of chemicals at different flow rates. The model is used to quantify the time periods required for the river to flush clear a spill from different possible locations.

While a toxic spill into the Truckee River is clearly a concern, this is an extremely rare event and such an event has not occurred to this date. However, depending upon the time of year, TMWA is able to operate without the river for a period of hours to days using system distribution storage and its production wells. A detailed plan cannot be developed for a major emergency on the Truckee River that would anticipate all possible combinations of circumstances requiring emergency actions. Variables include location, size, and type of spill; time of year; levels of reservoirs and streams; customer demands; and other factors. The supply of water available from TMWA's production wells enables TMWA to meet demands for average indoor water use throughout the year. The merger and integration of WDWR and STMGID water systems into TMWA has resulted in additional interconnections with adjacent water systems. These water systems, located within South Truckee Meadows, Hidden Valley, Spanish Springs and Lemmon Valley, rely on groundwater wells and provide an increased source of off-river supply during an extreme event and/or extended river outage. The merger and integration of the WDWR water systems also brings additional off-river resources and facilities to TMWA, including Thomas, Whites and Galena Creek water resources, the Longley Lane groundwater treatment plant, and the North Valleys Importation Project ("NVIP").

In addition to relying on its wells, other steps to reduce water use during an extreme event and/or extended river outage could include:

- Call for voluntary, then mandatory, water conservation including watering restrictions (e.g., once per week during summer months or no outside watering), reduced laundry at commercial properties, use of paper plates in restaurants, no use of potable water for non-potable purposes, and other measures.
- Engage all wells on the TMWA system for full operation subject to Health Department approval. This would include the use of wells that do not meet drinking water standards and do not pose an acute health risk.
- Modify flows in the Truckee River to either flush, dilute, or isolate the contaminant.
- Utilize extraordinary treatment processes in the pre-treatment section of the water plants. An example of this might be neutralizing pH through chemical additions in the pre-settling basins or addition of granular-activated carbon in the treatment process. The likelihood of these steps being successful will depend on the type of contaminant and its concentration.
- Where possible, utilize and expand emergency interconnections with other water systems.
- Acquire the use of all water in local irrigation ponds, recreational lakes, etc., to the extent that water can be conveyed to the TMWA's treatment plants through ditches or other means.
- Use isolated portions of the storm drain system and ditch system for conveying water from unusual source locations to the water treatment plants. This might include installing sandbag check dams in certain ditches, along with low-head pumps, in order to move water up-gradient in a ditch to a treatment plant. For example, the creeks in the South Truckee Meadows might be conveyed to the GTP by collecting the water in Steamboat Creek, pumping it into Pioneer Ditch, and thence through step pumping to Glendale.
- Temporarily pump the discharge from the Sparks Marina to the GTP.
- When TROA is in effect utilize the emergency worse than worst case water supply to flush the river of contaminants.

Besides the types of spill events described above, there may be other events that interfere with the availability of Truckee River water. For example, in April 2008 an earthquake triggered a rock slide destroying a 200-foot ("ft") section of flume along the Highland Ditch in the Mogul area. This incapacitated the primary raw water supply for CTP just as customer demands were increasing with the onset of springtime temperatures. Raw water supply to CTP was quickly restored (that same day) via the Orr Ditch Pump Station ("ODPS") at a limited capacity of about

60 MGD, but more supply was required. The GTP was brought on-line early in order to help meet those increasing customer demands. Within a few weeks a temporary pumping station along the river was also set up to provide enough raw water in order for CTP to resume operating at its full capacity of 83 MGD. By July the damaged section of flume was bypassed with a 54-inch aboveground high density polyethylene pipe and gravity flow from the river to CTP was restored at a limited capacity of about 26 MGD. The ODPS was used to supplement the additional 57 MGD or so that the CTP required to operate at full capacity. The earthquake event fast-tracked the Mogul Bypass Project with approximately 8,400-ft of 69-inch steel pipe placed underground along with over 5,850 feet of reinforced concrete boxes to enclose the Highland Canal.

Though it cannot be predicted when a river interruption event will occur or what the nature of an event will be, TMWA plans for and practices scenarios to manage through emergency events. The more extraordinary measures that can be engaged are believed to only apply in an extreme, worse-than-historic event that would occur in the peak of the summertime irrigation with contamination occurring between Boca and the diversion point of the Steamboat Ditch. Most combinations of scenarios as to time, place, and nature of event are manageable with existing production facilities and management options without such drastic measures. It must be emphasized that these are broad guidelines only. They are not intended as a definitive instruction list as to the response which should be taken in any given emergency situation. The event, if it occurs, must be evaluated on its specific conditions, and a response plan devised accordingly.

Source Water Protection Program

Surface Water. With the exception of the Thomas, Whites and Galena Creek resources acquired from the merger of WDWR and STMGID water systems and a small appropriated water right from Hunter Creek, all of TMWA's surface water rights used for municipal water supply come from the Truckee River. Attitudes have changed over the years and today the Truckee River, its tributaries, and watershed are recognized as a pristine, high quality water source that must be maintained and protected. Several governmental agencies[17] are charged with protecting the Truckee River and its watershed. All of the local agencies derive their authority from the Clean Water Act and the USEPA.

In support of Truckee River source water protection and TMWA's reliance on the Truckee River for most of its water supply, the Truckee River Fund ("The Fund") was established by TMWA in 2005. The Fund is used to support projects that protect and enhance water quality or resources of the Truckee River, or its watershed. In addition, the Fund provides TMWA a vehicle for not only responding to the numerous requests from outside groups and

[17] The Tahoe Regional Planning Agency ("TRPA") is a bi-state planning agency authorized by Federal Government. Its goal is to ensure that anthropogenic activities, including new development, do not degrade the quality of Lake Tahoe, its tributaries, or watershed. Standards are strictly enforced by TRPA to minimize sediment and nutrient loading to the lake, and TMWA certainly benefits from this enforcement and its programs. In California, the Lahontan Regional Water Quality Control Board enforces water quality standards on the Truckee River and tributaries outside of the Tahoe Basin. This Board derives its authority from the federal government and the Clean Water Act. The Nevada Division of Environment Protection ("NDEP"), under authority derived by the Clean Water Act, has a mission to preserve and enhance the environment of the state in order to protect public health, sustain healthy ecosystems, and contribute to a vibrant economy.

organizations that are involved in promoting and improving the health of the Truckee River system and watershed, but a means to encourage matching funds for the projects. Participation in these projects benefits the primary water source for the community and, in the long-run, TMWA customers. The Fund's Advisory Committee reviews potential new project proposals typically twice a year.

To-date the Fund has approved and funded 126 diverse projects that further the Fund's goals. Examples include river riparian cleanup and restoration, aquatic invasive species inspections and removal efforts, planning and reconstruction of the Pioneer Dam, Independence Lake Forest and Wildfire Management Plan, and many others completed or underway listed at www.truckeeriverfund.org.

Groundwater. Groundwater protection is an important element of the water quality assurance program. Summaries of the groundwater water quality and quantity conditions in each hydrographic basin where TMWA groundwater production wells are located can be found in Appendix 2-7. Each summary includes a brief history of the basin, the number of production and domestic wells within each basin, the history of groundwater pumping, the water level history and response to groundwater pumping, and the challenges that TMWA is addressing or may need to address related to groundwater quality and quantity issues.

The basin summaries identify potential threats to groundwater quality. TMWA, WDWR, Reno, Sparks, Washoe County, and the NDEP are monitoring and managing these threats. Figure 2-5 depicts rough outlines of the extent and nature of some of the current threats to groundwater.

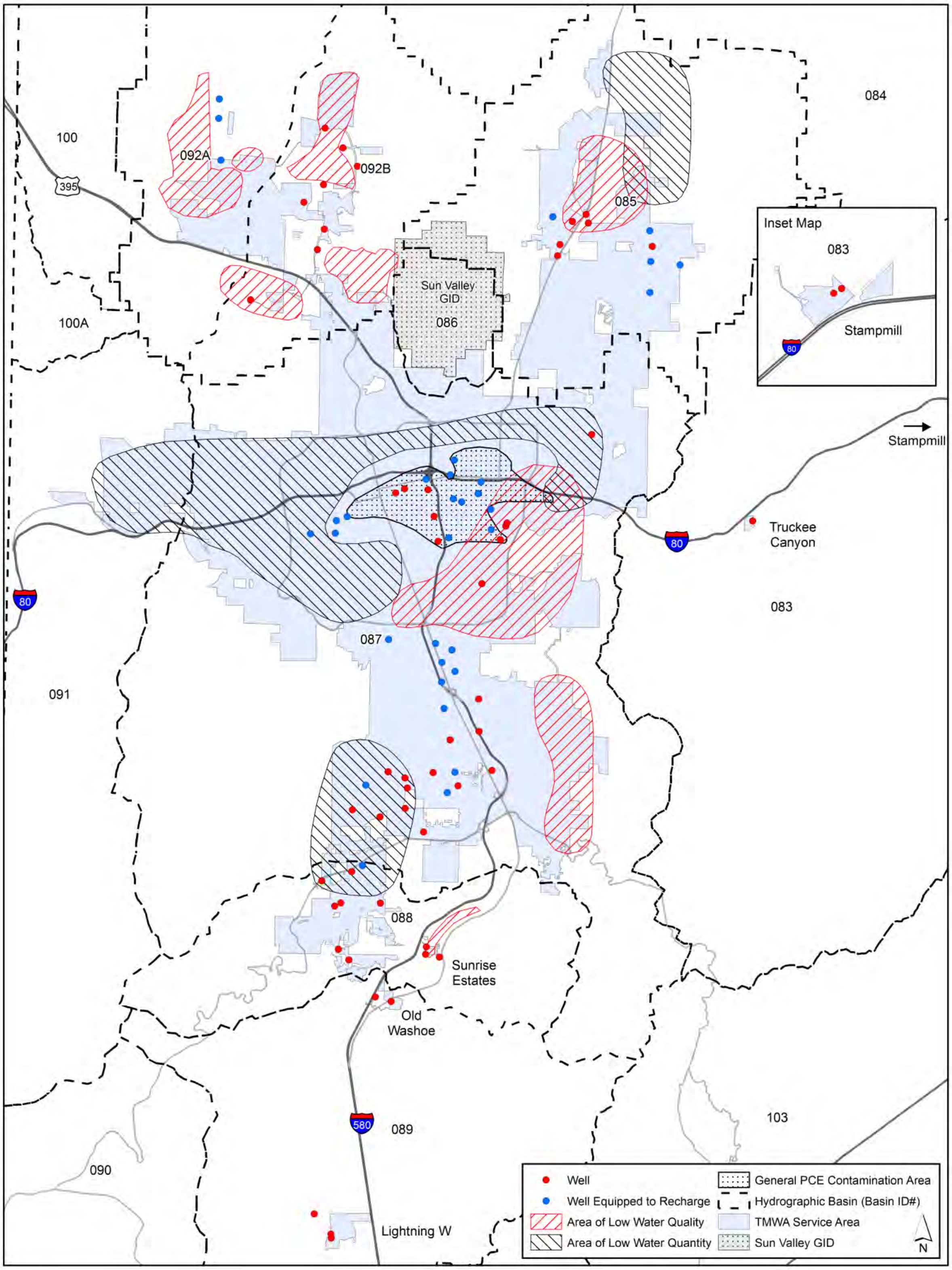


Figure 2-5. Production and Recharge Wells and Areas of Water Quality Concern

In 1986, amendments to the SDWA mandated that each state develop a Wellhead Protection Program ("WHPP") for the purpose of protecting groundwater that serves as a source for public drinking water supplies. The driving philosophy behind these efforts is that the cost of *cleaning up* contamination far exceeds that of *preventing* contamination.

In 1996, the first WHPP was completed for the Hidden Valley system and endorsed by the NDEP. Additional WHPPs were completed in 1998 (STMGID), 2000 (Lemmon Valley), 2005 (Mt. Rose), and 2008 (Spanish Springs) and were endorsed by the NDEP. The first WHPP TMWA completed was in 2005 and was endorsed by NDEP. Groundwater protection has received even more emphasis with the 2015 update and integration of the previously-endorsed TMWA WHPP and the former WDWR and STMGID WHPPs into one unified groundwater protection plan. TMWA's 2015 WHPP is a comprehensive action plan to protect aquifers and TMWA's production wells from further sources of contamination.

Through a concerted effort, TMWA has incorporated USEPA and NDEP suggested elements of a comprehensive 2015 WHPP by:

a. Coordinating and actively engaging with a team of local participants, including water quality experts and regulators from Washoe County Health District ("WCHD"), Reno, and Sparks jurisdictions.

b. Updating five groundwater flow models through 2014 for each of the major basins where TMWA operates groundwater wells: West Lemmon Valley ("WLV"), East Lemmon Valley ("ELV"), Spanish Springs Valley ("SSV"), North Truckee Meadows, and South Truckee Meadows.

c. Utilizing these updated models to develop 2-, 5-, 10-, and 20-year travel times and capture zones for each of the active groundwater wells that TMWA operates. These capture zones help identify where water that ultimately reaches a well comes from over a certain period of time.

d. Performing exhaustive database and records searches with the USEPA, NDEP, WCHD, and other sources to develop an inventory of active and Potential Contaminant Sources ("PCSs") in these basins that may pose a threat to groundwater quality.

e. Overlaying the capture zones and the PCSs to better assess threats to groundwater quality at each well.

f. Developing management strategies for the identified and potential contaminant sources.

g. Planning for the location of new wells.

h. Developing contingency plans to address potential contamination events.

The WHPP is an active tool used by TMWA for the coordinated protection of public drinking water resources. The WHPP provides information by which TMWA can develop and implement groundwater protection strategies, including educational outreach. The WHPP is operated voluntarily, under local jurisdiction and control, and utilizes both USEPA and NDEP guidance and criteria to provide for State endorsement. TMWA's recently completed 2015 WHPP is available for review in Appendix 2-8 and will be submitted to the State for endorsement.

TMWA's current overall groundwater protection action plan (which incorporates specific wellhead protection items) is fully integrated with other local agencies and includes the following elements:

A. Actively implementing the comprehensive WHPP.

B. Updating the WHPP regularly to identify and manage new PCSs.

C. Actively observing over 100 monitoring wells located within the North Truckee Meadows, South Truckee Meadows, WLV and ELV, SSV, Pleasant Valley, Washoe Valley, and Vidler. These monitoring wells are owned by TMWA, the Central Truckee Meadows Remediation District ("CTMRD"), and several privately-owned domestic well owners. TMWA monitors water levels in these wells on a monthly to quarterly basis.

D. Coordinating with the CTMRD for sampling and analysis of a number of monitoring wells for organic constituents in the North Truckee Meadows. The results of this testing, along with additional sampling and testing of production wells by TMWA and the CTMRD, allows TMWA to be proactive in joint groundwater remediation efforts and to prudently plan the location of future wells and groundwater treatment facilities.

E. Collecting and analyzing water quality samples at monitoring wells in SSV and Vidler on an annual basis to assess trends in groundwater quality in these areas.

F. Working closely with agency partners to determine the short and long-term impact of septic effluent to groundwater quality in basins throughout Washoe County where groundwater is relied on for drinking water supply.

The need to protect source waters gathered momentum when in 1987 TMWA's predecessor, Sierra, identified the presence of the organic solvent tetrachloroethylene ("PCE") in some of their production wells. This solvent has been used since the 1930's in a variety of commercial/industrial operations such as commercial dry cleaning, paint manufacturing, and auto repair.

In the mid-1990's and 2000's, TMWA implemented groundwater treatment at a number of wells which had become contaminated from PCE. Shortly after treatment was implemented, local governmental entities created the CTMRD to provide administration to the PCE clean-up effort and to collect funds necessary for the construction, operation and maintenance of the treatment facilities.

The PCE contamination occurs in eight plumes located along the current and historical commercial/industrial corridors along old U.S. 40 (Fourth Street/B Street/Prater Way), Virginia Street, and Kietzke Lane. Mitigation of the legacy (the responsible parties are unknown) PCE contamination is managed by the CTMRD which has paid for three air-stripping treatment facilities that remove PCE from five TMWA wells: Kietzke, Mill, High, Morrill, and Corbett. Two of the five PCE wells (Mill and Corbett) are piped to GTP. The other three PCE containing wells (High Street, Morrill, and Kietzke) have standalone air-striping facilities but may be piped to GTP in the future. The CTMRD program has achieved success in plume capture and containment resulting from the implementation of a prescriptive pumping schedule of the TMWA wells which are fitted with PCE removal technologies. The PCE plumes do not appear to be moving or growing. TMWA works and communicates closely with the CTMRD concerning

PCE removal and treatment at TMWA wells and is also proactive in the up-to-date delineation of PCE Plumes (see Figure 2-5). To-date, more than 4,150 pounds of PCE has been removed since 1996.[18]

In addition to CTMRD mitigation efforts, there are other, ongoing mitigation efforts being managed by NDEP including:

G. Sparks Solvent/Fuel Site Remediation. TMWA is an active team participant in monitoring the clean-up effort of this groundwater contamination site. Mitigation efforts are supervised under NDEP Permit UNEV-97207. TMWA's priority is the quality assurance of the clean-up operation with containment such that existing and future production wells are not compromised by movement of solvent/petroleum based plumes. Figure 2-5 depicts the approximate extent of the existing contaminant plume.

H. Stead Solvent Site Remediation. TMWA is an active team participant in the monitoring of the clean-up of solvent groundwater pollution on the southern boundary of the Stead Airport in the WLV hydrographic basin. TMWA's goal is to ensure that clean-up and containment efforts are performed in such a way that nearby TMWA production wells are not compromised by movement of the solvent based plume. Clean-up of trichloroethylene ("TCE") related material since 1999 at the Stead Solvent Site has successfully reduced the spread of the contaminant plume. All cleanup plans are developed and supervised under the direction of NDEP.

I. Leaking Underground Storage Tanks. As part of its WHPP implementation efforts, TMWA has identified seven leaking underground storage tanks in relatively close proximity to TMWA production wells. All thirteen sites are being remediated under the supervision of NDEP and the WCHD. As part of the remediation process, TMWA receives and evaluates quarterly reports concerning remediation of these sites, closely monitors water quality of nearby production wells, and provides input to regulatory/enforcement agencies as necessary.

The arsenic concentration in treated Truckee River water is typically below 2-parts per billion ("ppb"), and the arsenic concentration in the wells varies from below 10-ppb to as high as 88-ppb. Attaining the allowable maximum contaminant level ("MCL") for arsenic of 10-ppb from groundwater sources is an issue for TMWA's well operations. At 10-ppb, 11 of TMWA's production wells are affected. Four of the wells that exceed the 10-ppb MCL (Greg, Pezzi, Poplar #1, and Terminal) are piped to GTP for treatment and/or blending with treated surface water, while two other wells (View Street and Poplar #2) may require special mitigation for arsenic in the future. TMWA's compliance plan is based on three USEPA accepted methods of mitigation: (1) blending higher arsenic concentration source water with lower arsenic concentration source water, (2) minimizing use of higher-arsenic-concentration-source water throughout the year to achieve a running annual average ("RAA") of less than 10-ppb at the Entry Points to the Distribution System ("EPTDS"), and, (3) treatment. Because of TMWA's ability to maximize Truckee River water and minimize groundwater use to the summer months, USEPA recognizes the annual running average of TMWA's water supplies to comply with drinking water standards for arsenic. As a result of TMWA's cost effective arsenic compliance

[18] Further information about the CTMRD can be found on the Washoe County website at: https://www.washoecounty.us/csd/utility/ctmrd/downloads.php

plan, it received an award in February 2007 from the NDEP and the USEPA, and the President's Award from Partnership for Safe Water in 2015. The NDEP Drinking Water State Revolving Fund ("DWSRF") awards recognize the most innovative projects that effectively use state revolving funds to protect public health, comply with the SDWA, and rank high on a public health benefits priority list.

Table 2-3 summarizes data on 13 of TMWA's production wells with arsenic above or near 10 -ppb and the mitigation action taken at each well in order to ensure compliance with drinking water standards.

Table 2-3. TMWA Wells Affected by Arsenic and Compliance Actions

	Well Name	Ref.	Average Arsenic Value (ppb)	Treat at Glendale	Sample at EPTDS*	RAA** (ppb)
	------a-------	--b--	----c----	----d----	----e----	----f----
1	Terminal Way	1	88	X		1.84
2	Poplar No. 1	1	85	X		1.84
3	Pezzi	1	72	X		1.84
4	Mill Street	1	37	X		1.84
5	Greg Street	1	19	X		1.84
6	Corbett	1	17	X		1.84
7	Morrill Avenue		12		X	4.42
8	Silver Lake		10		X	4.61
9	High Street		9		X	4.42
10	Kietzke Lane		9		X	4.71
11	Sparks Avenue		9		X	4.87
12	Poplar No. 2		7		X	3.97
13	View Street	2	5		X	2.38

[1] Well output blended and treated with surface water at Glendale Treatment Plant
[2] The historical arsenic concentration has been as high as 13 -ppb; however extensive artificial recharge activities (underground blending) result in a current wellhead concentration of approximately 5 -ppb
* EPTDS - Entry Point To Distribution System
** RAA - Running Annual Average, average of four quarterly As testing results

Summary

This chapter has described major factors affecting TMWA's primary water supplies and finds that:

- Weather and source supply contamination are of greatest concern in assessing the quantity and quality of water supplies available for continued municipal uses.
- Changes in management of or any restriction to implementation of water resources due to climate change are not warranted at this time.
- Low precipitation years that lead to low snowpack accumulations affect the amount of water available to the Truckee River system; Lake Tahoe elevations provide an indication of the severity and duration of historic drought periods.
- Drought periods have established patterns, typically taking three years of consecutive dry winters to cause Lake Tahoe to fall to or below its rim; however, all the reservoirs may be replenished quickly with one or two wet winters.
- Hydrologic droughts (periods when TMWA availability to physical supplies of water diminishes) occur after 3 or 4 years of meteorologic droughts conditions.
- Drought periods occur in the Truckee Meadows and have ranged in duration from a few years to 8 years with intervening "wet" and "dry" years within the drought period.
- TMWA's source water is of very high quality, meeting, and in many cases, significantly better than all required standards. A Water Quality Assurance program has been implemented to ensure this high standard continues to be met in the future.
- While there is a risk to source water reliability from turbidity and toxic spill events, TMWA has sufficient well capacity and distribution storage to meet reduced customer demands during a water quality emergency; additional actions are available to TMWA in the event of extended off-river emergencies. An earthquake event in 2008 tested TMWA's emergency response plan with a loss in water supply and demonstrated TMWA's ability to respond by having trained staff and available alternate water supplies.
- TMWA has a robust Source Water Protection Program in place designed to preserve and enhance available surface water and groundwater supplies and to address known and potential threats to water quality.

CHAPTER 3 INTEGRATED MANAGEMENT OF WATER RESOURCES

Prior to significant population increases beginning in the late 1960's (see Figure 3-1), water supply planning was not as complex as the utility was able to rely on the combination of its decreed rights, the conversion of irrigated lands and associated water rights to municipal use, some groundwater, and upstream storage. However, continued, and at times rapid, growth in population in and around the Truckee Meadows challenged the region's ability to engage new water supplies, secure associated water rights, and optimize the management of existing water supplies given the various operating rules applied to the Truckee River.

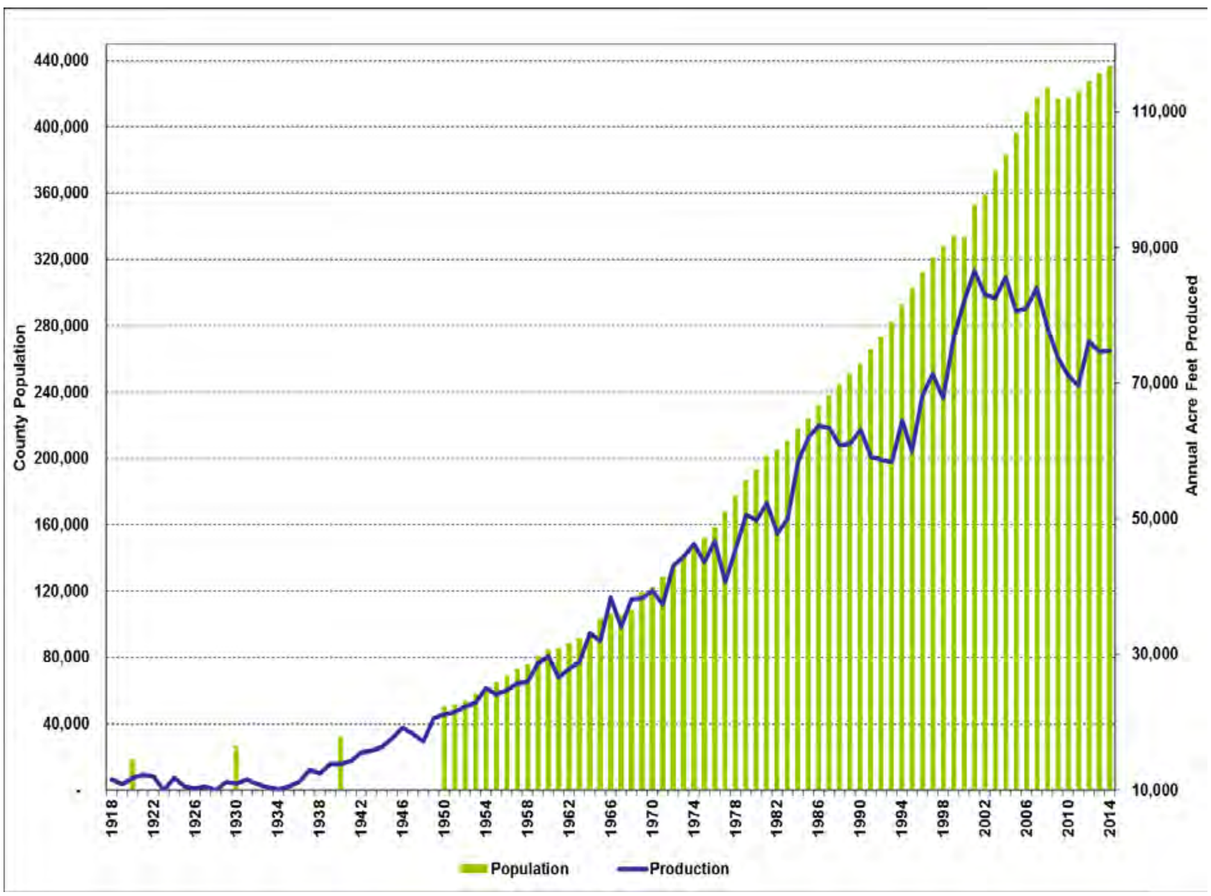


Figure 3-1. Comparison of Washoe County Population to TRA Production

This chapter examines the relationship between water resources, including all reservoir storage rights, Truckee River surface water rights, and ground water rights, and TMWA's surface and groundwater production facilities. The chapter discusses TMWA's integration of water rights and production facilities creating opportunity for the conjunctive management making it possible for TMWA to meet its service demands in drought and non-drought years for customers within reach of the TRA and non-TRA.

Truckee Resource Area

The dominate source of supply within TRA is from the Truckee River. To create a viable water supply with over 80 percent of that supply being Truckee River resources requires acquiring (1) sufficient water rights and (2) sufficient dry-year reserves or back-up supplies to support those water rights when Truckee River supplies are not available. This chapter examines the relationship between water resources, including all reservoir storage rights, Truckee River surface water rights, and ground water rights, and TMWA's surface and groundwater production facilities. The analyses in this chapter include information related to the integration of former WDWR groundwater resources as a result of the recent merger of WDWR and STMGID into TWMA.

Significant to the discussion is the fact that after 30-plus years of resource planning for TMWA customers and the region, all the prerequisites to implement TROA occurred in 2015 setting the context for this and future water plans. The implementation of TROA dramatically improves TMWA's drought operations by expanding the opportunity to store and carryover more water during times of the year that previous river operating requirements prevented.

Negotiated River Settlement and the Truckee River Operating Agreement

The Negotiated Settlement ("Settlement") of the Truckee River will provide drought reserves for the Truckee Meadows as well as quiet much of the controversy surrounding the operations of the Truckee River system to provide our current water supplies. The Preliminary Settlement Agreement ("PSA") signed May 23, 1989 between Sierra and PLPT was a successful first step to begin solving many Truckee River issues. On November 16, 1990 the Settlement Act (Public Law ("PL") 101-618) was enacted. PL 101-618 provides for the interstate allocation of water between California and Nevada on the Carson River, the Lake Tahoe Basin, and the Truckee River Basin subject to the finalization of a new operations agreement for the Truckee River, i.e., TROA[19]. The interstate allocation is an important resolution between the two states and gives TMWA the assurance of what water will continue to flow over the state line and into Nevada. Fulfillment of the Act that was assumed by TMWA in 2001, allows TMWA to store a portion of its irrigation water rights and POSW in federal reservoirs for drought use in exchange for waiver of its hydroelectric water rights. Water rights currently owned by TMWA would be stored in the excess space in the federal reservoirs for use during droughts periods. Some storage under TROA is firm storage which does not evaporate or suffer losses unless it is the only water in the reservoir. Some storage is non-firm storage which spills when the reservoir fills and, in non-Drought Situation years, such storage in excess of certain base amounts is turned over to the U.S. and PLPT to be used for recovery of endangered species and support of the fishery in the lower Truckee River. Total projected demand that TROA will support is 119,000 AF/yr and, in addition, it provides additional drought reserves in the case of a worse-than-worst drought of record. TROA provides TMWA customers with certainty regarding the operation of the system and additional drought supplies for existing as well as new customers. The agreement creates

[19] The five mandatory, signatory parties to TROA are TMWA, State of Nevada, State of California, U.S., and PLPT. The following parties also signed TROA: Carson/Truckee Water Conservancy District; City of Reno; City of Sparks; Sierra Valley Water Company; City of Fernley; Washoe County; North Tahoe Public Utility District; Truckee Donner Public Utility District; and Washoe County Water Conservation District.

benefits for those who did sign, and non-injury to the water rights of those who do not sign. PL 101-618 also provided for the 1994 Interim Storage Agreement to bridge the Truckee Meadows drought supply until TROA could take effect. That agreement will be superseded by the final TROA agreement.

TROA was signed by the five mandatory signatory parties--TMWA, State of Nevada, State of California, U.S., and PLPT -- on September 6, 2008; it was the culmination of 17-years of difficult negotiation of a new agreement for the operation of the federal reservoirs and TMWA's share of Donner Lake and Independence Lake. As its name implies, the Truckee River Negotiated Settlement is a negotiated agreement among many parties. The Truckee Meadows community both gains and gives up something as part of the Settlement. TMWA's customers are the major participants to making the Settlement a reality, and are also its major beneficiaries. Since TMWA's water customers are the taxpayers and sewer customers of Reno, Sparks, and Washoe County, many of the Settlement's benefits overlap jurisdictional lines in the Truckee Meadows. Many of the benefits have not and cannot be quantified for the purposes of the analysis as a resource but have been and will continue to be taken into account by the community in its support for the Settlement. In addition, since both states benefit from the interstate allocation of the Truckee and Carson Rivers and from the Tahoe Basin, there are other parties in the two states who indirectly benefit from the Settlement even without having participated.

Benefits and requirements of the Settlement are summarized here:

- Interim drought storage for the TMWA customers until Settlement becomes effective.
- Permanent drought storage for TMWA customers to support demands up to 119,000 AF.
- Certainty associated with the Interstate Allocation of the Truckee and Carson Rivers as well as the Tahoe Basin between California and Nevada.
- Certainty regarding the continued operation of the reservoirs to support existing water rights.
- Improved flexibility of river operations to accommodate changing circumstances, policies and values while protecting historic water rights from injury.
- Improved timing of river flows for the threatened and endangered fish species in Pyramid Lake.
- Enhanced minimum reservoir releases.
- Protection from claims that would harm TMWA's water rights.
- Increased recreational pools in the reservoirs.
- Improved fisheries and riparian habitat.
- Improved water quality enhancement through flow augmentation and retiming of flow.
- Water storage for California municipal and industrial use as well as environmental uses.

The river system is already the beneficiary of increased communication and cooperation, and solutions are being found regularly to areas of previous impasses through completion of TMWA's retrofit of water meters on flat-rate service, TMWA's annual conservation activities, the 1994 Interim Storage Contract, the 1996 Water Quality Settlement Agreement (between Reno, Sparks, Washoe County, PLPT and the U.S.), the Tahoe-Truckee Sanitation Agency water quality settlement, and PLPT's setting of water quality standards. After signing in 2008, several steps had to occur before TROA could be implemented. The following actions, completed in August and September 2015, were the final two requirements before TROA could be implemented:

- Provision of 6,700 AF of water rights for water quality purposes under Section 1.E.4 of TROA by RSW was satisfied by RSW in August 2015. Through cooperative efforts with WRWC and TMWA, RSW were able to provide mainstem Truckee River water rights to satisfy this obligation. RSW and PLPT executed the *Agreement Regarding Satisfaction of the Obligation of the City of Reno, City of Sparks and Washoe County Pursuant to Section 1.E.4 of the Truckee River Operating Agreement to Provide 6,700 Acre Feet of Water Right* on August 26, 2015. Preparations are underway to file with the State Engineer the transfer applications on all 6,700 AF that are due by December 31, 2015.
- Coincident with the provision of the 6,700 AF by RSW, is a joint filing by PLPT and the State of California in California state court to dismiss with prejudice that certain action entitled *Pyramid Lake Paiute Tribe v. California et al.*, Civil S-181-378-RAR-RCB; this was filed October 2015. The Mandatory Signatory Parties to TROA filed on August 25, 2015 the Joint Notice of Filing Re: Stipulation of Mandatory Signatory Parties to Truckee River Operating Agreement in that certain action entitled *United States of America, et al. v. The Orr Water Ditch Co., et al., Re: Petition to Modify or Amend Final Decree*, Case No. 3:73-cv-031-LDG, in the U.S. District Court for the District of Nevada to which they mutually stipulate and agree that there has been a final resolution of that certain action entitled *United States v. Truckee-Carson Irrigation District, et al.*, No. Civ. R-2987-RCB, in the U.S. District Court for the District of Nevada. As of this writing, response to either motion has not been received.

Still pending before various appeal courts are the following challenges to all prior decisions made by the U.S., Nevada State Engineer, California State Water Resources Control Board, and the Orr Ditch Court and include:

Chapter 5 The Operating Agreement was first published in the Federal Register on December 5, 2008, and its promulgation as a regulation became final on January 5, 2009. TCID, Churchill County ("Churchill") and the City of Fallon ("Fallon") have initiated litigation in the U.S. District Court challenging the regulation under the Administrative Procedure Act, 5 U.S.C. §§ 551, et seq., and under the Federal Advisory Committee Act, 5 U.S.C. App. 2 §§ 1, et seq. That same litigation also challenges the adequacy of the Final Environmental Impact Statement for TROA. The U.S. has filed an answer in this matter, and the PLPT, TMWA, City of Fernley, and the Washoe County Water Conservation District ("WCWCD"), have been allowed to intervene. It is difficult to estimate when there will be a decision on its merits. It is likely that there will be an appeal from any decision by the U.S. District Court.

Chapter 6 A motion to modify the Orr Ditch Decree was submitted to the Court in *United States v. Orr Water Ditch Company, et al.* for approval of modifications to the Orr Ditch Decree on November 17, 2008. The motion has been opposed by TCID, Churchill, and Fallon, and numerous owners of water rights. After determining how pleadings, motions and other papers will be served in this matter on represented parties and on approximately 900 unrepresented parties, the Court gave the Mandatory Signatory Parties until February 1, 2011 to file a definitive Amended Motion to Modify the Orr Ditch Decree, with all necessary supporting information.

That Amended Motion was filed and fully briefed by all parties. On September 30, 2014, the Court entered an Order granting the Amended Motion to Modify, and an Order which amends the Orr Ditch Decree as requested in the Amended Motion. Therefore, this required action has taken place. TCID and other represented parties filed appeals in December 2014.

On October 29, 2012, the California State Water Resources Control Board issued Decision 1651 approving the petitions to change the water rights for Boca Reservoir, Prosser Creek Reservoir, Stampede Reservoir, and Independence Lake. On March 7, 2013, TCID, Churchill, and Fallon filed a Petition for Writ of Administrative Mandamus in state court in California challenging Decision 1651. On April 18, 2014, the Petition was dismissed without leave to amend for failure to join indispensable parties. On May 21, 2014, TCID, Churchill and Fallon appealed that dismissal to the Third District Court of Appeal in Sacramento, California.

Approval of changes to water rights in Nevada to allow TMWA to hold the consumptive use component of some of its irrigation water rights in storage was approved by the Nevada State Engineer Order No. 6035 on March 19, 2010. TCID, Fallon and Churchill appealed the State Engineer's decision to the Orr Ditch Court. On March 31, 2014, the Orr Ditch Court denied the Petition, and affirmed the State Engineer's decision. TCID, Churchill, and Fallon appealed the Orr Ditch Court's decision to the Ninth Circuit Court of Appeals on May 21, 2014.

The Nevada State Engineer's ruling on unappropriated Truckee River water, State Engineer Ruling No. 4683, must be final, and the Orr Ditch Court must have made a determination that the Truckee River in Nevada is fully appropriated and closed to new appropriations. The Nevada State Engineer Ruling granted the unappropriated Truckee River water to the PLPT. The Ruling was appealed to the Third Judicial District Court of the State of Nevada, and the State Engineer's Ruling was affirmed. That District Court decision was appealed to the Nevada Supreme Court by Fallon. On March 30, 2009, the City of Fallon dismissed that appeal, and Ruling No. 4683 is now final. On September 30, 2014, the Orr Ditch Court made the determination that the Truckee River is fully appropriated and closed to new appropriations. Therefore, the required actions have taken place. The September 30, 2014, Order has been appealed by TCID and others.

Water Rights

Identification of sustainable water resources for 20-year planning purposes requires consideration of both the legal and practical availability[20] of water rights that can be converted from irrigation to M&I uses. This includes Truckee River mainstem, Truckee River tributaries/creek and groundwater rights. Sustainability, in the context of water resource planning, may be defined as the ability of a water resource to meet present needs while, over the life of the water resource, taking advantage of opportunities for future generations to optimize potential future economic, social and environmental benefits the water resource may provide. Water resources accepted by TMWA for will-serve commitments must meet these criteria.

Besides water rights established by decree, surface and groundwater rights in Nevada are generally established by the appropriation system defined in statute and administered by the

[20] Availability is a function of factors such as economic, hydrologic, environmental, financial, or legal factors that may constrain and pose opportunity for resource development.

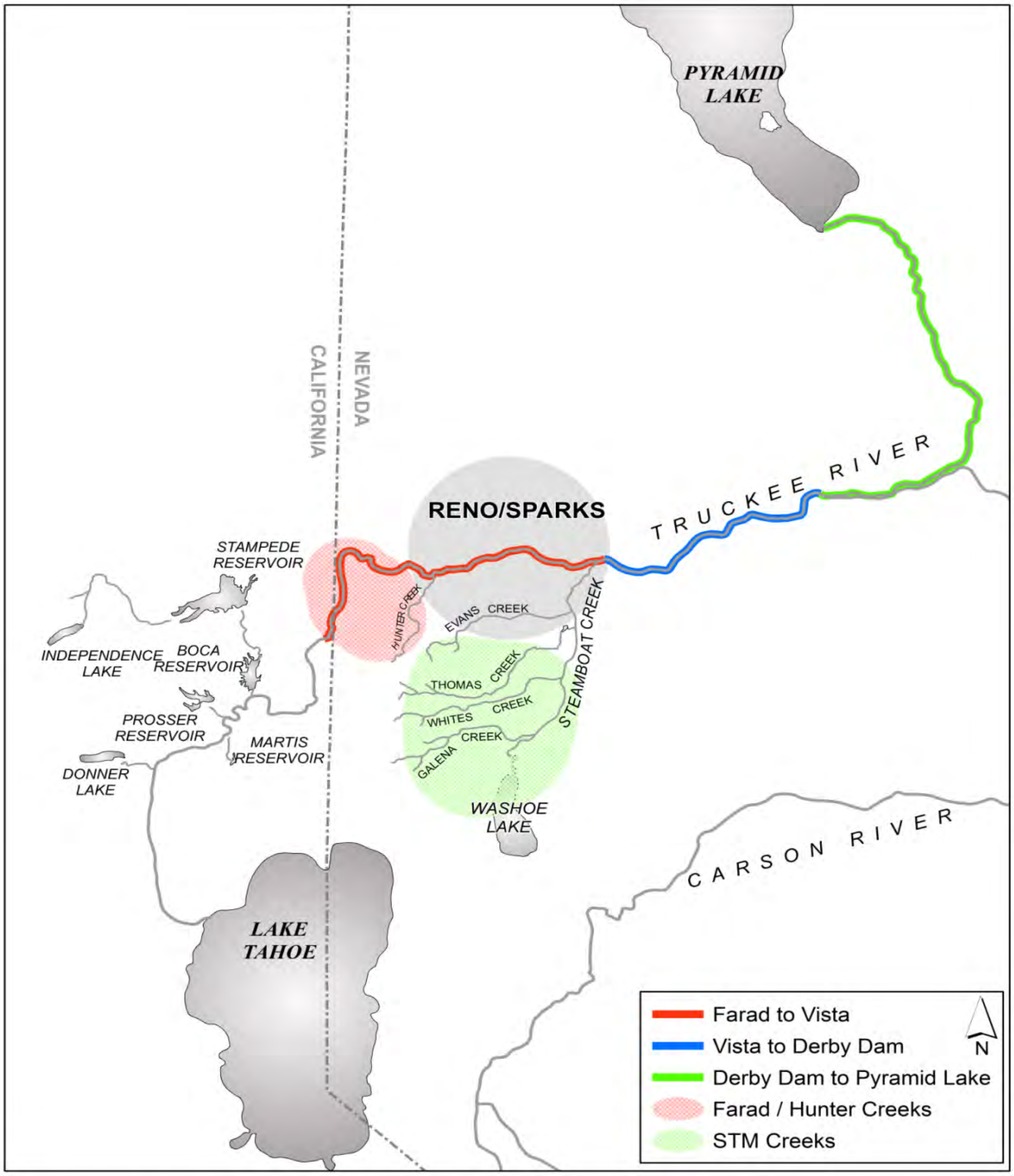
State Engineer. TMWA coordinates with and often relies on the State Engineer to determine the sustainable yield of water supplies. For example, the State Engineer makes an assessment of the perennial yield[21] based upon the best available science before allowing appropriation of groundwater from a hydrographic basin. TMWA also relies on its Rule 7 to govern the acquisition and dedication of water resources prior to the issuance of will-serve commitments. TMWA may acquire through dedication or purchase rights in the future as the need for resources arises, but before accepting a water right for a will-serve commitment, TMWA considers a water right's source, priority, quantity, dry-year supply/yield, permitability, unencumbered ownership, and the long-term ability to provide water. In this manner, TMWA ensures that future resources can be sustained in perpetuity.

Most surface water rights, such as rights to the waters of the Truckee River and its tributaries, have been adjudicated through court decrees. The Orr Ditch Decree, issued in 1944, established the number of water rights by priority, by owner, and by quantity associated with the Truckee River and all its tributaries. It is important to note that although water rights can be subdivided and/or converted from one use to another, for example agriculture to municipal use, the overall total number of surface water rights available from the Truckee River will not change from the amount of water rights defined in the Decree.[22] In addition to the Orr Ditch Decree, the Truckee River is currently governed by several operating agreements, which will be superseded by TROA when it is implemented. TROA is designed to provide long-term sustainable water operations for the multiple stake-holders on the Truckee River system through the continued use of converted irrigation rights to M&I purposes. This is crucial since TMWA derives approximately 80-90 percent of its M&I water for the TRA from the Truckee River. The Truckee Meadows is fortunate to have significant storage capacity in upstream reservoirs and Lake Tahoe to integrate with other resources to maximize the yield of the Truckee River. TROA further enhances the ability to maximize storage for drought supplies.

Figure 3-2 identifies the various reaches and more accessible water rights in "creek areas" of the Truckee River. The water rights within each reach or creek have varying priorities and yields that impact the ability to build a sufficient, consistent supply. For example, the Derby Dam to Pyramid Lake reach is of keen interest to PLPT and the Cities because during critical years, when flows are low, the water quality of the river as influenced by discharge of the treated effluent in the river at Vista can impact in-stream habitat. Transfer of direct diversion irrigation water rights to this reach could be used to mitigate low-flow conditions.

[21] Perennial yield is defined as "the amount of usable water of a groundwater reservoir that can be withdrawn and consumed economically each year for an indefinite period of time. It cannot exceed the sum of the Natural Recharge, the Artificial (or Induced) Recharge and the Incidental Recharge without causing depletion of the ground water reservoir." Also referred to as Safe Yield. http://water.nv.gov/programs/planning/dictionary/wwords-S.pdf

[22] The State Engineer granted Permit No. 4683 which granted PLPT right to all unappropriated water (e.g., flood waters) over and above Orr Ditch rights.



Map Document: (W:\projects\water_resources\River_System_general\projects\mxd\RiverSystem_reaches.mxd)

Figure 3-2. Primary Tributaries and Reaches of the Truckee River

TMWA's accumulation of Orr Ditch Decree irrigation rights was begun by TMWA's predecessor Sierra in the 1900's. Figure 3-3 compares the accumulation of TMWA's water rights (irrigation, groundwater, and Decree rights) over time to the annual production of water. The graph shows that until the 1960's, the demands of customers could be satisfied using the utility's base decree rights along with storage from Donner and Independence Lakes. As demands increased, more irrigation rights were acquired. In addition, groundwater resources began to be developed in the late 1950's and 1960's because the utility was limited in the amount of surface water it could treat, particularly in the winter months due to icing of the river and ditches. Adding wells was a less expensive alternative than adding surface water treatment plants in order to have production capacity to meet a growing summer peak demand. This strategy was heavily employed in the 1980's and 1990's in order to ensure peak-production capacity throughout the distribution system which was expanding further and further away from the centralized surface water treatment plants adjacent to the Truckee River.

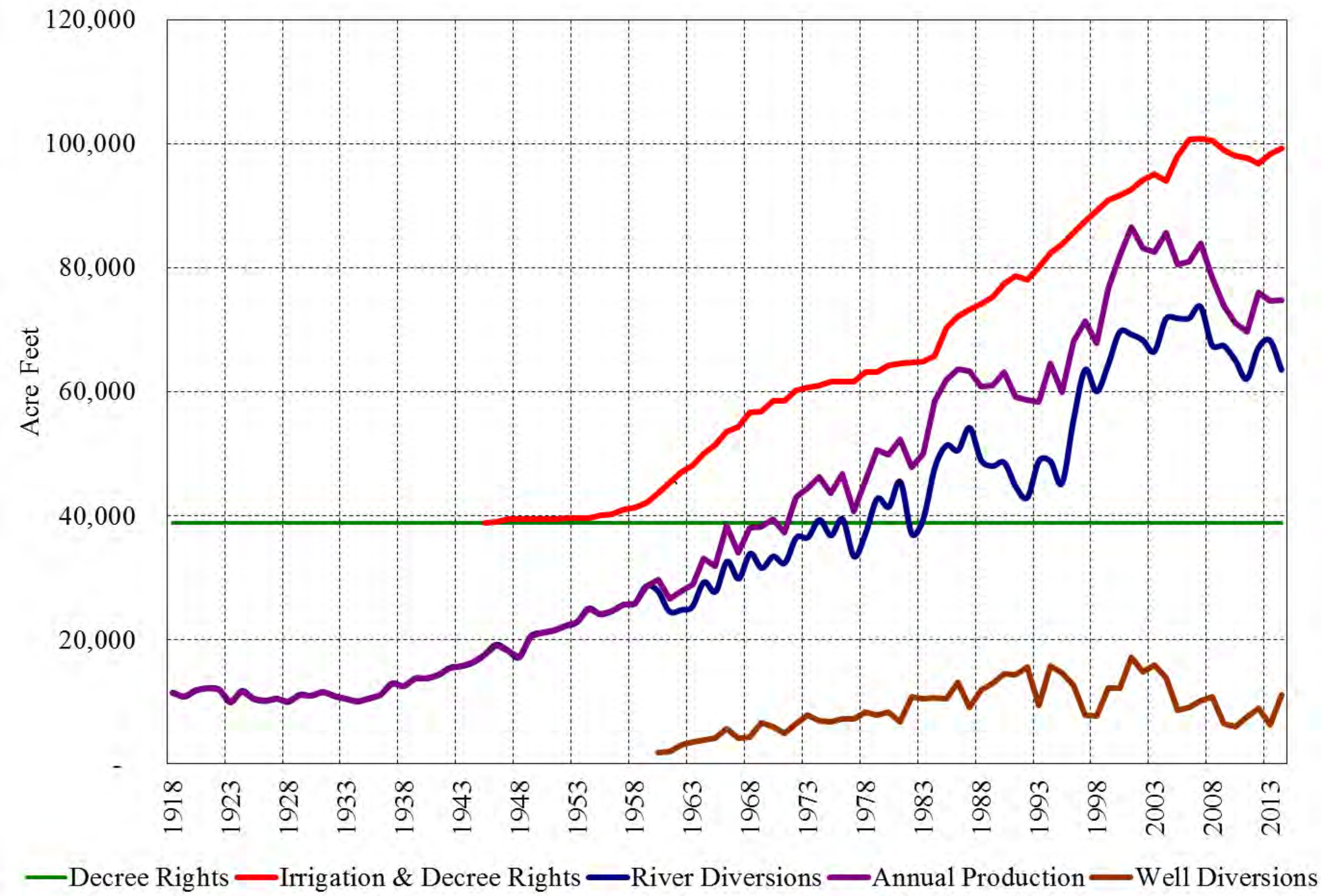


Figure 3-3. Historic Water Diversions, Production, and Acquisitions of Water Rights

This operational strategy changed dramatically in 1994 with the advent of year-round operation of Phase I of CTP (Phase II was completed in 1996 and Phase III completed in 2004). The GTP, originally completed in 1976, underwent significant upgrades in 1996 to comply with Safe Drinking Water Act. It, too, can operate year-round if needed. Given Chalk Bluff's ability to operate as the baseload surface water plant for both winter and summer demands, TMWA can utilize more of its surface water resources thereby preserving groundwater for use during the heavy summer demand months of July through September. This strategy allows better management of resources for drought and non-drought conditions and increases summer peaking capacity. Coupled with the continued acquisition and conversion of water rights from agricultural to M&I, this strategy has enabled TMWA to meet a larger drought-year demand and has thereby allowed the utility to continue to issue will-serve commitments in response to local government development plans and approvals.

After acquiring a water right, TMWA files applications to change the points of diversion, place of use, and manner of use with the Nevada State Engineer. TMWA's primary diversion points for surface water include the Highland Ditch and the Orr Ditch Pump Station for the CTP and the Glendale Diversion Dam for the GTP.

All TMWA's surface and ground water resources make up the water resources that are TROA dependent and were acquired to meet the demands of the pre-merger TRA. In addition to its decreed municipal water rights, TMWA has acquired and converted to M&I use over 69,000 AF of irrigation rights to meet the wholesale and retail will-serve commitments of its customers. These transferred irrigation rights are used in conjunction with TMWA's other groundwater and storage rights to create its water supply. The priorities of the acquired rights vary from very early, e.g., 1861, to later priorities of the early 1900's.

With the merger of STMGID and WDWR, the TRA expanded to include the former wholesale service areas of Washoe County and the retail area of STMGID. Through the merger process TMWA added over 20,000 AF of groundwater rights, some of which are within the expanded TRA and some in various hydrographic basins of the non-TRA. Table 3-1 identifies quantities of water rights that are included in the TRA or non-TRA and then within those designations quantities of water rights that are TROA dependent or not. Excluding 8,000 AF of Vidler groundwater resource, TMWA's combined pool of resources in the TRA is over 177,000 AF of decreed, irrigation, groundwater, and storage rights, and over 9,000 AF of groundwater resources in the non-TRA.

Table 3-1. Water Right Categories: TRA and Non-TRA

		TRA		non-TRA	
Description	Totals	TROA	non-TROA	TROA	non-TROA
a	b	c	d	e	f
Surface water-converted ag rights	69,717	68,438	1,279		
Surface water-decree, creek	44,843	41,476	3,366		
Surface water-POSW	22,250	22,250			
Surface Resources	136,810	132,164	4,646	0	0
Groundwater	41,620	15,950	24,322		1,348
Ground water-importation	8,000				8,000
Groundwater Resources	49,620	15,950	24,322	0	9,348
TOTALS	186,430	148,114	28,968	0	9,348

The combined production of systems in the TRA totaled 84,000 AF in 2014 and 77,000 AF is projected through 2015. Production in the non-TRA systems was 500 AF in 2014 and 500 AF is projected through 2015.

TMWA's Rule 7 requires that future applicants for new water service dedicate sufficient water rights to service their development. Applicants for new service can buy water rights in the open market and dedicate sufficient, acceptable water rights to the utility or, if the applicant chooses to acquire from TMWA, the applicant pays for a will-serve commitment based on

TMWA's costs incurred in acquiring, processing and maintaining its Rule 7 inventory. The availability of Truckee River water rights for future dedication within the TRA are subject to market conditions for water rights. The water rights market is a free market environment where the quantity of rights sold takes place between willing sellers and willing buyers. These exchanges are governed by the expectation of sellers attempting to maximize their return and the willingness of buyers to pay the market clearing price for the commodity. It takes a tremendous amount of time and effort to research the title information with respect to establishing who owns which and how many water rights, and then negotiate a transaction between a willing seller and a willing buyer.

The 1944 Orr Ditch Decree sets the total number of mainstem and tributary water rights at 224,000 AF. The original use of the water rights was for agricultural irrigation purposes. Over time the number of water rights used for irrigation has diminished significantly as TMWA acquired and converted the agricultural water rights to M&I use; Figure 3-4 illustrates the transition of water rights from agricultural to M&I.

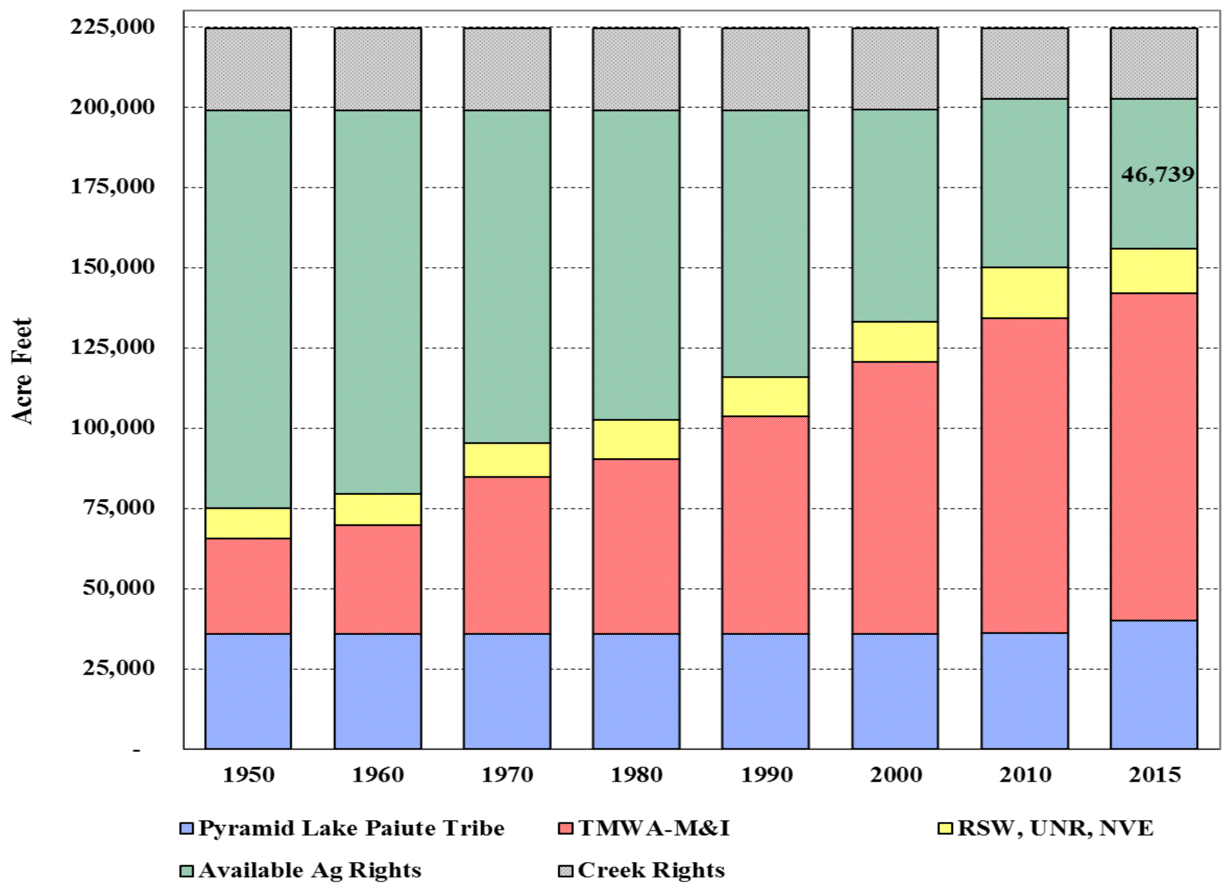


Figure 3-4. Number of Orr Ditch Decree Water Rights Held by Major Entities

Identified in the graph are ownership interests of large blocks of water rights, such as TMWA. The 'green' section shows the change in the number of mainstem irrigation water rights and indicates over 46,000 AF could be available for future acquisition and dedication in the TRA.

Although it appears a significant block of water rights is available for future will-serve commitments, the process of acquiring the water right is complicated by the fact that water rights in the state of Nevada, including Truckee River rights, are private property bought and sold in a free, open market. In addition to the economic pressures mentioned above, other issues affecting Truckee River water rights that may be available for dedication to TMWA or acquired through the purchase by the utility include:

- *Ownership*. Prior to 1979 the utility was solely responsible for the acquisition of water resources. However, since that time, water rights have been dedicated by project sponsors to the utility to meet a project's demand, or the utility purchased small quantities of water rights via Rule 7 and then subsequently sold will-serve commitments to meet the project's demand. Ownership of a water right is ultimately transferred to the utility through recordation of a deed with the County Recorder.

  TMWA has an obligation to protect its customers' interests and resources by accepting only transferable, usable water. Title to a water right is evidenced by a deed recorded at the County Recorder. This may be a deed of the real property including the water rights as appurtenances, or a deed for only the water rights. When TMWA accepts a water right and issues a will-serve commitment, it becomes obligated to provide water service to new projects in perpetuity. Although TMWA takes great care to ensure that it receives clear title to water rights offered for dedication and avoid potential conflicts in title and subsequent encumbrance of TMWA's resources, recording of ownership of water rights in Nevada has historically been somewhat haphazard, and it is sometimes difficult to obtain a complete and accurate chain of title. Such factors will limit TMWA's ability to accept certain water rights.

  Another complication with ownership of available Truckee River water rights is finding the owner. Based on Federal Water Master records, mainstem water rights and Truckee Meadows creek rights are fractionated in more than 40,000 pieces spread over more than 30,000 individual parcels, ranging in size from hundredths of an acre-foot on up. The complexities associated with fractionated water rights will require tremendous amounts of time and effort to research the information with respect to which water rights a seller owns and may be willing to sell.

- *Use*. Clear title does not necessarily imply the utility has the ability to "use" the water right. The State Engineer is required by State law to ensure that any change of use of a water right does not negatively affect other existing uses and is not detrimental to the public interest. This analysis takes place after the State Engineer has received an application from the developer or utility telling the State Engineer that the utility owns the water right and wants to change the use of the water, usually from agricultural to M&I use.

  The change application process is intended to consider the propriety of changing the point of diversion, place of use, or manner of use of a water right, but does not adjudicate conflicting claims to title. The State Engineer reviews the abstract of title and all other transfer documents relating to the actual water right referenced in the application. If the State Engineer is satisfied that the utility owns the water right and all the acre feet associated with the water right, he issues a permit. It is important to recognize that the State Engineer's review is substantive and not simply ministerial, and the process is necessarily time consuming. This process may take place after TMWA has issued a will-serve commitment.

There are instances when the State Engineer finds fault with the ownership claim or with the amount of acre feet in the application. When this happens, the utility must resolve the ownership question or correct the amount of acre feet, because, in most cases with old water rights, applications, or permits, the acquisition by the utility was incorrect or the original grantee is gone.

- *Yield*. The third issue facing the acquisition and use of any water right, Truckee or groundwater based, is how much water the water right will actually produce during a drought period. Prior to a water right being accepted as to its ownership and use, the "yield" of the right must be known, and/or the water right may require the dedication of other types of water rights to support the underlying right during drought years. For example, in June 2015 TMWA instituted a process in its facility planning Area 15 wherein if the developer wants to use groundwater rights from Basin 88, he/she must provide an equivalent amount of Whites Creek, Galena Creek or Thomas Creek water right to support the groundwater right. The plan is to treat these creek rights primarily during winter months and deliver to customers and/or inject in the ground so as to reduce groundwater pumping in the basin, thereby allowing the aquifer to recover.

With constrained amounts of river supplies resulting at times from hydrologic drought conditions, TMWA continuously works to maximize the yield it receives from its existing water rights -- decreed, converted irrigation, storage, and groundwater -- to generate a water supply that will meet the current and future needs of its customers. Despite the issues surrounding the ongoing development, acquisition, and management of water rights in the Truckee Meadows, over the years TMWA has acquired a sufficient number of water rights to meet current customer demands as well as maintaining rights available for new will-serve commitments through its Rule 7 processes. TMWA has rules in place to protect current customers and provide opportunity for new development to receive water service. TMWA will continue to have a role in optimizing the water resources available to it to meet future water supply requirements subject to existing constraints on the water rights market.

Currently, non-Drought Situation year demands are estimated between 80,000 to 84,000 AF in the TRA/TROA area. This equates to between 39,000 to 35,000 AF of Truckee River irrigation water rights dedicated to TMWA to take advantage of 119,000 AF annually TROA build-out demand; as described above there are over 46,000 AF available for future dedication which does not include 7,300 AF TMWA has in its Rule 7 accounts or approximately 2,500 AF of uncommitted groundwater and creek resources TMWA now manages for former WDWR customers in the TRA/non-TROA. In addition, in the TRA/non-TROA area, there is additional demand capacity of 8,000 AF from Vidler.

Water Production and Facilities[23]

The facilities employed to produce water for TMWA's customers are described in this section. The wells typically supply between 10 to 15 percent of total water production during non-Drought Situations, but during Drought Situations groundwater production ranges between 20 and 30 percent of total water production.

Chalk Bluff Water Treatment Plant

CTP is TMWA's largest surface water treatment plant, capable of producing approximately 90 MGD of finished treated water. CTP was constructed in phases: Phase I completed in 1994, Phase II completed in 1996, and Phase III completed in 2004. The CTP treats raw water via a conventional water treatment process through settling of heavy solids, screening, flocculation and sedimentation, filtration, and chlorination. The plant is designed for modular expansions to an ultimate treatment capacity of 120 MGD. The next expansion of 15 MGD (nominal treatment capacity) will be accomplished primarily through the addition of mechanical equipment, such as four additional filters and two flocculation bays, to existing structures.

The plant sits on Chalk Bluff overlooking the Truckee River on the west side of Reno. Untreated (raw) water is delivered to the plant by gravity via the Highland Canal or by pumps with approximately 70 MGD capacity via the Orr Ditch Pump Station ("ODPS"). ODPS is located 1,000 feet due south of the plant on the river. The pumping station was built in conjunction with the construction of CTP and was expanded to a capacity of 70 MGD in 2008. The ODPS has been used to supplement supply to the Chalk Bluff plant at times of the year when the Highland Ditch cannot provide 100 percent of the raw water required to keep the plant at full load (typically June-September), or when the canal is taken out of service for scheduled maintenance or repairs. Due to ice formation for a brief period of time in the winter months, the ditch is also sometimes taken out of service in favor of the ODPS.

The Highland Canal has a nominal capacity of 95 MGD, and is approximately 7.3 miles in length from the diversion dam to CTP. The ditch conveys raw water via gravity to the CTP through a series of concrete-lined open channel sections, flumes, and siphons.

Glendale Water Treatment Plant

GTP is the smaller of TMWA's surface water treatment plants and is located in Sparks just east of the Grand Sierra Resort. The plant borders the north side of the Truckee River and diverts raw water from the river about 500 feet upstream of the plant. The plant was originally built in 1976 and upgraded in 1996 (filtration and flocculation improvements). It employs the same treatment processes as CTP and also is authorized to filter at the same filtration rate as CTP. TMWA operates the plant under a District Health variance granted in 1997 that brings the

[23] Though not used in the production of treated water, TMWA operates four hydroelectric power-generating facilities located on the Truckee River upstream of Reno/Sparks. These hydroelectric plants are valuable assets, because of the historic diversion rights associated with hydroelectric generation, and the clean, renewable hydroelectric energy that they (3 operating plants since Farad has been inoperable since the Flood of 1997) generate offsets up to 100% of TMWA's power use and up to 50% of TMWA's annual electrical power costs.

net surface treatment capacity of the plant to 33.0 MGD. Groundwater from six wells[24] can be pumped to GTP and treated for arsenic and blended with surface water for distribution into the system. With the groundwater the combined output of GTP is 45 MGD.

The current capacities of the two surface water treatments plants are summarized here.

	Design Capacity	Net Production Capacity	Planned Capacity
Chalk Bluff	95.0 MGD	90.0 MGD	120.0 MGD
Glendale	37.5 MGD	33.0 MGD	45.0 MGD

Production Wells

A summary of TMWA's production wells including the location by hydrographic basin, the rated production capacity of the well, the year of installation, whether a TRA or non-TRA well, whether a TROA or non-TROA related well, rehabilitation information and the last 5-years of production is provided in Table 3-2 .

TMWA has 81 active production wells, 68 available to meet the demand of its customers in the TRA and 13 available for service in the non-TRA systems. Another 14 wells are completed but require pumps to be added at a future date, 3 are used for backup purposes, 8 are offline due to water quality issues or low water yield, and 3 are used for construction water purposes due to low water quality. Of the 68 wells in the TRA, 25 wells were part of TMWA's pre-merger inventory. All or a portion of the water rights and all their future production is to be included as contributing toward the water demands to be calculated under TROA operations, whereas the water rights and water production from all other active production wells is over and above the total demand provided under TROA operations.

Forty-four (44) of the active production wells are in Truckee Meadows Basin 87, 8 active production wells are in West and East Lemmon Valley Basins 92A and 92B, 8 active production well are located in Spanish Springs Basin 85, 9 active production wells are in Pleasant Valley Basin 88, 4 active production wells are in Washoe Valley Basin 89, 3 active production wells are located in Tracy Segment Basin 83, and 5 active production wells are in Honey Lake Valley Basin 97.

The majority of wells pump water directly into the distribution systems after chlorination. However, water from 5 wells (Morrill, Kietzke, High, Mill and Corbett) undergoes air-stripping treatment for PCE removal, and water from 6 wells (Mill, Corbett, Greg, Terminal, Pezzi and Poplar #1) is pumped to GTP for arsenic removal. TMWA's TRA production wells have an overall rated capacity of approximately 147 MGD. TMWA seeks to maximize use of surface water throughout the TRA and uses its TRA wells for summer peaking and when needed during Drought Situation years, with the exception of wells in Basin 88-west and Basin 87-southwest which are necessary to meet some winter months demands. All non-TRA systems are groundwater dependent therefore the wells operate daily year-round.

[24] GTP can treat water from the Mill, Corbett, Greg, Terminal, Pezzi, and Poplar #1 wells. The combined output of those wells is about 16 MGD, which in drought years is used to augment the reduced Truckee River flows into GTP. In non-drought years, when Truckee River water is available and its use is maximized, groundwater use from these wells is substantially reduced.

Table 3-2. Production Well Statistics

	Well Name	In-Service Year	Rated Capacity [MGD]	Cum Rated Capacity [MGD]	Date Last Rehab	No. of Rehabs	Rehab Reason	TRA	TROA	2010 [AF]	2011 [AF]	2012 [AF]	2013 [AF]	2014 [AF]
	---------------a-------------	-----b-----	-----c-----	-----d-----	---e---	---f---	---g---	---h---	---i---	---j---	---k---	---l---	---m---	---n---
	Spanish Springs (Basin 85)													
1	Desert Springs 1	1990	0.6	0.6	2012	1	A	Y		198	175	106	250	223
2	Desert Springs 2	1963	0.6	1.2				Y		193	166	209	195	246
3	Desert Springs 3	1979	1.1	2.3				Y		0	-	218	59	114
4	Hawkings	2008	4.3	6.6				Y		193	807	1,112	8	2
5	Spring Creek 2	1988	0.7	7.3	2012	1	A	Y		29	82	107	147	142
6	Spring Creek 5	2000	1.4	8.7				Y		267	192	353	252	256
7	Spring Creek 6	1997	2.5	11.2	2015	1	A	Y		505	469	228	209	0
8	Spring Creek 7	2000	2.9	14.1				Y		567	400	384	349	454
										------	------	------	------	------
										1,953	2,292	2,717	1,469	1,438
	Truckee Meadows (Basin 87)													
1	21st St	1991	2.0	2.0	2013	1	A	Y	Y	31	165	360	14	184
2	ArrowCreek 1	1995	0.5	2.5				Y		61	124	99	89	72
3	ArrowCreek 2	1995	1.1	3.6				Y		206	262	293	236	259
4	ArrowCreek 3	1998	0.7	4.3				Y		244	245	222	199	304
5	Corbett Elementary	1993	2.1	6.4	2005	1	C	Y	Y	879	470	470	866	459
6	Delucchi Ln	1972	0.8	7.2	2013	1	A	Y	Y	-	-	51	-	84
7	Double Diamond 1	1981	0.8	8.0				Y		146	151	258	268	199
8	El Rancho Blvd	1992	1.2	9.2	2010	3	A	Y	Y	102	-	109	28	235
9	Fourth St	1971	2.2	11.4	2010	1	A	Y	Y	1	64	400	24	352
10	Galletti Way	2000	2.3	13.7				Y	Y	-	162	305	82	418
11	Glen Hare WCSD	1999	1.7	15.4	2010	1	A	Y	Y	-	-	31	6	260
12	Greg St	1967	2.0	17.4	2014	2	A	Y	Y	-	38	91	19	219
13	Hidden Valley 3	1984	1.4	18.8				Y		1,608	1,546	949	767	1,000
14	Hidden Valley 4	1985	1.4	20.2				Y		-	-	709	928	639
15	Hidden Valley 5	1992	0.6	20.8				Y		177	229	286	257	-
16	High St	1961	2.2	23.0	2008	1	A	Y	Y	751	950	1,052	1,049	1,029
17	Holcomb Ln	1988	1.0	24.0	2010	2	A	Y		-	526	-	31	132
18	Hunter Lake Dr	1995	3.3	27.3				Y	Y	-	-	61	-	571
19	Kietzke Ln	1972	3.3	30.6	2012	1	A	Y	Y	1,075	1,473	1,457	1,377	1,487
20	Lakeside Dr	1985	0.9	31.5				Y		107	149	165	38	215
21	Longley Ln	2000	2.2	33.7	2015	1	A	Y	Y	123	-	632	191	394
22	Longley Treatment Plant	2005	3.6	37.3				Y		415	409	453	411	583
23	Mill St	1960	2.6	39.9	2013	2	B	Y	Y	668	554	578	1,357	799
24	Morrill Ave	1963	2.0	41.9	2008	1	A	Y	Y	715	907	943	895	900
25	Patriot (Huffaker) Blvd	1990	1.8	43.7	2012	1	A	Y	Y	-	-	172	18	111
26	Pezzi	1974	1.3	45.0				Y	Y	-	20	-	52	363
27	Poplar #1	1963	2.3	47.3	2009	1	A	Y	Y	-	48	-	33	283
28	Poplar #2	1967	2.2	49.5	2013	2	A	Y	Y	-	0	250	-	277
29	Reno High	1991	3.3	52.8				Y	Y	-	105	130	8	694
30	Sierra Plaza	2002	2.0	54.8				Y	Y	24	128	-	18	217
31	South Virginia St	1969	1.5	56.3	2012	1	A	Y	Y	-	676	-	31	207
32	Sparks (Nugget) Ave	1967	0.9	57.2	2013	2	B	Y	Y	-	-	57	27	80
33	STMGID 1	1984	1.1	58.3				Y		510	424	600	529	483
34	STMGID 11	2000	0.7	59.0				Y		364	391	520	477	332
35	STMGID 12	2011	1.0	60.0				Y		-	-	365	576	439
36	STMGID 2	1984	0.4	60.4				Y		118	184	213	193	188
37	STMGID 3	1984	0.7	61.1				Y		276	298	258	248	279
38	STMGID 4	1981	0.3	61.4				Y		79	71	78	68	50
39	STMGID 5	1988	1.1	62.4				Y		340	350	359	345	315
40	STMGID 6	1988	2.1	64.5	2011	1	B	Y		881	747	765	659	807
41	Swope Middle School	1993	0.9	65.4	2013	1	A	Y	Y	-	-	15	1	127
42	Terminal Way	1961	1.7	67.1				Y	Y	-	25	-	38	232
43	Thomas Creek	1978	0.6	67.7				Y		149	227	191	173	190
44	View St	1969	2.4	70.1	2014	2	B	Y	Y	1,003	163	273	75	400
										------	------	------	------	------
										11,053	12,282	14,222	12,699	16,869

A Clean/check well
B Loss of production
C Replace pump

TRA: production from these well can service the Truckee Resource Area
TROA: all or a portion of water rights on the well are TROA components

Table 3-2. Production Well Statistics (cont)

Well Name	In-Service Year	Rated Capacity [MGD]	Cum Rated Capacity [MGD]	Date Last Rehab	No. of Rehabs	Rehab Need	TRA	TROA	2010 [AF]	2011 [AF]	2012 [AF]	2013 [AF]	2014 [AF]
---------------a-------------	-----b-----	-----c-----	-----d-----	---e---	---f---	---g---	---h---	---i---	---j---	---k---	---l---	---m---	---n---
West Lemmon Valley (Basin 92A)													
1 Air Guard	1968	1.6	1.6	2009	3	B	Y		192	-	255	18	13
2 Silver Knolls	2006	1.7	3.3	2010	3	A	Y		116	-	65	0	0
3 Silver Lake	2005	3.2	6.5				Y		39	149	-	32	440
									------	------	------	------	------
									346	149	320	50	454
East Lemmon Valley (Basin 92B)													
1 Lemmon Valley 5	1970	1.2	1.2				Y		338	257	288	193	197
2 Lemmon Valley 6	1998	0.3	1.5				Y		82	96	89	129	48
3 Lemmon Valley 7	1970	0.6	2.1				Y		151	145	161	141	130
4 Lemmon Valley 8	1974	0.9	3.0				Y		43	69	96	110	132
5 Lemmon Valley 9	1997	0.8	3.8				Y		-	-	-	-	-
									------	------	------	------	------
									614	567	634	573	507
West Pleasant Valley (Basin 88)													
1 Mt Rose 3	1990	0.4	0.4				Y		102	107	124	159	86
2 Mt Rose 5	1990	1.0	1.4				Y		390	360	374	424	440
3 Mt Rose 6	2000	0.8	2.2				Y		289	329	395	363	372
4 St James 1	1995	0.5	2.7	2014	1	B	Y		122	108	74	64	94
5 St James 2	1995	0.6	3.3	2014	1	B	Y		151	137	84	84	68
6 STMGID 7	1983	0.2	3.5				Y		27	62	36	50	27
7 Tessa 1 (East)	2000	1.2	4.7				Y		350	210	297	377	506
8 Tessa 2 (West)	1999	0.9	5.6	2015	1	B	Y		270	142	354	284	141
									------	------	------	------	------
									1,701	1,455	1,738	1,805	1,735
Tracy Segment (Basin 83)													
1 Stampmill 1	1979	0.6	0.6						9	14	11	13	14
2 Stampmill 2	1979	0.3	0.9						9	14	12	14	13
3 Truckee Canyon 1	1997	0.1	1.0						18	11	18	17	18
									------	------	------	------	------
									36	39	41	45	45
East Pleasant Valley (Basin 88)													
1 Sunrise Estates 1	1983	0.4	0.4						42	39	161	66	34
Washoe Valley (Basin 89)													
1 Lightning W 1	1994	0.1	0.1						29	24	32	32	35
2 Lightning W 2	1963	0.2	0.3						43	0	68	-	-
3 Lightning W 3	2008	0.3	0.6						67	71	66	68	63
4 Old Washoe Estates 3	1994	0.2	0.8						47	45	54	48	53
									------	------	------	------	------
									187	140	220	149	151
Honey Lake Valley (Basin 97)													
1 Fish Spring Ranch Well 1 (A)	2006	4.3	4.3						-	-	-	-	35
2 Fish Spring Ranch Well 2 (B)	2006	2.9	7.2						-	-	-	-	8
3 Fish Spring Ranch Well 3 (C)	2006	2.2	9.4						-	-	-	-	66
4 Fish Spring Ranch Well 4 (D)	2006	2.2	11.5						-	-	-	-	0
5 Fish Spring Ranch Well 5 (E)	2006	3.2	14.8						8	-	-	-	167
									------	------	------	------	------
									8	-	-	-	276
81 <-Total Wells	Total Capacity (MGD):		117.1						------	------	------	------	------
68 <- TRA	TRA Capacity (MGD):		100.1	25.0					15,939	16,964	20,054	16,855	21,507
13 <-non-TRA	non-TRA Capacity (MGD):		17.0										

A Clean/check well
B Loss of production
C Replace pump

TRA: production from these well can service the Truckee Resource Area
TROA: all or a portion of water rights on the well are TROA components

Over time, wells can lose production capacity. Factors contributing to these declines may include chemical reactions between the groundwater, aquifer materials, and well casing leading to changes in the chemical and/or hydrogeologic characteristics of the well system. These changes can lead to precipitation of minerals that clog the well's screens or by biofouling whereby biological microorganisms combine with trace minerals in groundwater to clog the well. When the production rate or water quality of a well is affected negatively, TMWA begins an analysis to determine the cause of the decline and then takes action to rehabilitate the well so that the well production and water quality can be improved. Although well abandonment and drilling of a new well can mitigate the loss of well production, it is considered a last resort due to the expense to replace a well.

TMWA actively monitors its production wells with the goal of detecting those wells that need rehabilitation. The rule of the thumb for initiating rehabilitation work on a well is upon identification of a 20 percent to 25 percent loss of its design production rate. The rehabilitation program avoids the cost of drilling a replacement well, especially in view of the diminishing well sites within TMWA's services areas that can provide sufficient, high quality production capacity at minimal capital outlay. Well rehabilitation has occurred at more than 25 wells, some of which have been "rehabbed" multiple times. TMWA's approach to well rehabilitation involves the use of a combination of industry established methods along with monitoring and testing steps specific to the conditions found at each distinct well. Various issues and/or well characteristics, primarily a decrease in well yield, have initiated the rehabilitation of each well. Where extensive rehabilitation work was performed, the well's productive capacity was improved and/or restored. Fortunately, TMWA's wells have yet to experience water quality deterioration problems with the exception of sand production at some wells. Table 3-2 indicates those wells that have been rehabbed.

Conjunctive Operation of Surface and Groundwater Resources

Chapter 1 introduced and defined the TRA and non-TRA. For planning purposes in the non-TRA the groundwater resources available to the satellite systems are restricted to the individual system and are sufficient to meet the build-out needs within the established system over the planning horizon. Since these systems have no opportunity to benefit from Truckee River resources, planning conjunctive use within these areas in not possible.

The discussion in the remainder of this section relates to the conjunctive operation of Truckee River resources (mainstem water rights and upstream storage rights) and groundwater rights in the TRA which are combined and managed pursuant to TROA. Resource management within the TRA is subdivided into two categories: (1) surface and groundwater resources dedicated and committed for will-serve commitments that make-up the TROA supply and reservoir operations and (2) groundwater and creek water rights dedicated and committed for will-serve commitments that do not rely on TROA storage. Groundwater rights held by TMWA, pre-merger, *are included* in TROA. Any groundwater and creek water rights not dependent on TROA storage that have been acquired by TMWA *are not included* in TROA and are over and above the commitments and associated demands recognized under TROA. Included in this group of rights are the groundwater rights TMWA acquires through the purchase of water systems such as the Silver Lake Water Distribution Company in 1999 or the groundwater or creek rights TMWA acquired as a result of the merger with WDWR and STMGID in 2014. At the time of acquisition, those rights were adequate to meet the full demands of the customers to whom the water resources were committed without TROA support. In the TRA, those water resources that are supported by TROA operations and drought reserves will serve a demand of 119,000 AF; those water resources in the TRA not supported by TROA operations (e.g., prior WDWR groundwater commitments in Lemmon Valley) will serve a demand of approximately 25,000 AF.

The CTP and GTP make it possible for TMWA to utilize surface water year-round thereby eliminating the need for winter groundwater pumping throughout the TRA with exception of Basin 87-southwest. TMWA manages its plants to maximize surface water production and limit or compress its groundwater pumping to help meet peak summer customer demands. This conjunctive operation of surface and groundwater supplies allows TMWA to increase its pumping during higher summer demands and beyond the summer months when necessitated by lack of river supplies during extreme dry years[25]. This operational procedure also reduces facility use and overall cost of water production and creates the opportunity to aggressively pursue TMWA's aquifer storage and recovery program ("ASR") with potential for its expansion to serve more demand as described in Chapter 6.

The map in Figure 3-5 shows the location of TMWA's production wells and which of those wells are equipped for recharge.

[25] The benefits of conjunctive management of TMWA's surface water and groundwater resources were recognized and resulted in the issuance by the State Engineer of "Groundwater Management Order 1161" on May 15, 2000. Order 1161 resolved several issues with respect to TMWA's ability to exercise its groundwater permits and provides the opportunity for improving the Truckee Meadows aquifer by: reducing over the long-term, the average-annual pumping of the Truckee Meadows aquifer; building up a credit of underground banked surface water for later extractions during droughts; and allowing up to 22,000 AF to be pumped for three consecutive years if sufficient credit has been accumulated during non-drought periods.

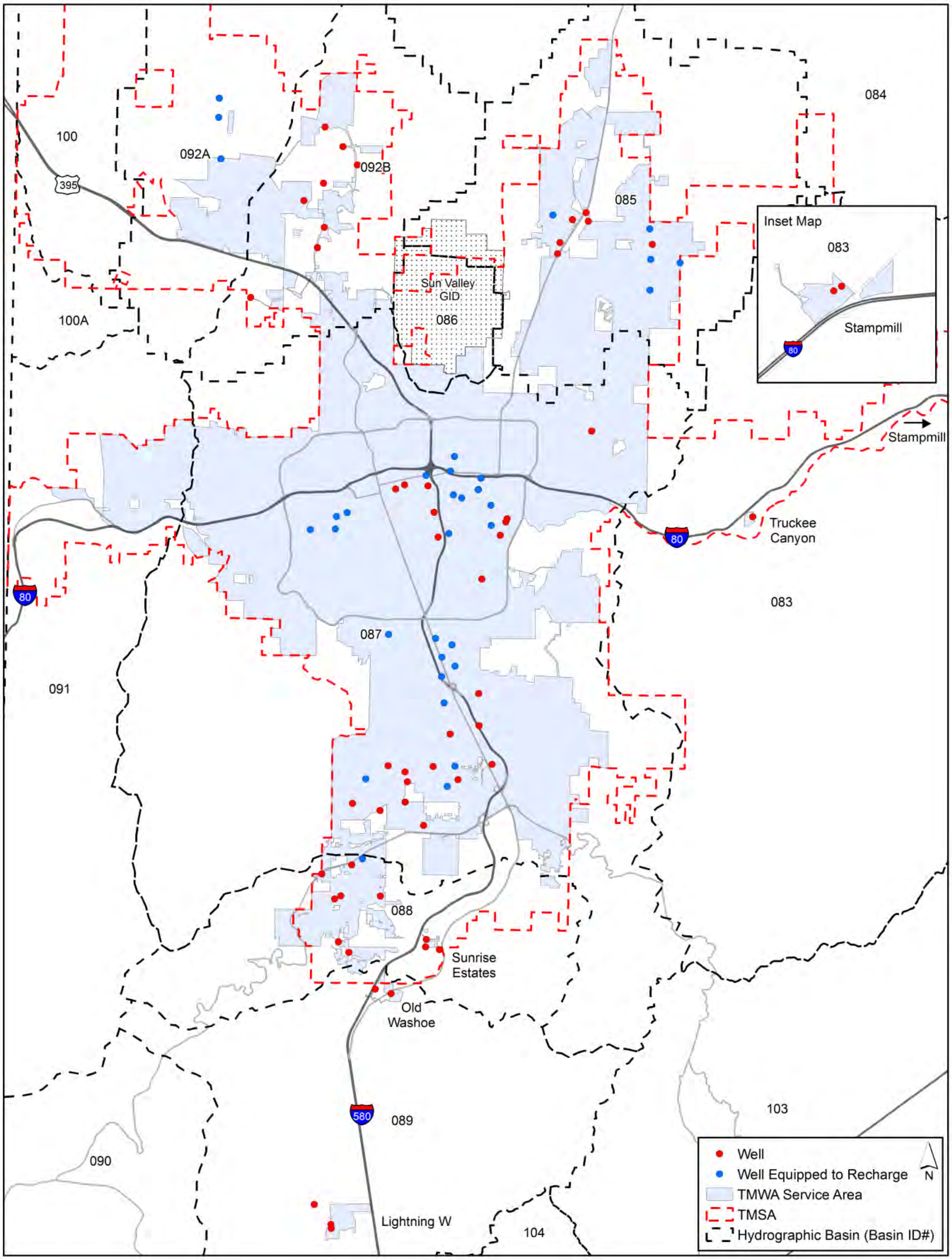


Figure 3-5. Production and Recharge Wells

In the winter season, many of the production wells are used to inject or recharge treated surface water into the groundwater aquifer for storage, water quality mitigation for marginal arsenic concentration wells, and future drought year use. TMWA's injection of treated water is governed by quantity permits issued by Nevada Division of Water Resources ("NDWR"), and quality permits issued by NDEP. TMWA has injected through FYE 2015 25,100 AF, 4,650 AF, and 720 AF in the Truckee Meadows, LVW, and SSV Hydrographic Basins, respectively. [26] Table 3-3 summarizes TMWA's recharge activities since 2001.

Table 3-3: Aquifer Storage and Recovery History by Basin (units in acre feet)

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	Mill Street														
2	High Street														
3	Kietzke Lane														
4	Morrill Avenue														
5	So. Virginia														
6	Fourth Street	452	309	152	139	82	113	90	158	107	71	15			189
7	Peckham Lane														
8	View Street	433	259	353	598	264	202	179	290	68	61	78	195	218	158
9	Poplar #2	46	70	9	44	37	2			7	3		41	5	21
10	Greg Street	135	137	177	164	41				16	56		191	34	13
11	Delucchi Lane													1	12
12	Sparks								19	18	5		14	8	
13	Poplar #1														
14	Pezzi														
15	Terminal Way														
16	Lakeside Drive	258	218	292	194	192	213	148	268	198	232	215	104	150	166
17	Holcomb Lane	39	187	123	72	17	137		39	48	87		3		72
18	Patriot														
19	21st Street	202	192	259	172	108	151	108	153	116	91				68
20	Reno High	216	142	173	26	50	213	181	254	184	134				86
21	El Rancho	216	178	255	139	97	103	62	118	22	76		43	136	124
22	Corbett					1									
23	Swope														
24	Hunter Lake	332	175	246	34	22			120	253	190				52
25	Glen Hare	117	62	99	15	9			61	70	70				45
26	Galetti	239	234	262	218	119	175	149	223	177	41				99
27	Longley Lane	10	14												16
28	Sierra Plaza														
		-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
	TRUCKEE MEADOWS	2,693	2,177	2,401	1,815	1,038	1,308	918	1,704	1,283	1,117	308	590	551	1,122
29	Silver Knolls								32	19	131	130	118	164	114
30	Air Guard	242	205	180	157	137	163	136	117	106	150	99	81	117	86
31	Silver Lake	149	88	83	84	93	147	136	171	191	192	89	63	87	76
32	Sherwin Williams														
		-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
	W LEMMON VALLEY	391	293	263	240	230	309	273	320	317	472	319	263	368	276
33	Hawkins Ct (Tucker)								51	391	444	470	422	442	396
	SPANISH SPRINGS								51	391	444	470	422	442	396
		-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
	TOTALS (AF)	3,084	2,469	2,664	2,056	1,268	1,617	1,191	2,074	1,991	2,033	1,097	1,275	1,361	1,794

[26] Appendix 3-1 contains the FYE 2105 semi-annual ASR reports for each basin filed with NDEP and NDWR.

Since its inception, TMWA's ASR has improved or stabilized groundwater levels in and around the injection sites thereby preserving TMWA's ability to utilize its groundwater resources to meet summer peaking and/or Drought Situation pumping requirements without degrading groundwater quality in the process. ASR is one element of TMWA's integrated management strategy to augment drought reserve supplies for later use during a Drought Situation. ASR, together with TMWA's POSW and credit water releases and increased groundwater pumping, create opportunity to maximize and expand service commitments while meeting critical-year-water-supply requirements during drought periods; this is a primary purpose of water resource planning for the Truckee Meadows. Under TROA the drought needs within the TRA will be met with TROA drought supplies, and only those water rights which need not be stored under TROA will be available for recharge purposes. The ASR drought reserve development can then be utilized to support demands above TROA's 119,000 AF supply.

Lake Tahoe is the largest storage reservoir on the Truckee River system; 95 percent of the water stored upstream and carried-over to the next year to be used to provide normal river flows can be captured in the lake. The top 6.1 feet of the lake is used as a storage reservoir. River flows, or Floriston Rates[27], are almost entirely dependent upon Lake Tahoe's elevation at any point in time throughout the year. Availability of Truckee River water, TWMA's primary water supply, can be negatively impacted during low snowpack years. When the elevation of the lake approaches its natural rim (6223.00-feet) Floriston Rates drop-off shortly thereafter. Figure 3-6 presents the history of recorded month-end elevations for Lake Tahoe. If these rates of flow fall off during the typical summertime demand season, it impacts TMWA's water production operations. Since typically 85 percent of TMWA's raw water is derived from the Truckee River, it is easy to see why Lake Tahoe is the best barometer regarding the health of our region's water supply. Depending on the projected elevation of Lake Tahoe determined by April 15 each year for the remainder of the year, enhanced demand-management measures described in Chapter 5 may need to be implemented depending on the projected impact to TWMA's drought reserves.

Figure 3-7 shows a 16-year history of daily river flows (the "blue area") measured at Farad compared to TMWA's daily diversion of surface water (the "green area") and groundwater and POSW (the "red area"). The graphic illustrates that the "red area" demand must be satisfied with increased groundwater production and/or releases of POSW. In the summer months of the driest years groundwater and/or POSW is used to meet demands when river supplies are not available. The reader should note, however, that in all years natural river flows make-up the majority portion of TMWA's water production requirements.

[27] Floriston Rates are the minimum required rates of the flow in the Truckee River that must cross the California/Nevada state line daily.

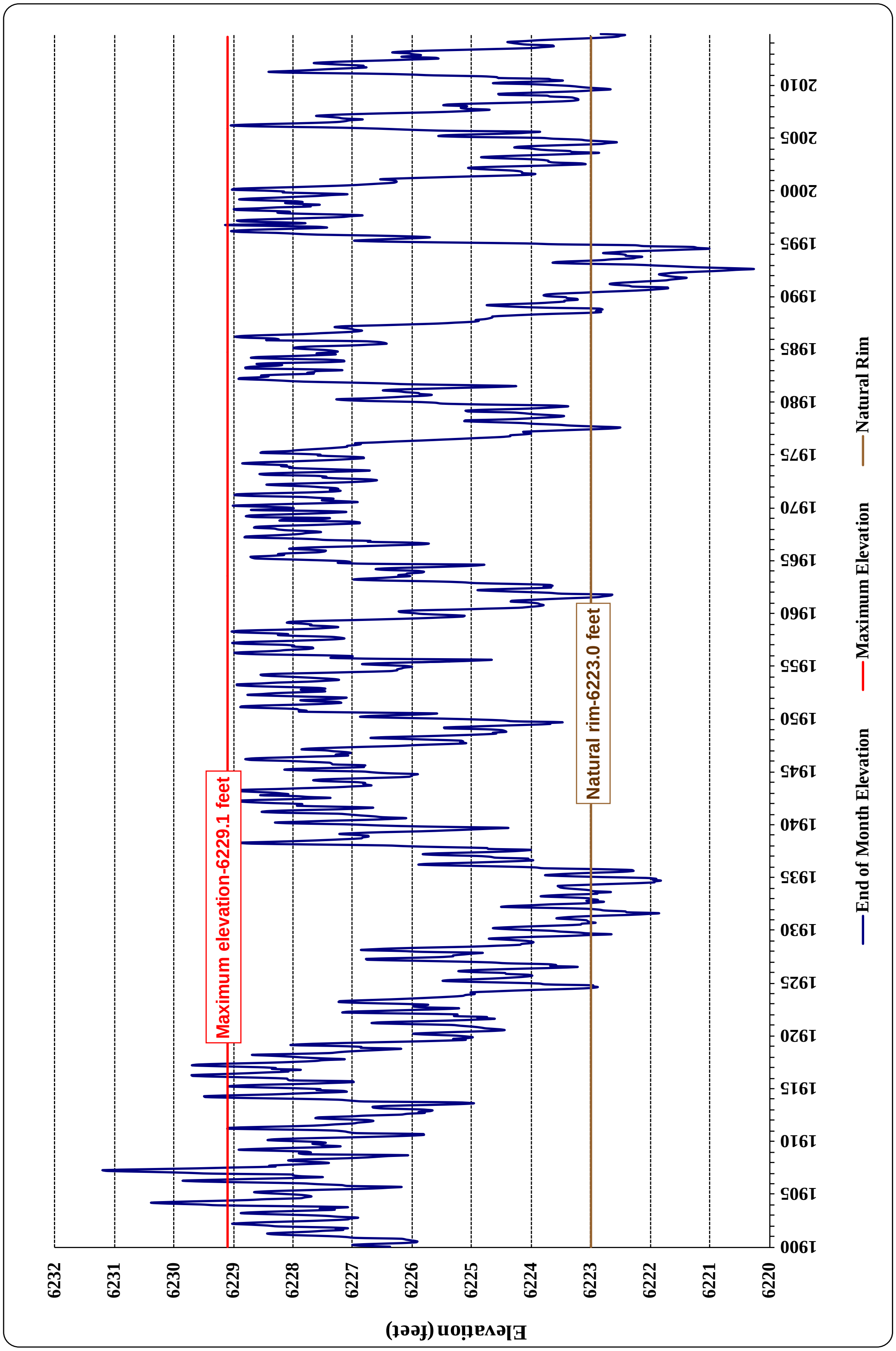


Figure 1-6. Lake Tahoe Elevations

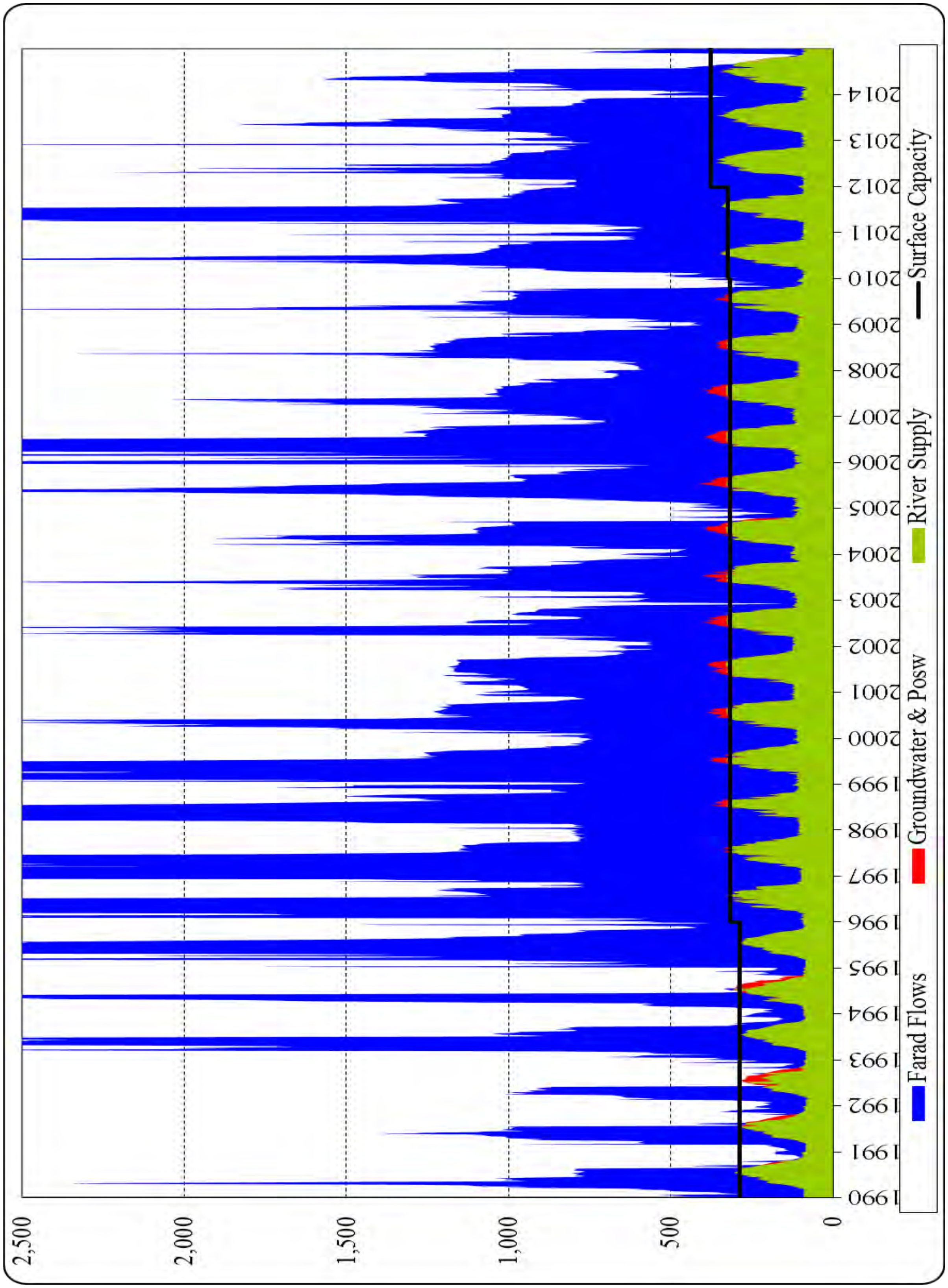


Figure 2-7. 1990 to 2014 Daily Water Sources (in acre feet)

Although the resource management schemes vary between non-Drought and Drought Situation years, experiences during prior droughts demonstrate the region's ability to manage its water resources during these dry periods which management is significantly simplified under TROA operations. A comparison of non-Drought and Drought Situations operating strategies highlights the differences in resources management required in order to optimize available resources. The two resulting management scenarios ultimately determine the type of production facilities necessary to produce potable supplies. The non-Drought and Drought Situation overall resource management strategies include:

Non-Drought Situation:

- Maximize surface water diversions every month.
- Maximize establishment of POSW and credit water per TROA operations.
- Limit groundwater use (attempting to pump an average less than 15,950 AF annually) to the critical months: July, August, and September, and eliminate its use as early as possible in October. No groundwater should be used in April, and if possible, preferably delay its use until May or June.
- Retain and carry-over POSW and credit stored water during the year per TROA operations.
- Artificial recharge, when required for operational purposes.

Drought Situation:

- Maximize surface water diversions every month while river supplies are available. This may require bringing GTP on-line earlier in the spring and implementing artificial recharge operations early in the fall.
- Maximize establishment of POSW and credit water per TROA operations.
- Request early fill of reservoirs from California Dam Safety.
- Optimize the use of credit water, POSW and groundwater during the months of June through October.

1. Enhance water conservation measures as appropriate to reduce customer use.

- Under TROA, if the drought lingers, exchange or trade credit water with other TROA parties, and move water out of Tahoe as soon as practicable to have it available for release from other reservoirs.

The 1987-1994 Drought was the most severe drought on record and is the benchmark for water resource planning criteria. Previous hydrologic analyses in prior water plans confirmed TMWA's managing its resources to withstand a repeat of 1987 to 1994 hydrology. The analyses tests for impacts during years when there is not enough natural flow in the Truckee River and TMWA must use some of its upstream reserves. The effect of one summer month when Floriston Rates are not met does not necessarily impact upstream reserves. Only consecutive months without meeting Floriston Rates during the irrigation season can significantly impact upstream reserves as happened beginning in August through September 2014 and June and through September 2015.

The last four years (2012, 2013, 2014, and 2015) have been the driest back-to-back winters in recorded history, producing the smallest amount of runoff ever seen over a four year period in the Truckee River system. Out of 115 years of actual hydrologic data available for the Truckee River, 2015 was the driest on record. It had the lowest recorded snowpack and the lowest recorded natural runoff. It was also 12% drier than the previous driest year on record which was 1977. Water year 2015 is by any definition the worst water year on record. To put water year 2015 in perspective, Figure 3-8 sorts the annual Truckee River flows from low to high (left to right) on the x-axis). These annual flows represent the total volume of water that crosses the California-Nevada Stateline at Farad, California. The graph shows water year 2015 to be lowest on record; it remains to be determined what the length of the current drought period will be and if the combination of water years since 2012 will supply more or less water than the combination of water years between 1987 to 1994 (identified in the graph by the black bars).

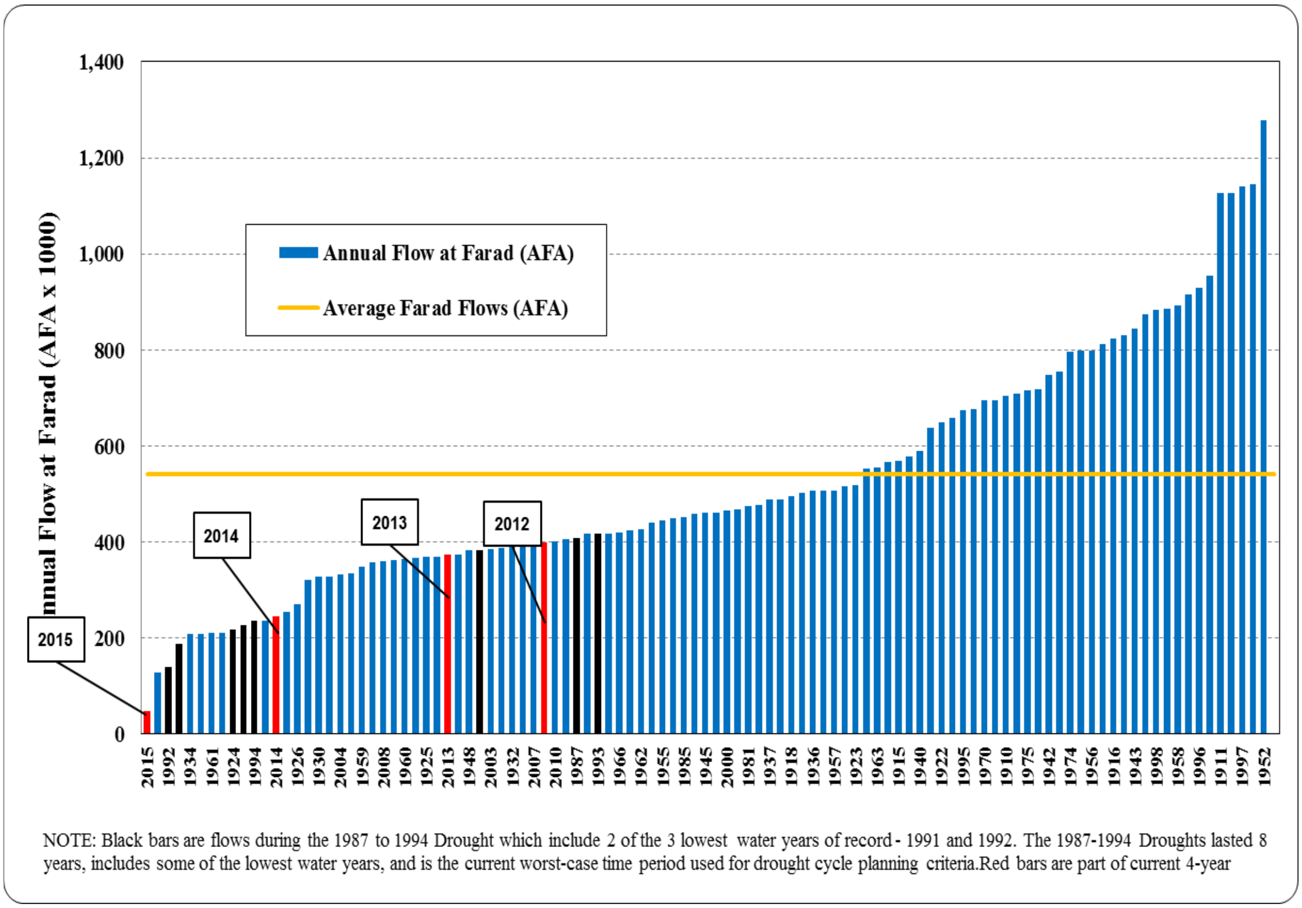


Figure 3-8. Average and Annual Truckee River Flows at Farad (in acre feet)

Previous planning efforts relied on a Fortran-based model developed by Sierra in the 1970's and revised to meet the rigors of the TROA EIS process. The Truckee River Operation Model ("TROM") was used extensively during TROA analysis and negotiation. By inputting municipal and irrigation demands, water right diversions, timing constraints, and hydrologic record, the model tracked all sources and uses of Truckee River flows. TROA, which creates various categories of credit water storage, exchange and release priorities, increased the complexities of river operations accounting which required the development of a new, more sophisticated model. Shortly after signing TROA in 2008, the U.S. Bureau of Reclamation ("USBR") took the lead in consultation with Federal Water Master and the other TROA signatory parties to develop a forecasting, operations and accounting model of the Truckee River in a software package called RiverWare. In side-by-side comparison RiverWare and TROM produce the same results when testing the resiliency of the 1987 to 1994 hydrology and its ability to meet TROA's annual build-out demand of 119,000 AF. However, with the RiverWare tool, the water master and the parties to TROA are able to plan for and manage their various water rights, reservoir storage, and releases under TROA operations.

To test the robustness of the region's water supply (in particular the back-up water supply), a hypothetical, 5-year worse-than-worse-case hydrologic scenario was developed and processed through the RiverWare operations model (see Appendix 3-2). Starting with actual conditions through the first four years (2012-2015), a 9-year drought with a repeat of 2015 hydrology for an additional five years (2016-2020) was simulated under both a TROA and non-TROA operating conditions. The 9-year drought used for this analysis is over two times more severe than the drought of record (1987-1994) plus the additional dry year (1987) currently used for planning purposes. The simulation used projected 2015 demands of 70,000 AF.

Under the non-TROA scenario upstream-drought reserves would run out in year seven of the modeled worse-than-worse-case drought; in other words, reserves are exhausted if 2015 hydrology is repeated three more years after actual 2015 hydrology. Under TROA, the results show that at current demands the region can withstand a hypothetical drought more than 2 times as severe as the drought of record and by the end of the 9-year simulation, TMWA would not only be able to meet demand at current levels, but actually continue to build up and accumulate additional drought storage.

Analyses of California blue oak tree-ring data in the 2025WRP concluded that drought periods of 8-, 9- or 10-years are rare occurrences with frequencies of 1 in 230 years, 1 in 375 years, and 1 in 650 years, respectively. While there has not been any new tree ring data collected since the 2003 study, a preliminary dendrochronological reconstruction of water-year streamflow was performed using as predictors the western U.S. tree-ring chronologies available from the public-domain International Tree-Ring Data Bank ("ITRDB") dataset and stream flows from the Carson River (see Appendix 2-2). The Carson River does not have reservoirs compared to the Truckee River and is therefore a more natural flowing river providing better higher correlation with select tree-ring cores. This reconstruction of the Carson River extended from 1500 to 2001, a period five times longer than the instrumental record. The reconstruction of the Carson River had 211 wet and dry spells with an average duration of 2.4 years, with the longest episodes being a 9-year wet period (1978 to 1986), and two 8-year droughts in 1841-1848 and 1924-1931. These three episodes were also the strongest found in the 502 year history in the reconstruction dataset. Table 2 from Appendix 2-2 summarizes the top 10 strongest wet and driest periods within the reconstruction dataset.

Table 3-4. The 10 strongest episodes identified in the 502-year (1500-2001) reconstructed Carson River Streamflow

Start (year)	End (year)	Episode	Dur (yrs)
1978	1986	Wet	9
1841	1848	Dry	8
1924	1931	Dry	8
1534	1540	Wet	7
1601	1606	Wet	6
1564	1569	Wet	6
1941	1946	Wet	6
1578	1582	Dry	5
1987	1992	Dry	6
1905	1909	Wet	5

This reconstruction of the Carson River provides some insight into the severity of dry periods on the eastern slopes of the Sierra Nevada range but also finds that up-to-date and more local tree-ring chronologies are needed to increase its reliability of conclusions as to the severity and durations of drought periods on the Carson and Truckee Rivers. Furthermore, a September 2015 report in the journal, *Nature Climate Change*, performed a similar multi-century evaluation of Sierra Nevada snowpack on tree-ring data. This short report (Appendix 3-3) shows the rarity of the 2015 dry snowpack year, and 2015 is considered to be the driest in 500 years with an estimated return interval of 3,100 years. The report also pointed to the possibility that a few years in the sixteenth century could have been drier.

Although the region is in the fourth year of a drought period, it cannot be determined with certainty when this drought period will end or how long it will be. Ongoing analyses of climate variability, specifically developing reliable streamflow datasets for the eastern slopes of the Sierra Nevada range affecting the Truckee Meadows, is recognized as a requirement by all researchers in the field. Based on available data and research results from studies for the Truckee Meadows, the 1987 to 1994 Drought remains the most severe drought on record. Figure 3-9 illustrates the calculated drought reserves TMWA is able to accumulate under TROA operations at full demand of 119,000 AF.

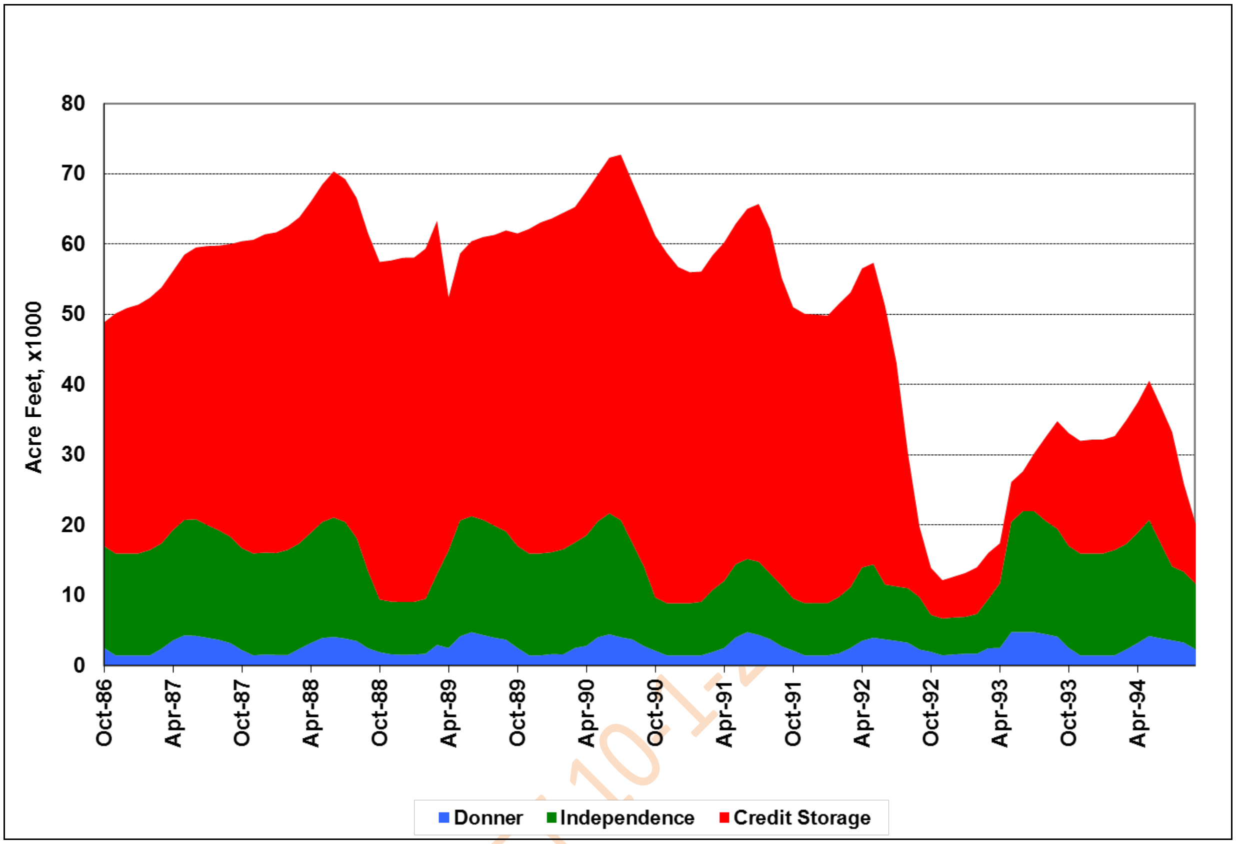


Figure 3-9. Projected Reserves Under the 8-Year Drought Design and TROA 119,000 AF Demand Limit

Under TROA operations during the 8-year drought design (1987 to 1994) at 119,000 AF of demand TMWA continues to accumulate drought reserves through the drought period. The "lumpy" nature of the graphs in Figure 3-8 reflect annual declines in reservoir storage due to (1) releases required for dam safety requirements to ensure there is sufficient flood storage capacity in the winter months; (2) release of credit water for dry demands; or (3) turnover of credit water to Fish Credit Water in Stampede or Boca reservoirs for fish purposes in non-Drought Situation years.

Summary

This chapter has described TMWA's existing water rights and water production facilities. The key points of the analysis derived from conjunctively managing surface rights, groundwater rights, and water production facilities are:

- TMWA has sufficient water resources to meet the demands of current customers.

- Within the TROA TRA and subject to future water-rights-market conditions, Truckee River water rights are available to take advantage of 119,000 AF of demand TROA provides.
- There are sufficient groundwater resources to meet current demands through the planning horizon within the non-TROA TRA.
- Current production capacities are:

	TRA	**non-TRA**
Chalk Bluff	90.0 MGD	na
Glendale	33.0 MGD	na
Subtotal Surface	123.0 MGD	na
Groundwater	100.0 MGD	17.0 MGD
Total	223.0 MGD	17.0 MGD

- Artificial recharge has improved or stabilized groundwater levels in and around the injection wells thereby preserving TMWA's ability to utilize its groundwater resources to meet summer peaking and/or drought situation pumping requirements without degrading groundwater quality.
- Drought year cycles are rare events, similar to flood events. The estimated drought frequencies are:

8-year	1 in 230 years
9-year	1 in 375 years
10-year	1 in 650 years

- Published tree-ring studies have shown a dry winter like 2015 occurs with a frequency of 1 in 3,100 years.
- Drought yield of TMWA's TRA existing resources is a function of available resources and drought-year design. Based on available data, research finds the 1987 to 1994 Drought remains the worse drought of record for the Truckee River and is the design criteria for TROA.
- Under TROA, hypothetical droughts which repeat the hydrology of 2015, a drought period more than 2 times as severe as the drought of record, TMWA continues to accumulate drought reserves; TMWA also accumulates drought reserves through the 1987 to 1994 drought period under TROA operations.
- Pending the outcome of the 2015/2016 winter and subsequent 2016 run-off projections, TMWA continue to base its planning on the 1987 to 1994 Drought Period, the worst drought cycle of hydrologic record for the Truckee River.

References

2005-2025 Water Resource Plan, Truckee Meadows Water Authority, March 2003.

2010-2030 Water Resource Plan, Truckee Meadows Water Authority, December 2009.

CHAPTER 4 WATER DEMAND PROJECTIONS

Water demand was projected through the year 2035 to ensure that TMWA will have the necessary water resources and facilities to serve its service area population. Projected water demand is based on projected population and water service connections through the planning period. Projected water demand has four main components: (1) Residential demand, (2) Commercial demand, (3) Irrigation demand, and (4) System losses. Each of these components is projected using established historic water demand factors. The projections include estimates of land use consumption, growth in dwelling units and commercial buildings, and were developed in a four-step modeling process as follows:

- Future population is projected for Washoe County.
- The number of single-family buildings, multi-family dwelling units, and commercial buildings are projected as a function of the population projection.
- A relationship between active water services and buildings is developed to project number of new active water services, including water use coefficients which are estimated for each class of customers using historic billed water use.
- Combine the building projections with the water services and water use coefficients to create the total water demand projection.

Water Demand Factors

The total demand for water is dependent on three general demands or uses: (1) residential consumption of water for internal household purposes; (2) commercial consumption of water as an input to producing goods and services in the local economy (i.e., each business has a demand for water that is dependent of the type of business and the building that it occupies); and (3) residential and commercial consumption of water for irrigation purposes. The quantity of water used for irrigation purposes depends on the type and size of landscaping that is being maintained and the weather. During periods of warm or hot temperatures irrigation increases as the landscape requires more water and during periods of cooler temperatures and/or rain, less water is required.

Residential demand is characterized by the number of people living in the community and the type of dwelling units. As the number of persons increase one can expect an increase in dwelling units and thus an increase in the residential demand for water. As people live in a community, they create the need for jobs and the demand for goods and services. The commercial demand for water is dependent on the population, the health of the economy, and types of commercial enterprises. Most separate irrigation water services are installed at commercial property and multi-family complexes, as such the number of irrigation services can be projected as a function of multi-family services and commercial services.

The core variables that are used to project water demand are population, economic health, and land use / building patterns.

Population and Economy

Population growth and employment are an inter-related time-series. In general, the population of a community grows faster during periods of low unemployment as the prospects of new jobs are good[28] (i.e., unemployment rates below 6 percent) and grows slower during periods of higher unemployment. Employment is the primary variable affecting population growth as evidenced by historic events in Nevada.

Employment statistics for the State of Nevada have been collected since 1976. Figure 4-1 shows how employment and population are related for the State of Nevada. During the 1970's through 1987, Nevada saw relatively slow population growth as the unemployment rate was consistently above 6 percent. Starting about 1988, population grew at a faster rate as the unemployment rate was generally below 6 percent, and in some years fell to record lows of less than 4 percent unemployment. When the unemployment rate increased in 2006 and continued to increase rapidly to what are now record highs, population growth slowed to almost no growth beginning in 2008.

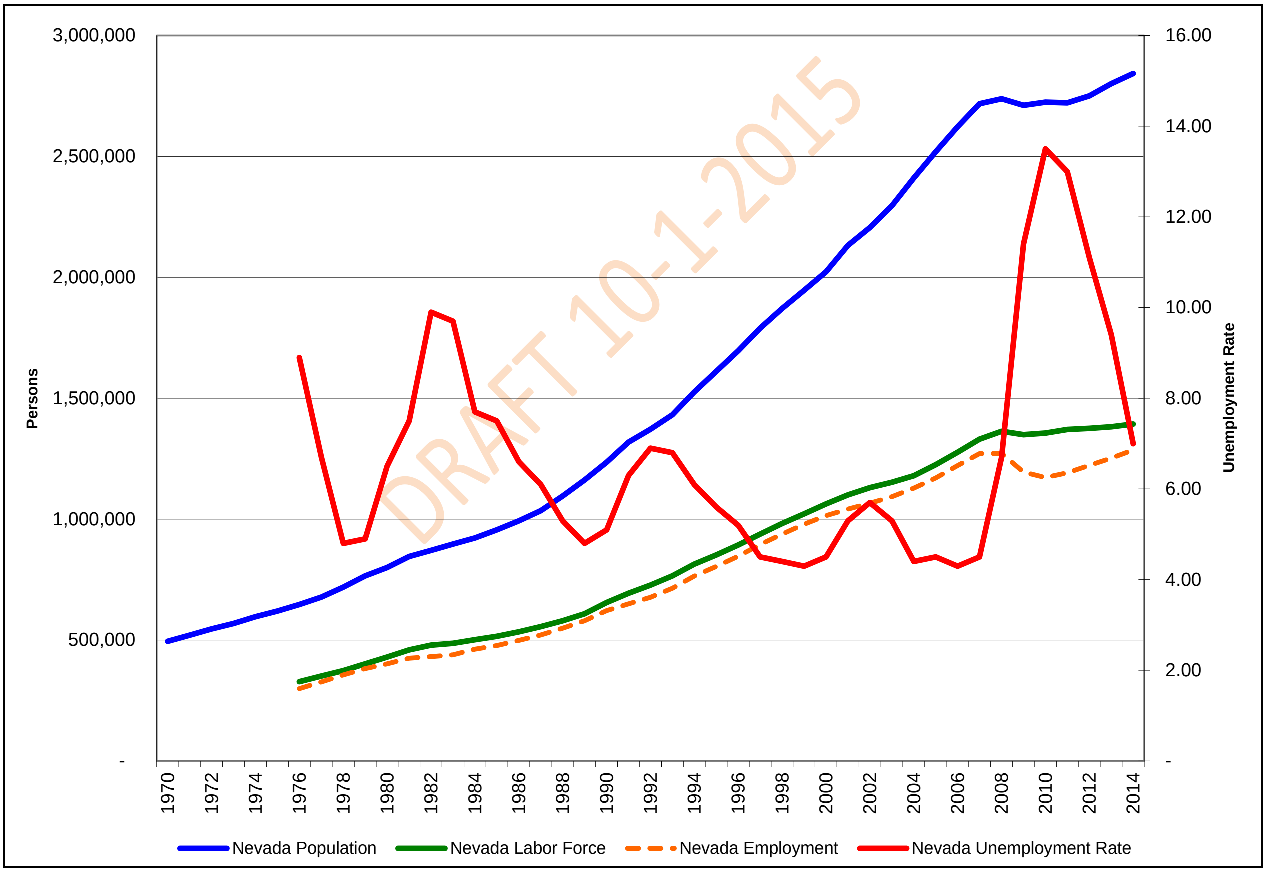


Figure 4-1. Nevada Population, Employment, and Unemployment 1970 to 2014

The employment trends in Washoe County are very similar to the State-wide trends shown above. Washoe County employment statistics from 1990 to 2009 are available from the Bureau of Labor Statistics. Figure 4-2 shows how the County experienced relatively stable

[28] In most regions an unemployment rate of 5 percent or lower is considered full employment.

population growth and low unemployment rates during the 1990's through 2006. Since late 2006, Washoe County has seen record unemployment rates and a flattening of the labor force that has translated into a period of slow population growth and a period of population contraction as people left the region in search of jobs.

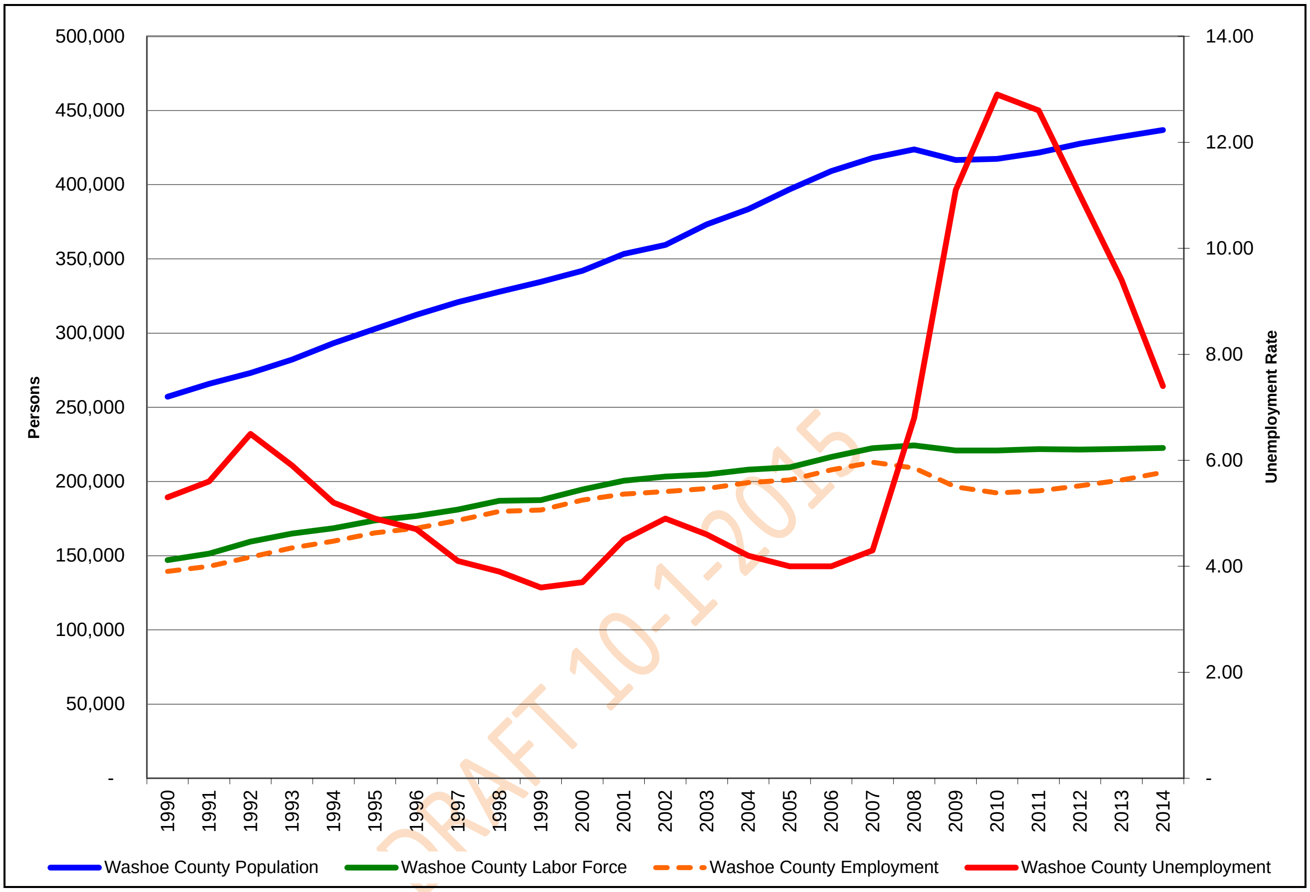


Figure 4-2. Washoe County Population, Labor force, Employment and Unemployment Rates 1990 - 2014

TMWA began using a logistic curve model of projecting population in its 2030WRP. The logistic curve model considers environmental and economic conditions to be implicit as opposed to an employment driven model that is directly dependent on employment data.

In developing a population projection, an important consideration is length of time period to be projected and available sources of data. This 2035WRP requires a projection through the year 2035. Ideally, the source data series should be at least 21 years and cover similar economic conditions. Annual population estimates for Washoe County are available for the years 1950 to 2014. This meets the need of a long time-series. This time-series covers the recessions of the 1970's and 1980's and the periods of high growth seen in the early 2000's.

Appendix 4-1 describes in detail the population model development, a summary of the population model, the logistic curve model, and its statistical properties; a brief description is included below.

Logistic Curve Model

Many of the extrapolation methods that can be used to project populations are not constrained by any limits on growth. This implies that population growth (or decline) can go on forever and in many cases this is not a reasonable assumption. The logistic curve, one of the best-known growth curves in demography, solves the resource constraint problem by including an explicit ceiling on population. It is a symmetric sigmoid shape (S-shape) curve that has an initial period of slow growth, followed by increasing growth rates, followed by declining growth rates that eventually approach zero as population size levels off at its upper limit. The idea of limits on growth is intuitively plausible and is consistent with many theories of population growth, geographic impediments such as public lands and unbuildable terrain, growth constraints created by water resources and government policies, and in-fill of existing vacant residential sites. The population model developed for Washoe County is called a Keyfitz (1968) curve and is described as:

$$Pop_t = \alpha / \left(1 + \beta 1 * e^{-\beta 2 * t}\right)$$

Where t is time index (1950 = 1), Pop_t is population in time t, α is population ceiling, $\beta 1$ and $\beta 2$ are shape parameters.

Using population values from 1950 to 2014 the model was estimated as:

$$Pop_t = 612{,}579.8 / \left(1 + 11.93398 * e^{-0.0536284 * t}\right)$$

Where "t" is time in years starting at t = 1 for 1950. The R^2 = 0.9995 shows that this model is a very good fit to the historic data. Figure 4-3 plots the results of estimation of this model.

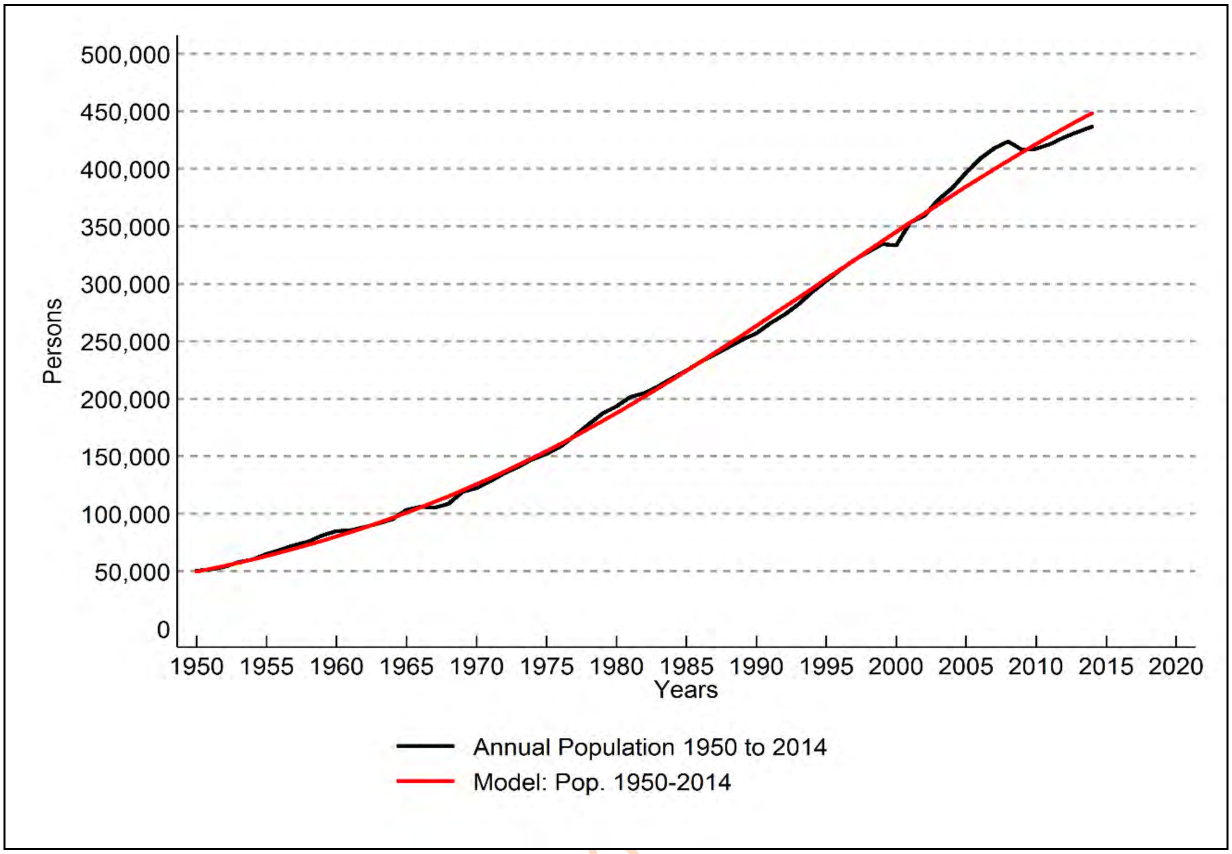


Figure 4-3. Population Logistic Curve Models Results

The results of the logistic model are shown in Figure 4-4. The model fits the data well and has a $R^2 = 0.99$. Figure 4-4 compares the model with the State Demographer's projection and the 2014 Consensus Forecast; the results of these three different models provide essentially the same projection through 2025.

The State Demographer's population projection is one of two other population projections produced locally for planning; the other projection is the Washoe County Consensus Forecast. The consensus forecast was last published by Washoe County in 2014 based on data that was provided by TMWA, the State Demographer in early 2014 and two national sources Global Insight, and Woods and Poole. The national sources are based on slightly older data due to the nature of the time to provide a forecast on such a large scale. TMWA and the State Demographer are able to provide timelier forecast by using more locally derived data sources.

The Demographer's projections are based on the REMI model and were last published in the fall of 2014. The REMI model is based on economic data since 2001 and thus has a limited ability to project population during this recession but is based on detailed local employment and economic data and can be compared with the logistic model.

As shown in Figure 4-4, through the year 2025 there is no statistical difference between the logistic curves and the State Demographer's projection ("SDP"). For the years 2025 to 2035 the SDP takes a more linear path and trends upwards. Since there is no statistical difference between the logistic curve and the SDP, (the SDP is contained entirely within the 95 percent confidence interval), the logistic curve model is used as the population model for this 2035WRP.

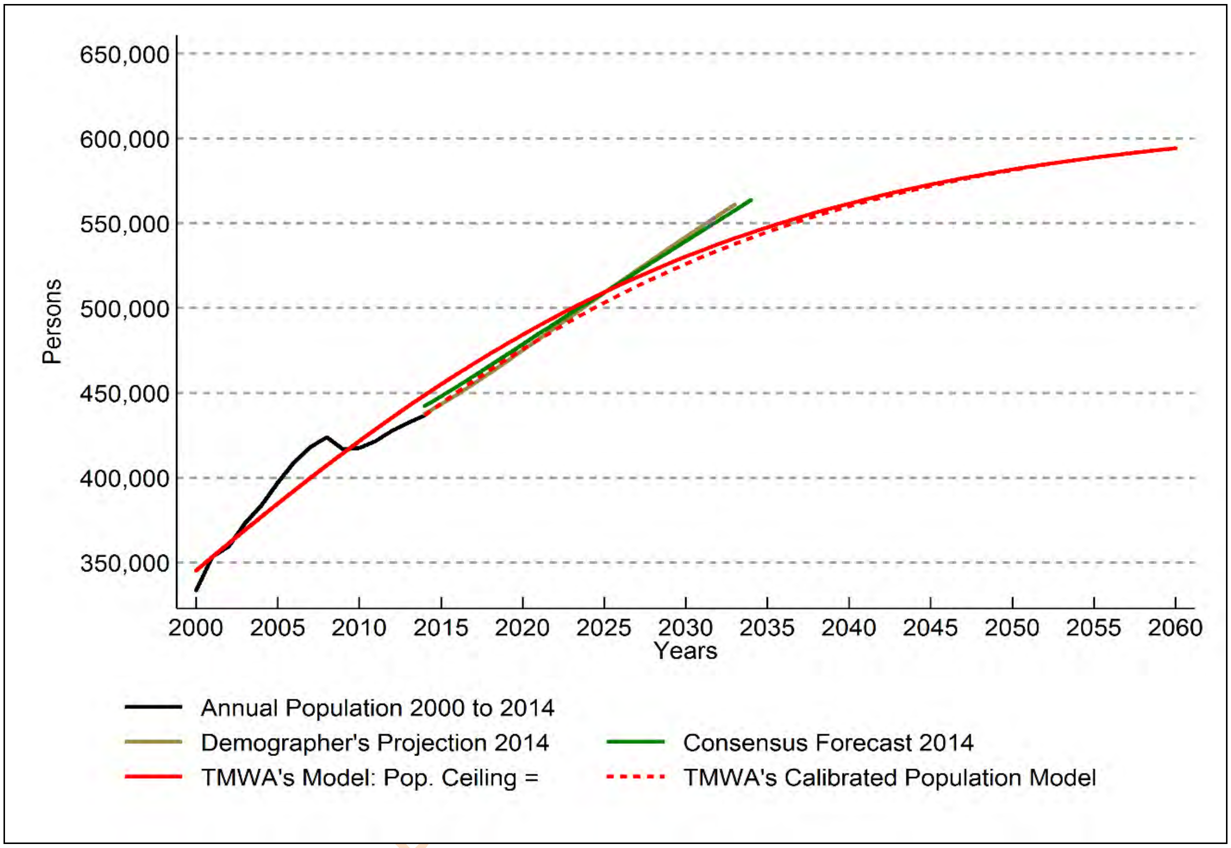


Figure 4-4. Comparison of Logistic, Demographer's, and Consensus Projections

Figure 4-5 shows the population projected to 2100 and compares the general trend with the SDP and the historic data used to estimate the model. The projected county population is expected to level out over time consistent with a logistic curve growth model. This model estimates the long-run population ceiling of 612,579 persons estimated to occur after 2100 with a 95 percent confidence interval of 576,493 to 648,666 persons.

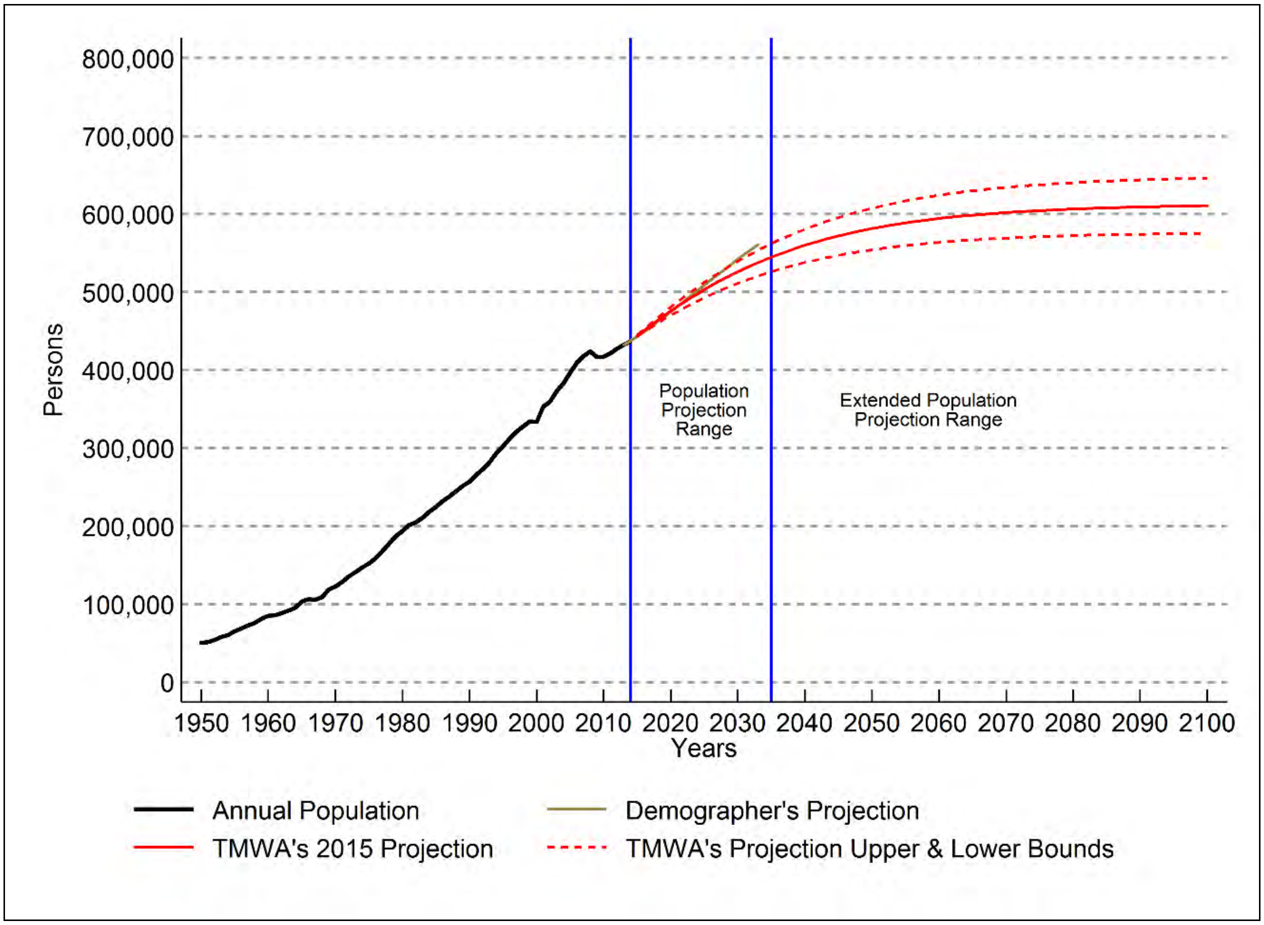


Figure 4-5. Population Projection Results

Table 4-1 provides the Washoe County projections for 2015 to 2060 to be used as the basis for the water demand projection. Washoe County is projected to gain a total of 150,630 persons between 2016 and 2035. This represents a 33.9 percent increase in population with an annual average increase of 0.65 percent.

Table 4-1. Population Projections 2015 to 2060

	Washoe County	TMWA (TRA+non-TRA)		Washoe County	TMWA (TRA+non-TRA)
	-----a-----	-----b-----		-----c-----	-----d-----
2015	443,729	386,752	2038	554,358	483,278
2016	450,488	392,607	2039	557,241	485,708
2017	457,072	398,383	2040	559,995	488,085
2018	463,476	403,965	2041	562,624	490,398
2019	469,699	409,397	2042	565,133	492,545
2020	475,740	414,720	2043	567,526	494,637
2021	481,596	419,797	2044	569,807	496,646
2022	487,267	424,740	2045	571,981	498,606
2023	492,754	429,457	2046	574,052	500,363
2024	498,058	434,052	2047	576,024	502,057
2025	503,178	438,515	2048	577,901	503,752
2026	508,118	442,905	2049	579,688	505,389
2027	512,879	447,048	2050	581,387	506,785
2028	517,463	451,094	2051	583,003	508,225
2029	521,874	454,825	2052	584,539	509,457
2030	526,115	458,450	2053	585,999	510,795
2031	530,188	462,016	2054	587,387	512,116
2032	534,099	465,610	2055	588,705	513,095
2033	537,850	468,748	2056	589,956	514,356
2034	541,445	472,037	2057	591,145	515,373
2035	544,890	474,929	2058	592,273	516,199
2036	548,187	477,712	2059	593,344	517,261
2037	551,342	480,497	2060	594,359	518,160

Note: Populations outside TMWA retail and wholesale areas are assumed to be served by existing groundwater sources and/or importation projects (e.g., North Valleys Importation).

The disaggregation of population within TMWA's retail and its one wholesale area and the balance of the county is a function of the location of dwelling units. An analysis of land use and distribution of the buildings in the different utility service areas and hydrographic basins provide the base data for projecting dwellings, commercial buildings, and the general consumption of land.

Data Construction and Trends

The Washoe County population is projected using a time-series from 1950 to 2014. Since no formal similar time-series for land use or building construction in Washoe County exists, it was constructed using information embedded in the County Assessor's data files. The County Assessor is the only source of detailed land use and building inventory for the entire county. A July 2014 snapshot of the assessor's data was downloaded from Washoe County's website for use in developing the projection of land consumption and building structures. The data provides a very detailed snapshot of what is known about each parcel and buildings that currently exist on each parcel. This database, when combined with a GIS parcel boundary database provides sufficient information for developing building(s) and dwelling unit history that can be used as part of the water demand projections.

Using a GIS application, each parcel was attributed with a utility service area and hydrographic basin. In this manner the database was used to model Washoe County land use, dwelling unit history, profile and distribution, and the distribution and development of commercial buildings. Figure 4-6 shows the constructed historic data from 1955 to 2014, historic population, and the general trend in persons-per-dwelling unit. The persons-per-dwelling unit is used to disaggregate the population into utility service areas and hydrographic basins. The construction of the persons-per-dwelling unit time-series was possible because of the long-life of buildings. The statistical models of dwellings and building presented below uses data from 1955 to 2014 due to a stable statistical relationship between number of dwellings to growth in population during that time span.

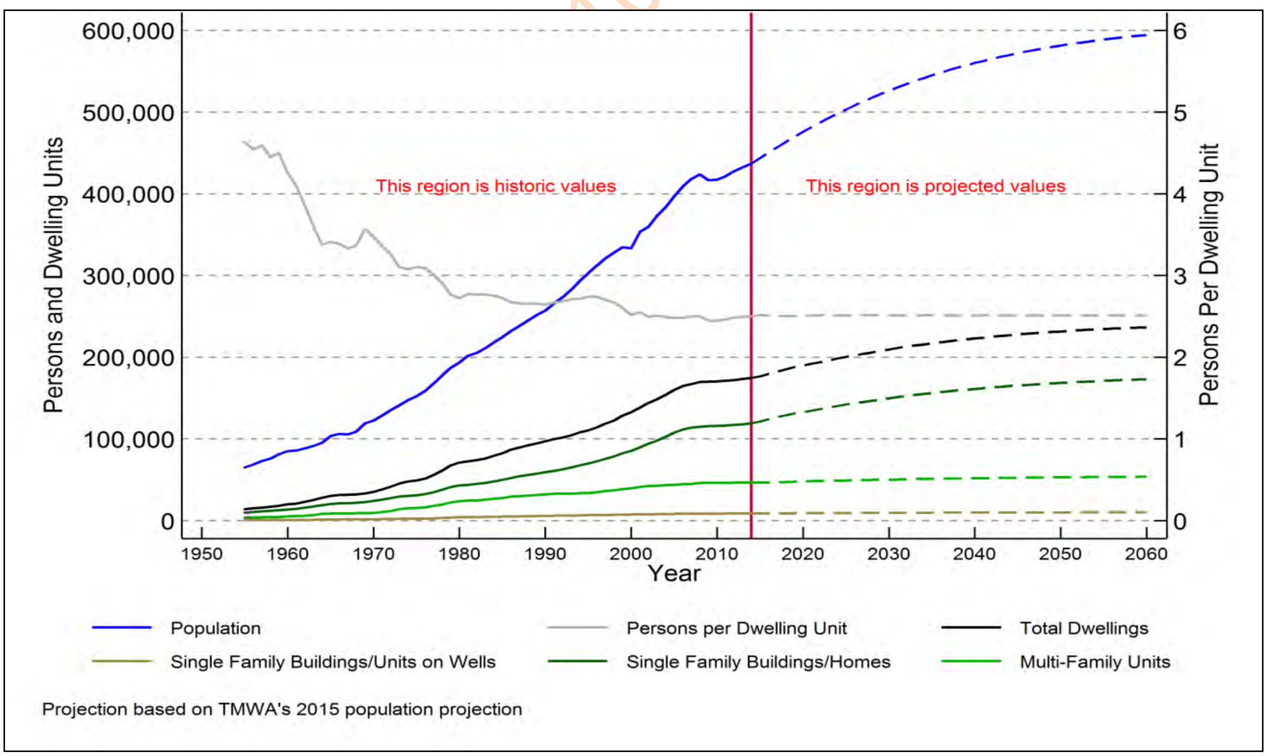


Figure 4-6. Washoe County Population, Dwelling Data and Projected Values

The Assessor's building data is reclassified into four classes that map to TMWA's customer classes. Dwelling units on domestic wells, while not served by any utility, are accounted for in the projection. Single-family dwelling units (generally single family homes, townhouses, or condominiums) are serviced under the TMWA Residential Metered Water Service ("RMWS") rate class. Multi-Family dwelling units are apartments, duplexes, and any multi-family structure that would be billed on TMWA's Multi-family Metered Water Service ("MMWS") rate. Last is the commercial building group which includes any non-residential buildings that would receive water on the General Metered Water Service ("GMWS") rate. Figure 4-6, Figure 4-7, and Figure 4-8 show the data used for the models and the projected units.

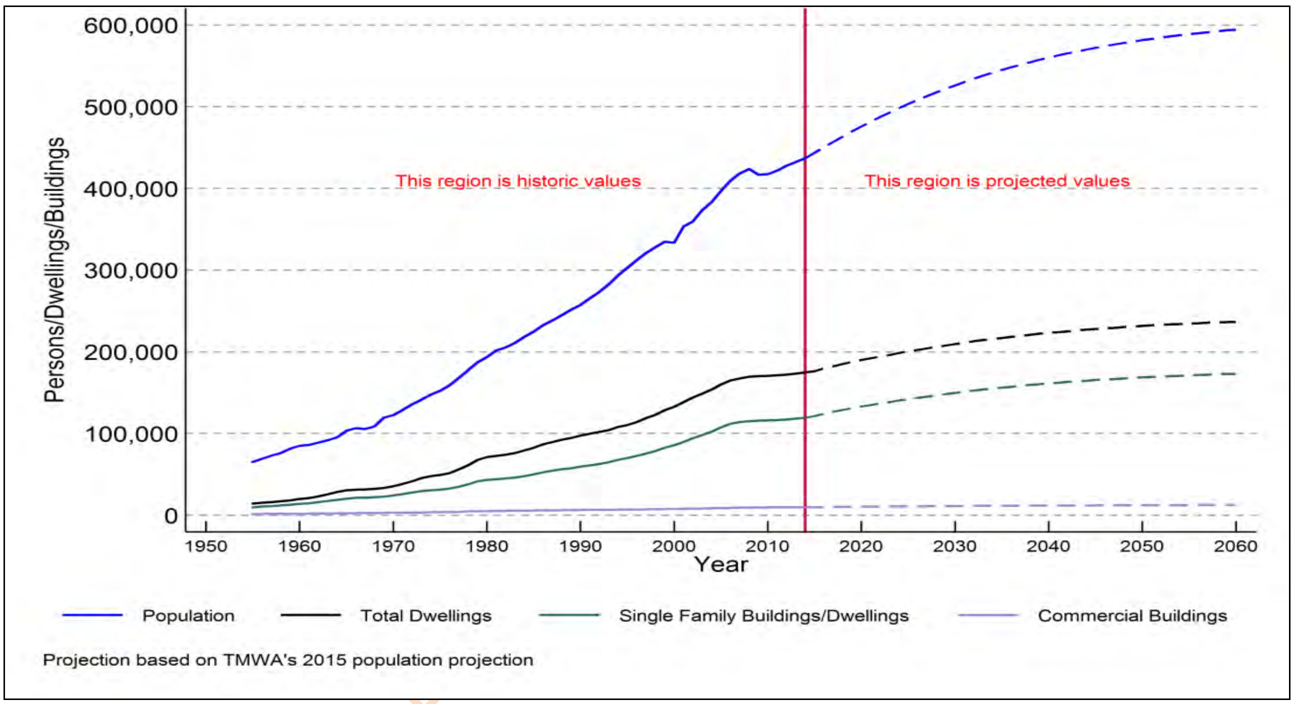


Figure 4-7. Washoe County Commercial Buildings Data and Projections

As a component of the model for dwelling units, Figure 4-8 shows the development of land over time and the projected amount of land that is projected to be developed through 2060.

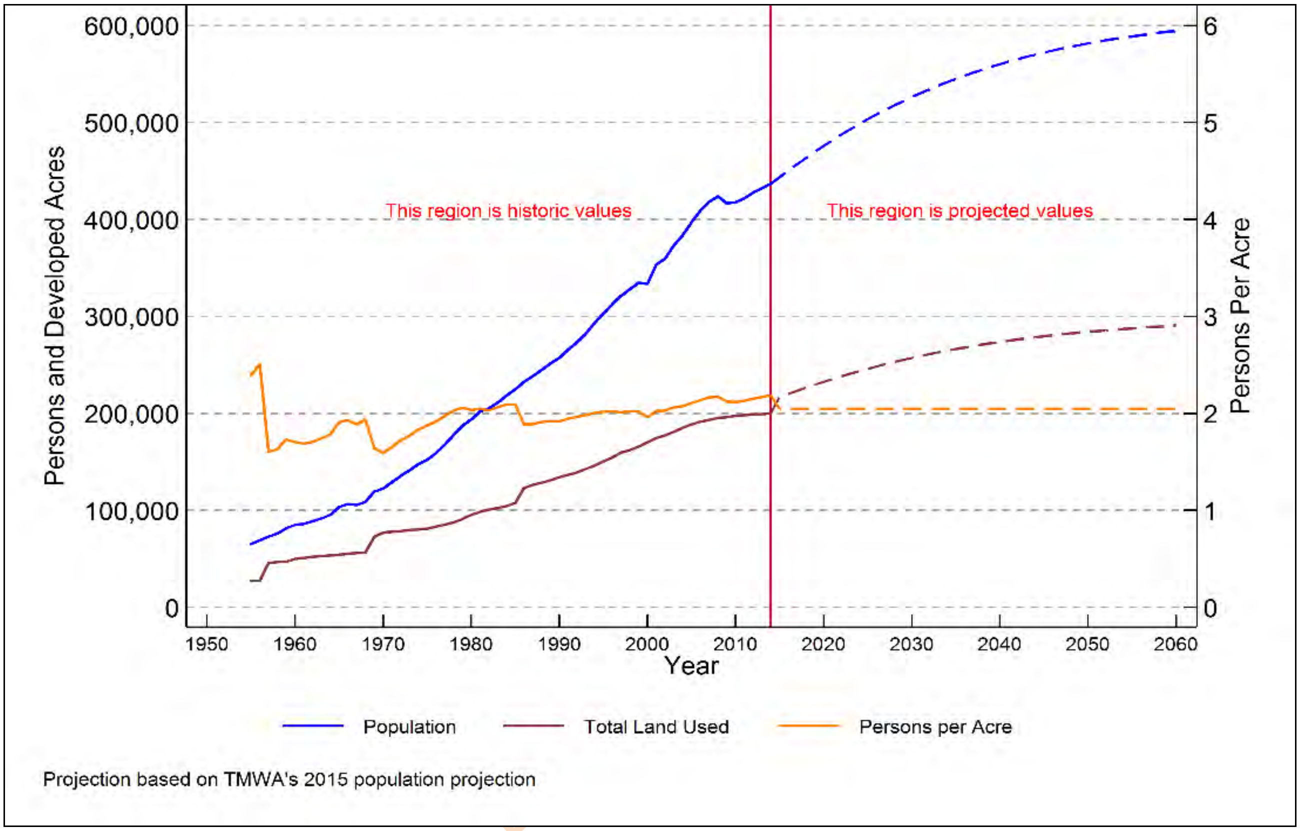


Figure 4-8. Washoe County Land Development Data and Projection

Statistical Analysis

Residential housing is the largest use of land, thus the development of land was best explained by trend of population over time. Figure 4-8 shows the projected development of land and the resulting persons per developed acre. The stock of single-family buildings, multi-family dwelling units and commercial buildings in a given year is related to prior changes in population, number of new buildings constructed and current inventory of dwelling units.

Population is an exogenous variable to the building model. When population projections change then the building projections will change in response to the new population projections. This modeling process uses a vector autoregression model ("VAR") that is shown with the data in Figure 4-6, Figure 4-7 and Figure 4-8. The three classes of dwelling units and commercial buildings are inter-related and dependent on past values of each class along with current and past population values. A VAR is a common statistical method for modeling multiple variables that are related through time; the full statistical analysis is presented in Appendix 4-2.

This model estimated the relationship between dwellings on wells, single-family dwellings, multi-family units and commercial buildings with population from the population projection model. The final step is to estimate the trend in land development as a function of population over time. To summarize, the modeling process:

- Population is projected using a logistic curve model.
- Single-family homes, multi-family dwelling units and commercial buildings are modeled and projected as a function of past and projected population using a VAR model.
- Land development is projected as a trend of past and projected population.

The persons-per-dwelling unit and persons per developed acre are used as a measure of model quality. The population densities display how well the models are meeting the needs of the projected population. If the model is performing well at modeling the past trend, then there should be little change in the trends in the densities.

Persons-per-dwelling unit has remained stable since 1980 and the resulting projected dwelling units maintain the mix of units that will meet the future population needs. The persons-per-dwelling-unit is also used as the means to allocate county population to county sub-areas based on projected new dwelling units in a sub-area.

The county projection is disaggregated into sub-areas listed here.

Utility Service Areas

ID Code	**Name**
TR	TMWA Retail Area
SV	TMWA Wholesale (Sun Valley)
WC	Washoe County (Non-TMWA)

Hydrographic Basins

ID Code	**Name**
083	Tracy Segment
085	Spanish Springs
086	Sun Valley
087	Truckee Meadows
088E	Pleasant Valley East
088W	Pleasant Valley West
089	Washoe Valley
091	Truckee Canyon
092	Lemon Valley
000	All Other Basins in County

Sub-area projections are derived from the County total projection using a ratio share analysis that allows for trends in the area shares over time, while requiring the sum of the shares to always equal 1. This ensures that in any projection year the sum of the sub-areas will always equal the County total.

Figure 4-9 and Figure 4-10 show the disaggregation of population, units and commercial buildings for TMWA retail area and the one wholesale service area. It is these values that form the basis for the water demand projections.

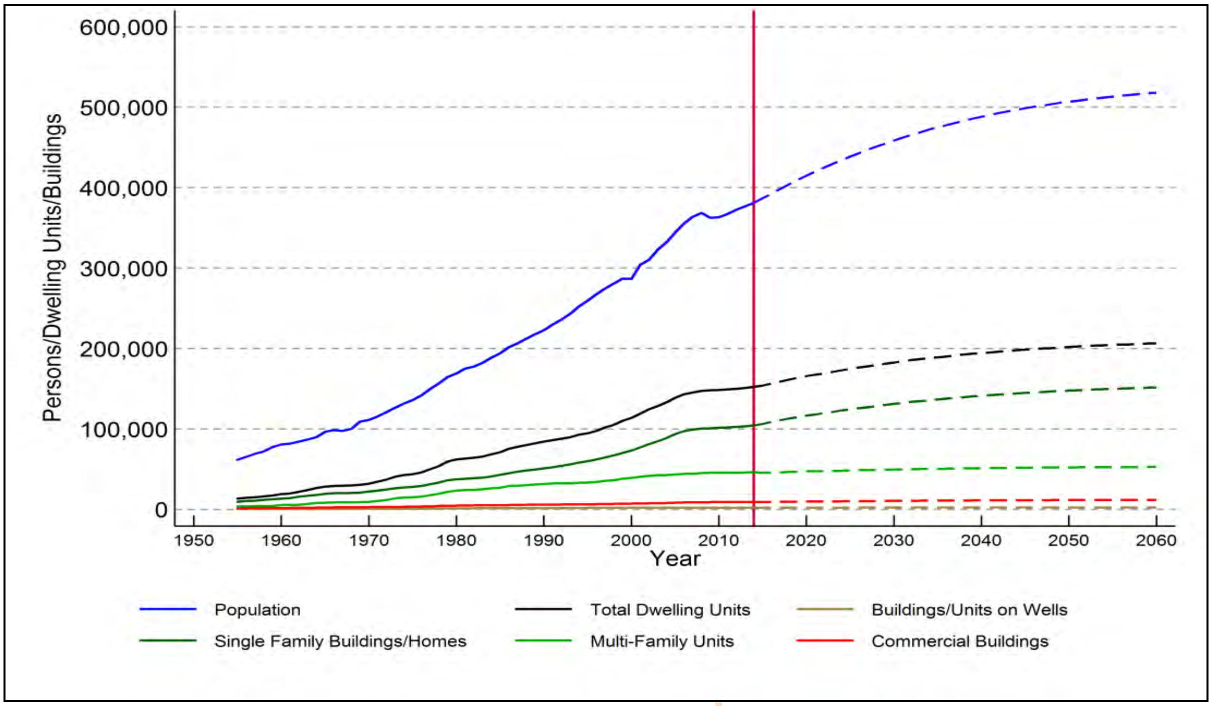


Figure 4-9. Dwelling Units and Commercial Buildings in TMWA's Retail Service Area

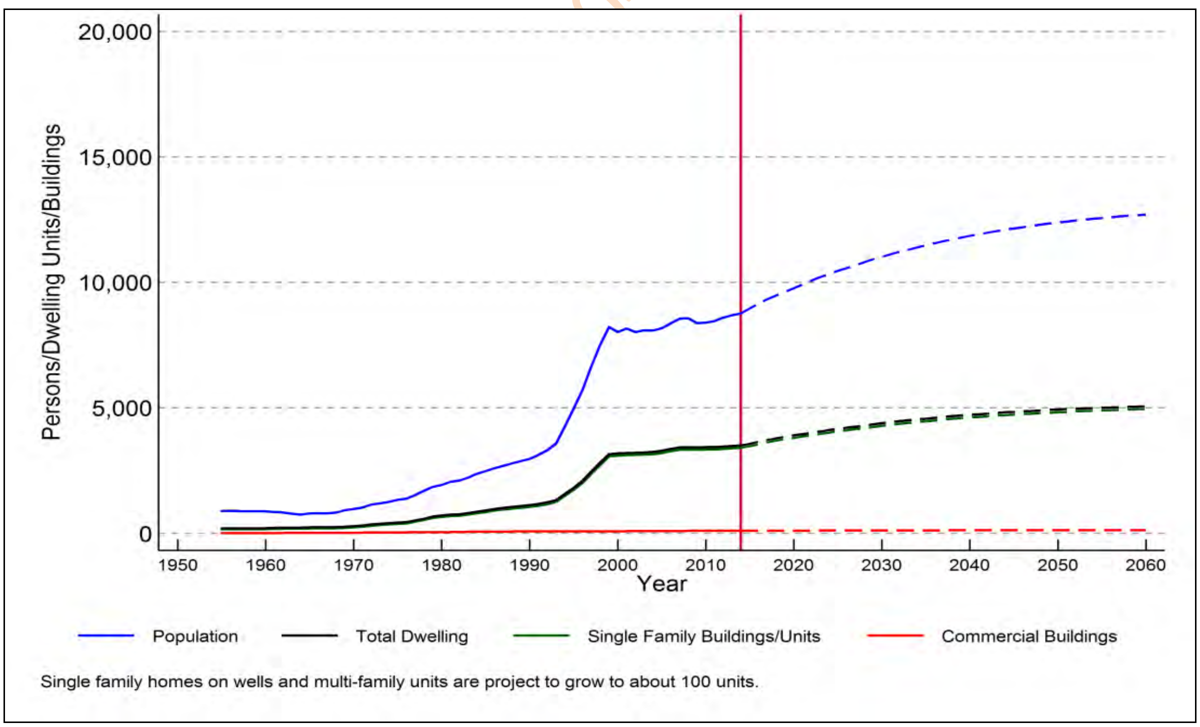


Figure 5. Dwelling Units and Commercial Buildings in TMWA's Wholesale Service Area (SVGID)

Water Demand Projections

The water demand analysis uses a time-series from 2003 to 2014 in order to project demands into 2060. In some instances the Assessor's data does not match TMWA's billing records due to differences in how the data is recorded and used by each party. Not every parcel and building is served by TMWA and some buildings or properties may have more than one water service. To translate the dwelling and building projections into water services an adjustment factor is applied to each water service class. Since nearly all flat-rate customers have transitioned to metered rate, water demand projections are only made for metered-water service, any remaining flat-rate services are pending the installation of a meter and will be counted as a metered service for this analysis. Therefore, the coefficients are only based on water usage in the previous 5-years (2009 to 2014), when the majority of customers had transitioned to a metered rate schedule. A full description of how the water demand projections are estimated can be found in Appendix 4-3.

The results of this analysis are that:

- Total demand for water is expected to increase from projected typical year of approximately 81,000 AF in 2015 to 101,000 by 2035.
- 95 percent of future single family residences may be served by a single service under RMWS, the remainder may share a RMWS service or be on an individual domestic well.
- 75 percent of all future commercial buildings may be served under a single GMWS service while the remaining 25 percent may share a GMWS service.
- RMWS and MMWS account for 62 and 8 percent of the total projected demand, respectively, through 2035.
- RMWS demand per service is expected to increase by 2 percent while the demands by MMWS and MIS are expected to decrease by 1 percent by 2035.
- GMWS demand per service is expected to remain constant through 2035.

Using active water service counts for each year from 2009 to 2014 a ratio of active water services to dwelling units or buildings was computed (See Table 4-2).

Table 4-2. Active Water Service Ratios Per Year

Year	Average Number Multi-Family Units (MMWS)	Ratio of Active: Single Family Units (RMWS)	Multi-Family Units (MMWS)	Commercial Units (GMWS)
	----a----	----b----	----c----	----d----
2009	10.12	0.85	1.10	0.73
2010	10.27	0.87	1.14	0.73
2011	10.26	0.87	1.12	0.73
2012	10.23	0.88	1.08	0.73
2013	10.23	0.89	1.09	0.73
2014	10.21	0.89	1.09	0.73
2015	10.20	0.90	1.13	0.74

Multi-family service projections are converted from units by dividing the total number of multi-family dwelling units by the average number of units per service. Metered Irrigation Water Services ("MIS") do not have a direct counter-part in the Assessor's data and therefore, new MIS cannot be projected using the same method. However, irrigation water services are typically attached to either multi-family complexes or commercial properties; therefore, a regression model of MIS services, as a function of MMWS and GMWS, is used to project the number of MIS.

The active water service ratios and the results from the MIS regression are interacted with the projected number of dwellings to estimate the number of services by service class is displayed in Table 4-3.

Table 4-3. Current and Projected Active Retail Water Services 2015 - 2035

Year	Single Family	Multi-Family	General Meter	Irrigation	Total Services
	----a----	----b----	----c----	----d----	----e----
2015	103,438	4,955	6,714	3,539	118,646
2016	105,854	4,977	6,792	3,570	121,193
2017	108,066	4,991	6,891	3,604	123,552
2018	109,954	5,049	7,011	3,658	125,672
2019	111,699	5,102	7,091	3,697	127,589
2020	113,328	5,135	7,143	3,724	129,330
2021	114,877	5,154	7,183	3,741	130,955
2022	116,458	5,154	7,237	3,757	132,606
2023	118,090	5,175	7,318	3,787	134,370
2024	119,730	5,211	7,406	3,825	136,172
2025	121,164	5,242	7,480	3,856	137,742
2026	122,437	5,283	7,537	3,884	139,141
2027	123,698	5,304	7,574	3,903	140,479
2028	124,985	5,312	7,614	3,916	141,827
2029	126,369	5,332	7,670	3,939	143,310
2030	127,740	5,351	7,736	3,964	144,791
2031	128,982	5,381	7,806	3,994	146,163
2032	130,105	5,417	7,861	4,022	147,405
2033	131,096	5,435	7,901	4,039	148,471
2034	132,058	5,453	7,934	4,054	149,499
2035	133,080	5,463	7,967	4,067	150,577

NOTE: One wholesale (LVS) customer is included in the total.

Coefficients on the average water use per service class, presented in Table 4-4, are calculated using an average of the average annual water use for each hydrographic basin within the TMWA retail service by basin, between 2003 and 2014. This “averaged” average is used to compensate for variation in the weather conditions and number of active water services, per year.

Table 4-4. Average Water Use Per Service (x1,000 gallons)

HydroBasin	Average*	GMWS	MIS	MMWS	RMWS
----a----	----b----	----c----	----d----	----e----	----f----
083	149.574				
085		326.897	1140.281	359.942	161.962
086		171.500	735.500	191.033	98.797
087		632.300	895.303	421.011	144.493
088E					254.778
088W		301.545	1036.000		262.587
089		375.800	118.000		368.748
092		600.937	849.244	636.457	110.447

* Average use in smaller basin service areas

By multiplying the averaged water use by the projected number of services, the result is a water demand forecast, by service type. Table 4-5 presents the water demand forecasts for each service class, the system loss and total production.

Table 4-5. Projected Retail Water Use by Class Through 2035 (unit in acre feet)[29]

	RMWS	MMWS	GMWS	MIS	LVS	Subtotal	System Loss	Total Production
	----a----	----b----	----c----	----d----	----e----	----f----	----g----	----h----
2015	46,252	6,494	12,716	9,777	1,869	77,108	4,626	81,735
2016	47,332	6,523	12,864	9,860	1,903	78,481	4,709	83,190
2017	48,321	6,541	13,050	9,952	1,937	79,801	4,788	84,589
2018	49,165	6,617	13,277	10,101	1,972	81,131	4,868	85,999
2019	49,945	6,687	13,429	10,209	2,007	82,277	4,937	87,213
2020	50,674	6,730	13,527	10,283	2,043	83,259	4,996	88,254
2021	51,366	6,755	13,604	10,330	2,080	84,136	5,048	89,184
2022	52,074	6,755	13,707	10,374	2,118	85,028	5,102	90,129
2023	52,803	6,782	13,860	10,458	2,156	86,058	5,163	91,221
2024	53,537	6,829	14,026	10,563	2,195	87,150	5,229	92,379
2025	54,178	6,870	14,167	10,649	2,234	88,098	5,286	93,383
2026	54,747	6,924	14,275	10,726	2,274	88,947	5,337	94,283
2027	55,311	6,951	14,345	10,779	2,315	89,701	5,382	95,083
2028	55,886	6,962	14,420	10,814	2,357	90,440	5,426	95,866
2029	56,504	6,988	14,526	10,879	2,399	91,296	5,478	96,774
2030	57,118	7,013	14,651	10,947	2,443	92,172	5,530	97,703
2031	57,673	7,052	14,784	11,030	2,486	93,026	5,582	98,608
2032	58,175	7,099	14,888	11,108	2,531	93,802	5,628	99,431
2033	58,619	7,123	14,964	11,155	2,577	94,438	5,666	100,105
2034	59,049	7,147	15,027	11,196	2,623	95,042	5,703	100,745
2035	59,506	7,160	15,090	11,232	2,670	95,658	5,739	101,398

[29] System losses are estimated at 6 percent based on review of production and to metered consumption.

Figure 4-11 shows the projected retail water sales and provides a graphical view of the projected trends by service class. Of note is the slowdown of growth that starts after 2035. This is directly related to the slowing of population growth in these later years.

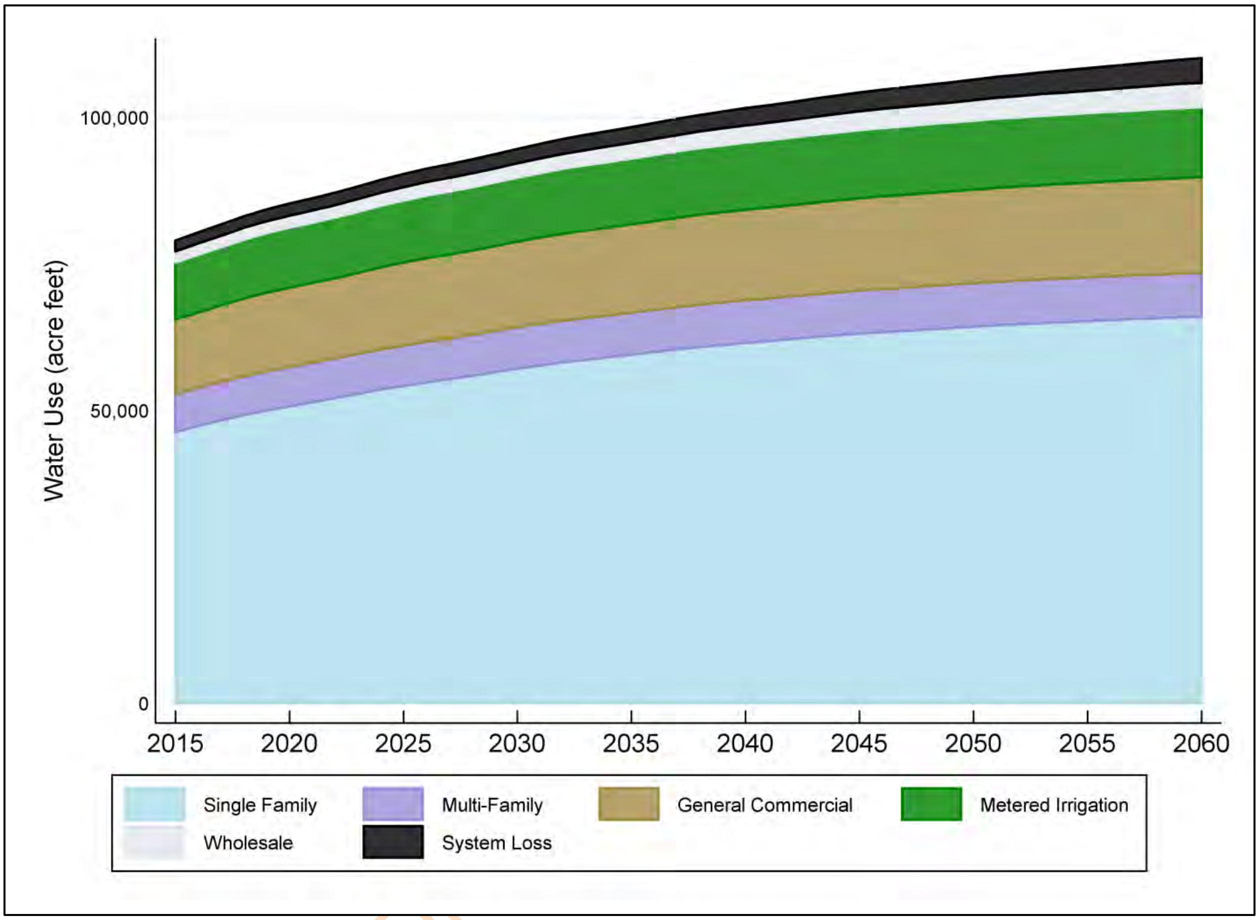


Figure 4-6. Projected Retail Water Use by Class Through 2060

Table 4-6 presents the projected water production within the TRA and non-TRA by hydrographic basin. The system loss is calculated using an estimate of 6 percent of the total demand.

Table 4-6. Projected Water Use by TRA and non-TRA by Hydrographic Basin Through 2035

	TRA					non-TRA		
	Spanish Springs	Sun Valley	Truckee Meadows	Pleasant Valley-West	Lemmon Valley	Tracy Segment	Pleasant Valley-East	Washoe Valley
	85	86	87	88	)2A & 92I	83	88	89
	----a----	----b----	----c----	----d----	----e----	----f----	----g----	----h----
2015	8,961	2,205	64,940	1,030	4,388	25	46	140
2016	9,160	2,245	66,042	1,054	4,473	26	46	144
2017	9,343	2,286	67,115	1,075	4,550	27	46	147
2018	9,506	2,329	68,221	1,094	4,625	27	47	150
2019	9,652	2,370	69,163	1,112	4,690	28	48	152
2020	9,786	2,411	69,946	1,128	4,751	28	49	154
2021	9,911	2,453	70,641	1,143	4,802	28	50	156
2022	10,042	2,496	71,339	1,159	4,857	29	51	158
2023	10,179	2,540	72,173	1,174	4,916	29	51	159
2024	10,321	2,584	73,059	1,191	4,980	30	52	162
2025	10,441	2,629	73,829	1,205	5,034	30	53	164
2026	10,545	2,674	74,514	1,218	5,084	30	53	166
2027	10,651	2,719	75,105	1,230	5,126	31	54	166
2028	10,753	2,766	75,682	1,243	5,169	31	54	169
2029	10,875	2,814	76,355	1,256	5,218	31	55	170
2030	10,985	2,862	77,055	1,271	5,269	31	56	174
2031	11,091	2,911	77,740	1,282	5,320	32	56	175
2032	11,185	2,961	78,364	1,293	5,362	32	56	177
2033	11,271	3,011	78,855	1,303	5,398	32	57	178
2034	11,348	3,062	79,321	1,312	5,433	32	57	180
2035	11,429	3,114	79,790	1,323	5,470	33	58	181

Summary

This chapter included TMWA's population forecast, water demand forecast, factors impacting the demand forecast, and peak day projections. The results are summarized:

- A long term population projection through 2060 is developed using historic county population estimates from 1950 to 2008.
- In developing the water demand forecast, TMWA's population forecast was found to be similar to the 2014 SDP for Washoe County.
- Through the year 2035 Washoe County population is expected to see an average annual growth of 1.17 percent and a total population increase of over 101,000 persons from approximately 444,000 persons in 2015.
- Using recent trends in average water use per service for 2009 to 2014 combined with projected new water services, water demand is projected through 2035.
- Over 150,000 active water services are projected for the year 2035.
- Extrapolation of building trends and water demands show a plateau in water demand starting in 2035.
- Total water demand in 2035 is projected to be about 102,000 AF.

CHAPTER 5 WATER CONSERVATION PLAN

Introduction

In the arid Western U.S., water is a scarce resource necessary not only for the well-being of a community's inhabitants, but also for the ecologic and economic vitality of a region. Nevada, and of interest to this plan, Washoe County, is characterized as a high desert environment that is in a constant state of drought, intermixed with brief periods of wet conditions. Such conditions imply efficient water use is not a concept that applies only during dry times, but is rather a way of life in Northern Nevada.

As the water purveyor for approximately 90 percent of Washoe County residents, TMWA has a substantial responsibility as a steward of the region's water resources. In southern Washoe County, the majority of the water resources come from seasonal snow melt that flows down the Truckee River. From year-to-year, the amount of snow melt can fluctuate greatly. In response to these climatic conditions, a robust conservation plan must be in place to successfully manage water supply and demand so that there exists an adequate bank of water reserves available during persistent dry hydrology conditions.

Water conservation is achieved through efficient storage and delivery of the water supply and effective management of demand for that supply. Water supply management has been defined as the control of the water supply by the water purveyor or authority (Stephenson, 2012). Water demand management has been defined as "the development and implementation of strategies, policies, measures, or other initiatives aimed at influencing demand, so as to achieve efficient and sustainable use of this scarce resource" (Savenije and van der Zaag, 2002). TMWA's conservation plan contains the necessary elements to manage both the supply of its water resources as well as demand for those resources. TMWA's conservation plan has two components: 1) supply-side management programs ("SMPs") designed to reduce production and distribution losses and 2) demand-side management programs ("DMPs") designed to conserve water supplies by limiting water waste, inefficient use, and overuse. TMWA's SMPs are actions taken to maintain water resources and provide alternative sources to potable water in a cost-effective manner, as well as to ensure water is delivered to customers in an efficient manner. Once delivered, TMWA's DMPs target customers' watering practices in order to promote efficient use. During periods of extended drought, TMWA's DMPs can be enhanced to promote further reduction in water consumption by its customers. This chapter discusses TMWA's Conservation Plan and how its SMPs and DMPs are used in response to non-drought and drought periods based on annual projected hydrologic conditions.

To support the many benefits of effective conservation, the target goals of TMWA's conservation plan include:

1. Minimizing source water supply disruptions
2. Preserving community and customers' landscaping assets
3. Maintaining a low cost of service
4. Ensuring environmental preservation

Minimizing Source Water Supply Disruptions

When there is not enough Truckee River water to be shared between TMWA and other water rights stakeholders in the region, the priority of water rights dictates the amount of water provided to each stakeholder. TMWA is the largest holder of senior Truckee River irrigation water rights on the Truckee system. However, when the natural flow in the river is not able to provide adequate quantities of water for consumption, reductions in water use can decrease the amount of water to be released from TMWA's upstream and underground reserves. By banking or storing water in reservoirs when allowed under certain river operations, TMWA can minimize, if not prevent, supply interruptions to its treatment plants.

At the water user level, there are steps customers can take to ensure their water services are uninterrupted. When pipes break or leaks occur, not only is it an inconvenience to the customer, it wastes water in the process. TMWA is committed to ensuring its water delivery system stays up-to-date and in good working order. Also, TMWA takes every opportunity to educate customers on how to inspect and maintain their water systems on their property so the water stays on.

Preserving Community and Customers' Landscaping Assets

Property characteristics associated with landscaping add substantial economic value to the property. Government entities and property owners invest significant amounts of time and money in landscape-related assets, both at the time of installation and its ongoing maintenance. Developed land is required by local ordinances to meet specific landscape requirements as part of the building permit process. TMWA requires a sufficient amount of water rights be dedicated for each new development and meet its obligation to serve water to the property in perpetuity. TMWA's Conservation Program is designed to promote efficient demand in general and lower demands during periods of drought, without requiring customers to sacrifice their investment in their landscape assets.

Maintaining a Low Cost of Service

The facility and operating costs to capture, treat and deliver water are the main components that determine the amount customers pay for service. While the majority of costs related to water production are fixed (i.e., there is a very high initial capital cost), there is a portion of that cost associated with system repair and maintenance that can vary annually. When demand for water is efficient, an optimal amount of water is produced and delivered. With optimal supply through the delivery system, wear and tear on the system's components (e.g., pumps, valves, pipes, meters, etc.) is minimized, prolonging their lifecycle. Capital improvement projects ("CIPs") designated to replace aging parts of the system are part of TMWA's supply-side management. Therefore, through effective demand-side management, TMWA is able to keep the associated supply-side management costs low, which in turn provides stable prices to its customers over time[30].

[30] Since 2002, on average, TMWA's per unit cost of service has increased by 13 percent, an increase less than the national average of 31.6 percent adjusted for inflation

Ensuring Environmental Preservation

Maintaining adequate surface flows within the Truckee River has benefits above meeting customer demand. Higher river flows have benefits to the riparian ecosystem as well[31]. A variety of wildlife species, such as the Cui-ui and Lahontan Cutthroat Trout, depend on the habitat found in Lake Tahoe, along the Truckee River, and its terminus, Pyramid Lake. In times of drought, natural river flows are diminished, which has adverse impacts on native species of fish and other wildlife that rely on the riparian system. By conserving water, upstream reservoirs stay fuller longer. This additional storage allows TMWA to ensure river flows are supplemented during times when the level of Lake Tahoe cannot provide sufficient outflow, which indirectly benefits the riparian habitat along the Truckee River.

TMWA's Water Conservation Plan

Legislative Satisfaction

TMWA's conservation plan extends beyond a responsibility for resource stewardship and must fulfill specific provisions—including water conservation requirements per the JPA, the NRS, regional planning, and TROA. Under NRS 540.131, every water purveyor in Nevada must submit a water conservation plan to the State. This plan must include provisions related to: 1) increasing public education awareness; 2) encouraging reductions in the size of lawns and use of drought-tolerant plants; 3) identifying leaks in the supply system; and 4) increasing the reuse of effluent water. TMWA's current Conservation Plan's contains DMPs and SMPs that meet these requirements (Fig. 5-1). Figure 5-1 provides a diagram illustrating how various elements of TMWA's Conservation Plan meet these NRS requirements (NOTE: expansion of TMWA's water resources (i.e., wells and groundwater supplies) are discussed in Chapters 2 and 6).

The statute also mandates a contingency plan be in place to ensure potable water is available during drought conditions and a schedule for how such a plan will be implemented. The end of this chapter outlines TMWA's Drought Response Plan, which provides how TMWA classifies drought conditions pursuant to TROA, the enhanced DMPs it takes given a certain drought condition, and an explicit timeline for when those enhanced actions occur. In 2007, NRS 540.141 added a mandate requiring each conservation measure specified in a purveyor's conservation plan to have an associated estimate outlining the amount of water that will be conserved each year, stated in gallons per-person, per-day (see NRS 540.141 1.(g)). In addition, the NRS now states the rates charged for water will maximize conservation and the plan must estimate the manner in which rates will affect consumption (see NRS 540.141 2.(b)).

[31] Riparian systems include those lands or areas situated along the banks of a watercourse.

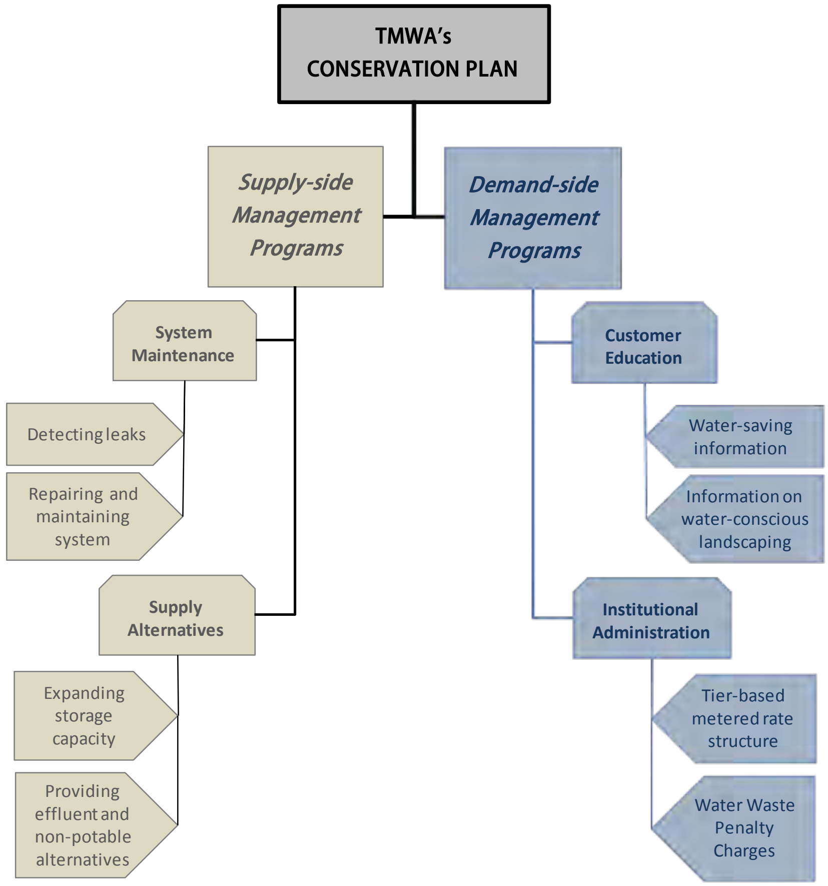


Figure 5-1: Diagram of TMWA's Conservation Plan as Related to NRS 540.131

Overall, residential water use in the TMWA service area has become more efficient over time. By 2014, the average single family household used 11.6 percent less water than the average household in 2003. Much of this savings can be attributed to changes in plumbing codes, reduction in the average size of the property of new residences, separation of TMWA's bills from NV Energy's bills in 2001, metering of previously unmetered (flat-rate) services, and increasing rates commensurate with the cost to serve TMWA's customers. However, there are issues that can confound or preclude estimations of 'per-person, per-day' water savings for individual DMPs. Moreover, the effectiveness of SMPs do not directly relate to 'per-person, per-day' savings. SMPs are not savings *by* customers but rather savings on the supply-side that accrue to the distribution system and therefore all users. For such programs (e.g., leak repair and effluent use) a 'percent of the total supply' savings is a more meaningful metric from which to estimate effectiveness.

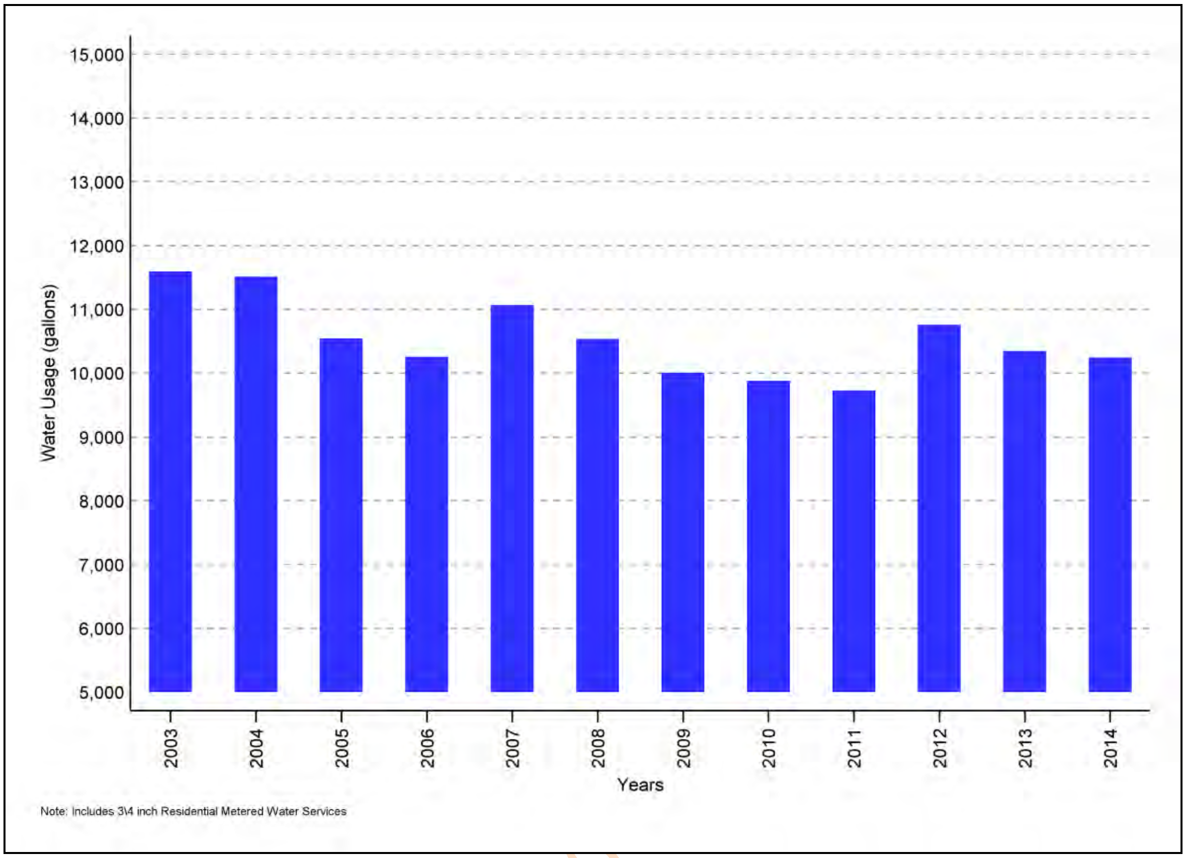


Figure 5-2: Average Monthly Residential Metered Water Use between 2003 and 2014

The major roadblock to quantifying efficacy of DMP's, for which 'per-person, per-day' metrics can be determined, is lack of data. Take for example educational programs (e.g. multi-media messaging, online resources, in-person workshops, etc.). It is not feasible to track the information to which customers have been exposed to each program. Even if such tracking was feasible, customers are exposed to information via a host of different formats, so any attempt to delineate the effect of any one program from another would prove unreliable in the uncontrolled environment. In such contexts, the combined effect of individual programs is the only possible estimate of effectiveness. This chapter provides estimates of benefits from each activity and states the measure of gallons saved 'per-person, per-day' whenever possible (or meaningful). For programs in which 'per-person, per-day' estimates are not relevant, the most meaningful metric will be provided. Programs for which there is no data available from which to estimate effectiveness will be noted.

In early 2015, TMWA partnered with the University of Nevada to conduct research on how different forms of communication and messaging influence customer behavior using a controlled study (i.e. treatment and control groups). TMWA is also investigating how customers conserve water in times of drought, their attitudes about drought, and their attitudes about TMWA's drought communication efforts. Results from this investigation will be available by the spring of 2016. These studies will offer a deeper understanding into the scope and effectiveness of TMWA's water conservation programs.

TMWA's Conservation Plan will continue to serve as the cornerstone of the region's efforts to conserve local water resources. Given primary reasons for TMWA's Conservation Plan is to promote efficient use of water resources and minimize water waste, each program within the plan plays a unique role in meeting these goals. While many of the water conservation benefits outlined above are interrelated, each program within the Conservation Plan is designed to elicit a specific response from a targeted customer base, in order to achieve a specific set of goals. Table 5-1 summarizes each program, along with its targeted goal(s) and customer(s).

Table 5-1: TMWA's Standard Conservation Plan Programs

Water Conservation Plan	Target Goal	Target Customer
Supply-side Management Programs/Activities		
System Maintenance		
Leaks and System Repairs	1,3	All users
Meter Replacement	1,3	All users
System Pressure Standards	1,3	All users
Supply Alternatives		
Non-Potable Water Service	1,3	Irrigation
Demand-side Management Programs/Activities		
Customer Education		
Conservation Consultant Program	2,3	Residential
Water Audits/Water Usage Reviews	1,2,3	Residential & Business
Public Workshops	1,2,3	Residential
School Educational Programs	1,2,3	Residential
Standing Advisory Committee	1,3,4	All users
Online Resources	1,2,3,4	Residential & Business
Conservation Materials	1,2,3	Residential & Business
Multi-media Messaging	1,2,3,4	All users
Institutional Administration		
Water Rates	2,3	All users
Assigned-Day Watering	1,2,3	All users
Watering Time Restrictions	1,2	All users
Water Waste Restrictions	1,2,3	All users
Unauthorized Use of Water	1,3	All users
Landscaping Regulations	2,3,4	All users

Target Goal
1. Minimize service disruptions
2. Preserve Customers' Landscaping Assets
3. Maintain a low cost of service
4. Ensure environmental preservation

Supply-side Management Programs/Activities

To ensure water resources are captured and delivered to customers in an efficient manner, the majority of TMWA's SMPs are CIPs that maintain the integrity of its water system's infrastructure.

System Maintenance

As system components wear out, there is a greater potential for water loss. TMWA is constantly engaging in CIPs that reduce water loss within the delivery system by detecting and repairing aging infrastructure. TMWA continually monitors and maintains its water system infrastructure in order to ensure service disruptions are minimized. TMWA is also very conscious about the cost-effectiveness and expected benefits of system maintenance. Therefore, TMWA incorporates the likelihood and consequences of water main failure to reduce risks to the system associated with unplanned outages and emergency repair costs.

Leaks and System Repairs. Over time, parts of the water-system infrastructure degrade and require repair or replacement. TMWA actively monitors for leaks in the system. When assessing leak repairs, maintenance scheduling considers the safety to the general public and work crews, while providing minimal interruptions to public and private services, as well as minimal overtime expenditures. If water leaks are not large, not causing a safety problem, and are reported outside normal working hours, response staff will determine the urgency of the needed repairs and schedule repair work accordingly.

When the source of the leak is determined, TMWA implements a proactive maintenance program to fix the problem. Once the underground locations of other utilities are determined, the crew will excavate the leak site and make repairs. In the case of a leaking poly-butylene pipe, the crew will usually replace the entire service, as this type of pipe has proven particularly prone to repeated leaks. All leaks are reported and entered into a database.[32] Below are the number of main and service repairs since January 2012.

FYE	Mains	Services	Totals
2012	60	147	207
2013	58	216	274
2014	69	224	293
2015	49	287	336

In order to keep leak occurrences to a minimum, TMWA prioritizes system repairs and replaces aging infrastructure on a continual basis, before an incident occurs. Prioritization is given to pre-1960 systems made of steel, cast iron, concrete, or riveted steel. Coordination with local agencies' street and highway replacement programs has proven to be the most cost effective and least disruptive approach to system replacement and

[32] TMWA's Computerized Maintenance Management System was deployed beginning CY012; prior to that time leak data records are not as reliable

rehabilitation for TMWA customers. See Appendix 5-1 for more information on TMWA's Main Replacement Program.[33]

Quantification of Effectiveness: TMWA's system-wide leakage rate is very low at 3.1 leaks per 100 miles per year, indicating very high service levels currently exist. On average, TMWA loses approximately 6 percent of total supply through system leaks, well below the national average of 16 percent[34]. This 6 percent also includes non-revenue water (i.e., unmetered, authorized use in firefighting as well as hydrant testing and flushing) and apparent losses (i.e., unmetered, unauthorized use resulting from water theft). This means the real loss of water is some percentage lower than the reported amount. In 2014, TMWA produced approximately 75,000 AF of water. When compared to the national average for water loss, due to TMWA's proactive maintenance schedule, the reduced system loss resulted in 7,500 AF of water loss adverted that year. This equates to an additional 6.7 MGD available for customers.

Meter Replacement. In order to effectively identify leaks and other forms of water loss in the system, accurate metering is critical. Since the internal workings of a meter wear out over time, TMWA's Meter Replacement Program replaces meters as soon as they begin to show signs of failure (e.g., seemly incorrect readings). This practice ensures meters remain in good working condition yet still allows for an extended return on the investment. It is anticipated that TMWA will spend approximately $8.9 million in FYs 2016-2020 on meter and meter reading device replacement. As meters are replaced, additional water savings may be achieved, since improvements are made to the system when leaks in older facilities are found and repaired during the process.

Quantification of Effectiveness: At the time this report was written, no measure of water saved from meter replacement had been estimated.

System Pressure Standard. Pursuant to the Nevada Administrative Code ("NAC") 445A, TMWA's engineering design criteria plans for a max-day-demand-residual pressure of 40 pounds per square inch ("PSI") to be maintained at the customer's service connection. Pressures exceeding 125 PSI may increase the propensity for main breaks or accelerate the development of leaks, both on TMWA and customer facilities. Excessive pressure results in more water delivered through the tap since flow rate is proportional to pressure. This can result in such forms of water waste as sprinkler overspray and higher leakage flow rates.

Quantification of Effectiveness: At the time this report was written, no measure of water saved from TMWA's pressure standard had been estimated.

[33] Appendix 5-1 provides a narrative of the analytic process and findings with maps provided to give the reader a general characteristic of the range of TMWA's main replacement.
[34] Source: Water Audits and Water Loss Control for Public Water Systems, USEPA July 2013

Supply Alternatives

In order to maximize the amount of potable water available to customers, TMWA actively seeks out opportunities to provide non-potable or effluent sources of water whenever possible.

Non-Potable Water: TMWA has a Non-Potable Service ("NPS") tariff to provide customers that can use sources of non-potable water – either untreated Truckee River water or poor quality ground water – for specific applications with minimal capital investment. The non-potable water service is available at a reduced rate, providing incentive for qualified customers to switch to this service. The service reduces TMWA peak day demand and lowers system capacity needs. Irrigation and construction sites utilize NPS to conserve potable water, enabling existing water resources to go further.

Specific facility needs for each service connection are identified in the service agreements between TMWA and the customer receiving non-potable service. The recipient of the service demonstrates each site's ability to tolerate the interruptible nature of the service (due to system or drought requirements) and/or the potential to switch between treated and untreated water. For example, TMWA has worked with the Washoe County School District, one of TMWA's largest municipal customers, to implement non-potable watering solutions at Reno High School.

TMWA also coordinates with the Truckee Meadows Water Reclamation Facility ("TMWRF") to provide use of effluent water in lieu of TMWA's water supplies. TMWA has agreements with Reno, Sparks and Washoe County to ensure that the use of treated effluent is being applied for irrigation purposes at suitable sites where the infrastructure is, or is planned to be, installed. Providing service connections with effluent leaves capacity for new municipal demand that requires treated water. TMWA's rules require that new service applicants submit verification of whether or not the site applying for municipal, treated water is designated to be, or is within feasible range to be, serviced by effluent water. If the project meets the effluent provider criteria for service, treated effluent will be provided for irrigation purposes instead of potable water from TMWA. Replacement water rights are provided as required by TROA.

Quantification of Effectiveness: On average, TMWA's NPS supplies 34 million gallons of non-potable water annually, which saves approximately 93,000 gallons of potable water each day for use by other customers. Effluent water use reduces demand for TMWA's potable and non-potable water resources. On average, 3,810 AF of effluent water is provided annually, which keeps 3,401,353 gallons of TMWA's water resources available for other customers on a daily basis.

Demand-Side Management Programs/Activities

While many communities use conserved water to serve new growth, TMWA uses conserved water to ensure adequate supplies are provided to its existing customers. Once delivered to the customer, TMWA promotes efficient water use through its proactive DMPs. By utilizing a mix of education-based programs and institutional administration, TMWA's DMPs directly target customer behavior to promote efficient water use year-round and lower demands during periods of extended drought. By lowering demand during drought periods, DMPs reduce or eliminate the need for TMWA to use its drought reserves (aka POSW).

Customer Education

TMWA is deeply committed to public education about conservation and efficient water use. TMWA utilizes every opportunity to promote education. Since water use during the irrigation season is on average four times higher than during the winter months, much of TMWA's public education focuses on the efficient use of water for landscaping. TMWA facilitates efficient use by distributing information through various forms of communication including in-person workshops and events, multimedia messaging, and printed materials.

<u>Multi-media Messaging.</u> TMWA is committed to providing the public with the most recent information regarding the state of the local water supply. Using media outlets such as radio, television and billboards, TMWA produces targeted advertising to get its messages to customers. TMWA also uses social media platforms (i.e., Facebook, Twitter, YouTube and Google Plus) to help spread information regarding changing conditions in weather and the water supply, as well as tips for efficient water use. TMWA also works with local news stations to help pass on accurate, up-to-date drought information to its customers.

Quantification of Effectiveness: Given the inability to track the customers whom were exposed to different forms of multi-media messaging, it is not possible to determine the individual effect the materials have on conservation. As of the writing of this report TMWA has 1,231 Facebook followers, 1,201 Twitter followers, and 17 Google Plus followers. Such participation rates are noted when considering the effectiveness of various messaging components. Moreover, when asked to reduce water consumption (via all forms of communication), customers' responses are on par with what TMWA requires to help withstand periods of drought. In 2014, a drought situation occurred in August and lasted through September. During this time, TMWA's request for customers to reduce their use by 10 percent compared to their use in 2013 was met favorably. This was the *first* time since TMWA's founding in 2001 that TMWA asked for a specific reduction in use beyond the annual DMP deployment. This request resulted in an average of 8.5 million gallons saved per-day in 2014 by TMWA customers. It is important to note that while the multi-media messaging campaign directly requested the 10 percent reduction, the subsequent educational programs detailed below help facilitate this additional reduction by customers. Therefore, the effectiveness of programs should be evaluated at the aggregate. See Table 5-6 for a comparison in retail sales for the months of August and September in 2013 and 2014.

<u>Conservation Consultant Program.</u> TMWA's conservation consultants provide customers information regarding responsible water use, reducing water waste, and TMWA's regulations. During the irrigation months, TMWA ramps up its efforts by hiring additional seasonal consultants to provide both residential and business customers with additional information about leaks and water waste associated with outdoor watering.

TMWA's water conservation consultants investigate water waste complaints and provide tips to customers that help curb excessive water usage and facilitate lower monthly bills.

Quantification of Effectiveness: At the time this report was written, no measure of water saved from TMWA's Conservation Consultant Program had been estimated.

Water Audits/Water Usage Review. In 2003, TMWA began a water audit program. The Water Usage Review Program is co-sponsored by TMWA and the WRWC. At the request of the customer, a TMWA technician will conduct an analysis of the customer's current water usage practices and provide recommendations on how the customer can reduce their water consumption and subsequently their monthly bill. Customer response to TMWA's Water Usage Review Program is extremely positive. As of December 2014, nearly 20,000 customer usage reviews have been completed (see Table 5-2). While the majority of water usage reviews are initiated by a customer's concern about a high bill, TMWA monitors spikes in individuals' water use to proactively assist customers in achieving a balance between water savings and maintaining a healthy landscape.

Quantification of Effectiveness: Difference in means analysis was performed on 1,239 residential customers who requested a water audit between 2003 and 2013. To be included in the comparison study, these customers had *at least* one full year of information on water consumption before a water usage review was conducted. Comparison of residential customers' monthly water consumption before and after an audit request was made indicated an average annual per-customer water savings (i.e., reduction in water use) of 6.5 percent[35]. The greatest total savings (in terms of gallons per month) came at the peak of the irrigation season. During the months of June, July, and August, approximately 1,400 gallons per month (or 6.0 percent) were saved per customer each month equating to a savings of 47 gallons 'per-service, per-day' during the peak of the irrigation season. At the time this report was written, analysis on effectiveness on commercial customers had not been performed.

[35] This difference in average usage is significant at the 99 percent level of convention.

Table 5-2: TMWA Customer Water Audits 2003 - 2014

Year	Residential	Commercial	Total	Cumulative Total
2014	1,351	162	1,513	19,754
2013	1,351	126	1,477	18,241
2012	1,522	141	1,663	16,764
2011	1,838	206	2,044	15,101
2010	2,949	381	3,330	13,057
2009	2,375	300	2,675	9,727
2008	2,196	265	2,461	7,052
2007	1,804	221	2,025	4,591
2006	661	70	731	2,566
2005	771	123	894	1,835
2004	431	66	497	941
2003	402	42	444	444

Public Workshops. Over the course of a year, TMWA provides regular workshops regarding landscaping and irrigation. Topics include: tree care, irrigation system start up, sprinkler maintenance, landscape and xeriscape design, and proper winterization. TMWA also co-sponsors seminars that address landscape design, operation and maintenance of irrigation systems, and related topics. During years when drought conditions are present, TMWA holds special workshops that help customers understand TMWA's water delivery system, how TMWA responds to drought conditions, and how customers can take action to help reduce water usage.

Quantification of Effectiveness: TMWA workshops are offered as an educational resource to promote conservation through efficient water use. Effectiveness is measured by both demand for the workshops and attendance. In 2014 and 2015, enrollment demand was such that additional sessions were offered most of which enjoyed capacity attendance. Unfortunately, it is not feasible to estimate the per-person, per-day water savings such programs would have but, like all of TMWA's customer-education efforts, the emphasis is placed on correcting wasteful behavior by increasing awareness of effective conservation practices.

School Educational Programs. TMWA representatives regularly engage students and teachers regarding northern Nevada's water resources through classroom participation and presentations.

Quantification of Effectiveness: Given the privacy concerns about connecting student participation in TMWA's educational programs to actual customer usage, it is not possible to determine the individual effect this form of education has on conservation. Regardless, early involvement in conservation is an important component in TMWA's conservation plan.

Online Resources. A key part of TMWA's educational messaging centers around understanding the region's water resources. TMWA's main website (www.tmwa.com) directs customers to information on local water supplies and how they are managed. Table 5-3 outlines the various online resources available to customers to help them use water efficiently and avoid water waste. In addition to its primary website, TMWA also deploys situation-specific "micro-sites". These temporary online resources contain enhanced messages that address specific concerns and goals during times of drought. Refer to this chapter's Drought Response Plan section for details on designating drought classifications. It is possible that some or all of these micro-sites will be incorporated into TMWA's primary website when it is updated.

Quantification of Effectiveness: Given the inability to directly track the conservation response of customers who access each website for information on efficient water usage, it is not possible to determine the impact such websites have on conservation. Regardless, these online resources are important components in TMWA's Conservation Plan and its positioning as a community leader in promoting responsible water use.

Table 5-3 TMWA's Online Conservation Resources

Program	Website	Description
Truckee River Flows and Storage	www.tmwastorage.com	Tracks water storage in the largest reservoir on the Truckee River system, Lake Tahoe.
Water Conservation Overview	http://tmwa.com/conservation	An overview of why conservation is important and directs customers to additional conservation links.
Water Conservation Checklist	http://tmwa.com/conservation/checklist	Tips to save indoor and outdoor water use
Winterization Tips	http://tmwa.com/conservation/winterize	A guide to winterizing residential homes
Finding and Repairing Leaks	http://tmwa.com/conservation/leaks	Provides information and links to online videos that help locate water leak.
Water Efficient Landscape Guide	http://www.tmwalandscapeguide.com	An interactive guide to help customers design and evaluate their landscaping choices.
Principles of Xeriscape	http://tmwa.com/conservation/xeriscape	Seven horticultural principles of xeriscape.
tmwa.com/save	www.tmwa.com/save	This micro-site was launched to provide customers with a simple list of things they can do to reduce their water use "at least 10%," (that summer's goal). The site will be updated as needed to support future conservation campaigns.

Conservation Materials. TMWA provides a multitude of written materials regarding ways customers can use water efficiently, reduce their usage, and avoid water waste. These conservation materials include:

1. Direct Mail - In addition to providing detailed information on how water usage affects their monthly bill, TMWA uses its billing system to convey conservation messages and facts directly on customer's bills. These bill inserts serve as reminders about summer and winter habits that can conserve water.

2. Landscape Design PDF resources – These downloadable PDF resources, found at TMWA's *Water Efficient Landscape Guide* website, provide detailed information on landscaping, irrigation, and plant and turf maintenance.
3. Door hangers - Whenever a TMWA conservation consultant visits a home or business to remind customers of their watering times, a door hanger is left containing a variety of pertinent materials such as water times and restrictions, tips on tree and lawn care, etc.
4. Water saving devices – Upon request by customers or whenever a TMWA conservation consultant visits a customer's premise, TMWA provides sprinkler timers, hose nozzles, low-flow shower heads, dye tabs, flow-rate bags, or faucet aerators to further assist customers in their water saving efforts.
5. Enhanced Drought Information Materials – During times of drought, TMWA provides materials regarding detailed information and specific actions customers can take to help TMWA manage water demand. These enhanced materials include table tents for restaurants, stickers for public restrooms, and letters to homeowner's associations, etc. Refer to this chapter's Drought Response Plan section for details on designating drought classifications.

Quantification of Effectiveness: Given the inability to track the customers who receive different conservation materials, it is not possible to determine the individual effect the material have on conservation. Regardless, these printed resources are important components in TMWA's conservation plan.

Institutional Administration

TMWA has internal rules and regulations that apply to water supply services. Under state law, TMWA is not authorized to supply service to any customer who does not comply with all regulations. TMWA regulations can be found at http://tmwa.com/customer_services/waterrules/. Additionally, local governments and agreements within private developments have codes regarding landscaping design and water conservation practices. In general, municipal codes are designed to work in tandem with TMWA's rules and regulations.

Water Rates. In order to ensure customers use water responsibly and adequately recover costs, metered rates are employed. Municipal service rates are assessed using an inverted block structure with three to five tiers. This increasing rate structure allows for low costs associated with indoor water use and incentivizes customers to use outdoor water efficiently to avoid going into the more expensive tiers. Irrigation services pay a constant rate per 1,000 gallons, which varies according to a seasonal rate structure. During the peak summer months of June through September the rate is higher than during the off-peak months of October through May. This helps encourage conservation-related behaviors such as scheduling new plantings for cooler months when less intensive watering will be required. As part of the merger agreements with WDWR and STMGID, rate structures for their former customers have been maintained as of June, 2015. TMWA will continue to use a tiered volumetric billing rate structure for all non-irrigation services. Every few years, water rates and cost of service are reevaluated to account for customer base growth and system component requirements. For the most up-to-date water rates schedules, go to http://tmwa.com/customer_services/waterrates/.

Quantification of Effectiveness: Research conducted by the University of Nevada, Reno Department of Economics indicates that, on average, a 10 percent increase in price is associated with a 2 percent decrease in water usage by residential customers.

Assigned-Day Watering. Since 2010, TMWA has recommended a three-times-per-week, Assigned-Day Watering schedule, with a no-watering restriction on Monday to allow for treatment-operations recovery. The water days schedule and restrictions on times of the day under Assigned-Day Watering is summarized here:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
All "EVEN" addressed services	No	Yes	No	Yes	No	Yes	No
All "ODD" addressed services	No	No	Yes	No	Yes	No	Yes

Quantification of Effectiveness: TMWA began studying watering schedules beginning in 2004 through 2008 before converting from 2-day-a-week (required until such time that over 90 percent of the flat-rate single family residences were retrofit with a meter which occurred in 2009) to 3-day-a-week watering. Study results found that the three-day-a-week schedule results in less overwatering and waste than the prior 2-day-a-week watering schedule: during the 2-day-a-week schedule it was determined that over 55 percent of customers either were watering 3-days-a-week or were over-watering on their assigned days (see Appendix 5-2 for full report). However, because the system was not fully metered and the change in water schedule went into effect system-wide, no estimate of gallons 'per-person, per-day' could be made as the metered data did not exist at the time.

Watering Time Restrictions. Along with Assigned-Day Watering, TMWA discourages watering during the hottest, and typically the windiest, part of the day. Thus, there is a restriction on time-of-day watering between Memorial Day and Labor Day; there is no watering from 12:00 p.m. to 6:00 p.m. during this time of year. During drought years, these no-watering times are expanded by two hours: 11:00 a.m. to 7:00 p.m. Refer to this chapter's Drought Response Plan section for details on designating drought classifications.

Quantification of Effectiveness: Water loss due to evaporation and wind has many associated factors (e.g., temperature, relative humidity, etc.) that vary daily, making estimating the effectiveness of the regulation problematic. At this time, no specific method of measuring effectiveness has been estimated for restricting water-times. However, watering-times are still considered an important regulation regarding water use efficiency.

Water Waste Penalties. In 2004, TMWA enhanced its rules by adding penalties for water waste violations and for watering on non-assigned days or times, which are billed directly to the customer. These rules provide for a warning followed by an increasing penalty of up to $75 per occurrence for repeat violations. However, TMWA has discretion on issuing citations and goes to great length to avoid penalties by instead using education to instruct customers on responsible water use. Many times customers are simply unaware that they are wasting water due to broken or misaligned sprinkler heads.

Quantification of Effectiveness: To date, TMWA has issued 297 penalties to commercial and residential water users. While the behavior is typically corrected, it is difficult to determine the amount of water saved through issuance of penalties.

Unauthorized Use of Water. Use of water without dedicated water rights or without TMWA's permission is not allowed under TMWA's rules. Examples of unauthorized use may include: two active service lines on a premise where one service is not being billed, an illegal tap off a water main, or an unauthorized hook-up to a fire hydrant. TMWA's rules and tariffs are designed to cover all costs to the utility in cases of illegal service taps, damage to TMWA facilities, and/or theft of water at $1,000 per occurrence. Use of fire hydrants as a water source is also illegal under municipal ordinances except for approved city vehicles. TMWA monitors its system to locate and correct unauthorized water use on an ongoing basis.

Quantification of Effectiveness: Since illegal water use is not separately metered it is difficult to estimate how much water is saved by identifying fraudulent water usage. Regardless of the impact, preventing and stopping illegal use is important to keeping customer rates low, preventing service disruption, and facilitating effective firefighting operations.

Landscaping Regulations. The Cities of Reno and Sparks, and Washoe County have landscape ordinances that regulate the types of landscaping developed land must have. In general, these municipal ordinances are designed to support TMWA's conservation efforts and allow enforcement of penalties to water wasters. TMWA conducted an initial review of the municipal ordinances, for Washoe County and the cities of Reno and Sparks related to water conservation and landscaping mandates, in 2005. In April of 2015, the codes for the three entities were revisited to 1) determine what changes have been made to these code provisions since TMWA last reviewed them, and 2) identify recommendations to the Reno City Council, Sparks City Council, and Washoe County Board of Commissioners regarding revisions to the current ordinances, as well as, the potential addition of new requirements. In a series of meetings with planning representatives from the three entities, TMWA determined fundamental changes in the landscaping/water conservation codes and discussed recommendations to improve water conservation planning in the region.

Additional, legal agreements for private master developments can have regulations (e.g. Home Owners Associations' ("HOAs") rules and regulations) beyond what is required under municipal ordinances. During times of drought, TMWA asks HOAs to allow their residents the ability to comply with TMWA's requests for customers to reduce their water use without penalty. In 2005, a piece of legislation, NRS 166.330, was passed prohibiting HOAs from "unreasonable" restrictions of homeowners utilizing drought-tolerant landscaping on properties within their jurisdictions. However, in order for the homeowner to convert his or her landscaping from the approved vegetation type(s) to a drought-tolerant variety, the homeowner must first submit a detailed architectural plan of the new landscaping design. The HOA has the right to review the plan and can approve or deny the request; however, the HOA cannot deny a plan unreasonably, i.e., if, to the maximum extent possible, the altered design is compatible with the overall style of the community. While this statute clearly applies to all covenants, conditions and restrictions ("CC&Rs") that were established *after* the adoption of the law on October 1, 2005, it remains to be determined if such a law can apply to CC&R's prior to that date without impairing the existing contract.

Quantification of Effectiveness: Since municipal ordinances apply to all properties within a jurisdiction and these ordinances can vary both within and between jurisdictions, it is not possible to estimate the water savings that results from changes to municipal ordinances designed to further reduce water waste.

Drought Response Plan

Under normal circumstances when TMWA does not need to use its drought reserves, the aforementioned DMPs are adequate to promote efficient water use. However, if a Drought Situation is identified within the Truckee River Basin and drought reserves are required to be used, TMWA's customers are expected to take additional actions to reduce their water use. Depending on the severity of the drought and the available quantity of TMWA's reserve water supplies (i.e., Independence Lake, Donner Lake, Stampede Reservoir, and groundwater storage), the aforementioned DMPs may be modified to achieve water reductions necessary to ensure TMWA's drought reserves are adequate to meet customer demand in the current and succeeding years. In these situations *enhanced* demand-side management programs ("*e*DMPs") are needed. Therefore, similar to Drought Response Plans in previous WRPs, the level to which *e*DMPs are employed can vary during the year, given the severity of the Drought Situation.

Pursuant to the operating criteria outlined in TROA, determination of a Drought Situation[36] takes place in April. That determination is dictated by the amount of water available for the Truckee River system based on available stored water in Lake Tahoe and Boca Reservoir, snowpack amounts, and run-off estimates for the current year; together these are early indications of when river flows will no longer support Floriston Rates. When the elevation of Lake Tahoe and subsequent Truckee River flows fall off significantly earlier than normal, this creates operational challenges for TMWA, forcing TMWA to use additional groundwater pumping and/or back-up drought supplies (i.e., POSW stored in upstream reservoirs) in order to

[36] Pursuant to TROA: "**Drought Situation** means a situation under which it is determined by April 15, based on procedures set forth in Section 3.D, either there will not be sufficient **Floriston Rate Water** to maintain **Floriston Rates** through October 31, or the projected amount of **Lake Tahoe Floriston Rate Water** in Lake Tahoe, and including **Lake Tahoe Floriston Rate Water** in other **Truckee River Reservoirs** as if it were in Lake Tahoe, on or before the following November 15 will be equivalent to an elevation less than 6,223.5 feet Lake Tahoe Datum."

meet the demands of its water customers during the irrigation season. Discussion of drought period operations is found in Chapter 2.

TMWA uses a three-stage Drought Situation classification system. Per TROA, in a non-drought situation the elevation of Lake Tahoe is such that natural river flows will maintain Floriston Rates through Labor Day. Under this situation, no reserves are projected to be used, thus no *e*DMPs are necessary since demands typically are reduced after Labor Day. Similarly, when a Drought Situation is identified but Lake Tahoe and Boca Reservoir supplies remain adequate to maintain Floriston Rates until after Labor Day, no *e*DMPs need be deployed. While customer irrigation demands may remain after Labor Day, requiring POSW to meet those demands, a certain amount of those reserves must be released anyway to be in compliance with federal flood regulations. However, during a Drought Situation, if Lake Tahoe and Boca Reservoir supplies are not sufficient to maintain Floriston Rates in any month before Labor Day, then one of three levels of *e*DMP is identified and actions outlined to ensure customer demands are reduced in the current year. Such actions will reduce the use of drought reserves in the event a successive Drought Situation occurs the following year.

Table 5-4: TMWA's Drought Situation Classification System

	NON-DROUGHT SITUATION	**DROUGHT SITUATION**	
	Reserve Supplies NOT Released	**Reserve Supplies Release AFTER Labor Day (Level 1)**	**Reserve Supplies Release BEFORE Labor Day (Level 2, 3, or 4)**
A. Watering Restrictions			
Between Memorial Day and Labor Day	12 to 6 P.M.	12 to 6 P.M.	11 to 7 P.M.
B. Public Education and Advertising	Standard programs	Standard programs	Increased programs
C. Water Waste Prevention	Standard enforcement	Standard enforcement	Increased enforcement
D. Other Actions			Additional *enhanced* DMP are deployed depending on the severity of the drought and time of impact to water supplies. These include but are not limited to; 1) Drought Rates during irrigation season 2) Reduced number of watering days 3) Daily water allotments set 4) See Appendix 5-3 this Chapter for other options

Each level of *e*DMPs depends upon when Floriston Rates are anticipated to be lost. The first *e*DMP TMWA will employ is an enhanced messaging campaign ("EMC") which provides the public with additional information on current water supply conditions and what TMWA will be expecting from its customers in the coming months. TMWA's Drought Situation classification system is presented in Table 5-5 along with recommended timing for changes in existing conservation measures to occur over the course of a Drought Situation.

Table 5-5: TMWA's Enhanced Demand Management Programs by Drought Situation

		Month					
		May	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**
Non-Drought Situation		DMP	DMP	DMP	DMP	DMP	DMP
Drought Situation							
Reserve supplies **not** needed before Labor Day	Level 1	DMP	DMP	DMP	DMP	DMP	DMP
Reserve supplies needed *before* Labor Day	Level 2	DMP	DMP	EMC	*e*DMP	*e*DMP	DMP
	Level 3	DMP	EMC	*e*DMP	*e*DMP	*e*DMP	DMP
	Level 4	EMC	*e*DMP	*e*DMP	*e*DMP	*e*DMP	DMP

DMP - standard demand-side management program

*e*DMP - *enhanced* demand-side management program

EMC - enhanced message campaign begins at least a month prior to *e*DMP deployment

The following figure illustrates the process, pursuant to TROA, to determine if a Drought Situation exists and then access the level of severity of the Drought Situation may have on TMWA's drought reserves in order to develop an action timeline to deploy *e*DMPs along with an accompanying communication plan to meet the targeted reduction in annual water demands.

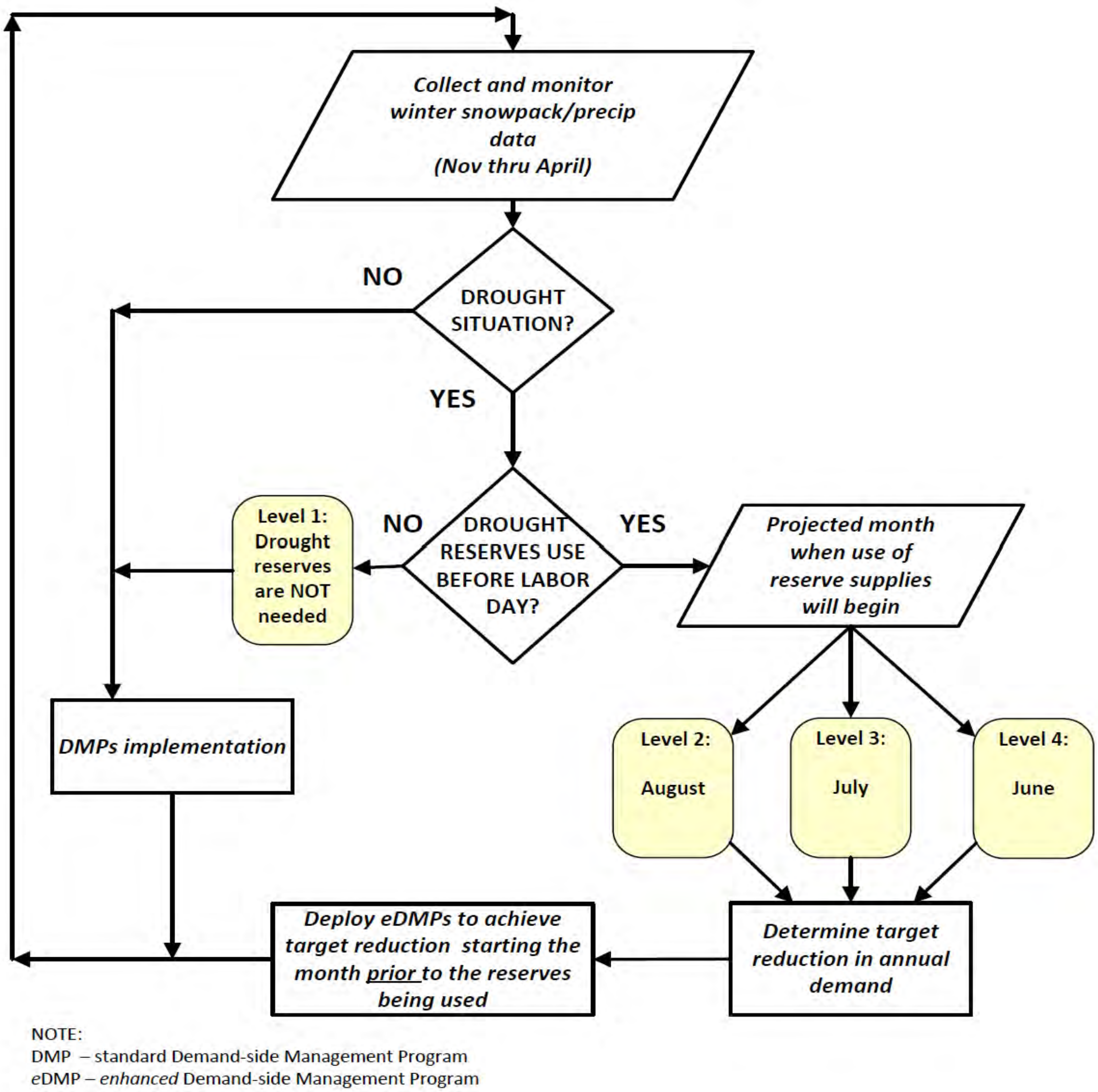


Figure 5-3: Drought Situation and Demand-side Management Response Flowchart

The Drought Response Plan TMWA initiated in 2014 is a good example of how this system works. In April of 2014 a *Drought Situation: Level 2* was identified. Factors for this classification included a seasonal snowmelt which would result in Lake Tahoe falling below its rim in the fall and Floriston Rates were expected to drop-off by late-July. This meant, in addition to groundwater pumping, release of POSW would be required in the late summer months. Starting in July, TMWA began its EMC by asking its customers to reduce their water use by 10 percent compared to their use in 2013.

> *Quantification of Effectiveness:* In 2014, customers responded well to the request for a voluntary reduction of 10 percent. Overall, in August all metered commercial and residential customers reduced their use by 7 percent. By September, the entire customer base responded with an 11 percent reduction in use. The following table compares the monthly retail water sales for August and September in 2013 and 2014.

Table 5-6: Month Retail Water Sale for August and September 2013 and 2014

	August	September
Monthly Water Sales in 2013 (AF)	9,377	8,884
Monthly Water Sales in 2014 (AF)	8,759	7,908
Total Savings (AF)	618	976
Total Savings (%)	-7	-11
Total 'Per-Day' Savings (AF)	20.6	32.5

Sales figures exclude wholesale customers.

In April of 2015, due to the worst snowpack on record it was determined that the drought period would extend into the next irrigation season. In response to these hydrologic conditions, TMWA elevated the Drought Situation to *Level 4*. In May of 2015—two months earlier than 2014—TMWA began its EMC and customers were asked to reduce their use by at least 10 percent in the coming months, again compared to 2013's usage. In the subsequent months the following *e*DMPs were deployed:

- television advertising,
- increased radio advertising,
- dedication of conservation website (tmwa.com/save),
- increased Conservation Consultant staffing,
- conservation-car wraps (10 vehicles),
- internet advertising,
- table tents at restaurants stating water was served upon request,
- stickers in commercial restrooms reminding people to save 10 percent,
- increased educational programs, and;
- letters to HOAs requesting they not fine residents who let their lawns turn brown.

There was also a significant increase in media engagement with TMWA staff being interviewed almost daily. Compared to 2013 the water use reduction result was a 10.5 percent in June, a 16 percent drop in July, a 9 percent in August, and no measurable percent drop in September; the combined estimated water use reduction comparing 2015 to 2013 is estimated to be 10 percent, or approximately 5,000 AF. The following table (Table 5-7) compares the monthly retail water sales for June and July in 2013 and 2015. Some of this reduction was attributed to greater-than-average rainfall in the region during May and June of 2015.

Table 5-7: Monthly Retail Water Sale for June through September 2013 and 2015

	June	July	August	September
Monthly Water Sales in 2013 (AF)	[illegible]	[illegible]	[illegible]	4
Monthly Water Sales in 2015 (AF)	*Awaiting final 2015 dataset to complete analysis; will be provided in final version.*			
Total Savings (AF)				
Total Savings (%)				
Total 'Per-Day' Savings (AF)				

Sales figures exclude wholesale customers.

The management of TMWA's customer demand during drought conditions in 2014 and 2015 are examples of how well TMWA's Drought Response Plan succeeded in achieving water use reductions warranted for the given year's water supply. These years provide a case study of how the eDMPs are flexible enough to adequately control water demand based on the level of drought severity. As of the writing of the 2035WRP, TMWA is engaged with scientific experts and relevant stakeholders on a USBR sponsored project to provide an updated Drought Response Plan given potential changes in the variability of the local climate. Results of this two-year study will be available in July of 2017.

Demand Management Programs and Emergency Supply Conditions

Natural disasters and other unforeseen events can interrupt TMWA's available water supplies. These include floods, extreme low precipitation years, earthquakes, equipment failure, or distribution system leaks. Sometimes the events are localized within the distribution system and sometimes the whole community can be affected in which cases the government can declare a state of emergency. Under such cases, TMWA's goal is to minimize service disruptions and, when necessary, the community is asked for, and has responded favorably to, increased and more aggressive conservation messages and calls for water use reductions and restrictions. Some of the *e*DMPs to be used during a state of emergency include mandatory water conservation (i.e., once-per-week or no outside watering during summer months, reduced laundry at commercial properties, use of paper plates in restaurants, no use of potable water for non-potable purposes, heavy fines for water wasters, temporary "drought" rates, etc.). For more information on potential DMPs please see Appendix 5-3.

TMWA's personnel train for management operations under various emergency situations. This training has proven successful as water supply interruptions have been mitigated as swiftly and efficiently as possible such as the April 2008 earthquake in Mogul which destroyed the Highland Flume thereby precluding gravity-fed delivery of water to the Chalk Bluff Water Treatment Plant. TMWA mitigated the incident by 1) turning on its Orr Ditch Pump Station and installed temporary pumps to feed Chalk Bluff, 2) turning on its Glendale Water Treatment Plant, 3) turning on its wells as needed for irrigation demands, and 4) installing temporary piping around the Highland Flume failure to deliver more water to Chalk Bluff. These actions avoided any water supply interruptions for TMWA customers. Increased conservation by TMWA customers during emergencies is just one element of successfully managing water supply interruptions. Chapter 2 describes the types of response tactics TMWA deploys during emergency situations.

Summary

TMWA's Conservation Plan includes a comprehensive list of SMPs and DMPs. As water supplies fluctuate year to year—due to fluctuations in the seasonal snowpack—these programs ensure TMWA and its customers are able to conserve to the degree which is warranted. To the best extent possible, TMWA continually assesses the benefits from each SMP and DMP and may modify any to reflect new practices, technologies, or information. The success of a program is evaluated depending on its scope and TMWA's ability to collect data on the participants and amount of water saved. Such metrics may include: the number of gallons saved (in total gallons or as a percent), the level of customer participation, estimated reduction of peak day usage, visibly improved water management practices, or the number of customers receiving water conservation education. The key findings in this chapter include:

1. TMWA's Conservation Plan meets the requirements of the JPA, NRS 540.313 through 540.151, and TROA.
2. TMWA will continue to be fully engaged in the regional dialogue on responsible water use and will implement programs for its customers that benefit the region and support regional water use goals.
3. TMWA's water demand management programs pursue measures to efficiently use its available water resources by addressing water waste, system deficiencies (e.g., leaks, pressure changes, etc.), public education and outreach, watering schedules, and drought/emergency conditions.
4. TMWA will continually assess the benefits of implemented programs and may modify programs to reflect new practices, technologies, and information. Program success is evaluated differently depending on the type of program and TMWA strives to provide the most meaningful effectiveness metrics, whenever possible.
5. Innovative ways to improve efficient water use will continue to be assessed, including expanded uses of non-potable supplies.
6. Demand management programs may be progressively enhanced during Drought Situations to address the need to reduce water use when water reserve supplies are impacted.
7. Enhanced DMPs may be necessary in response to natural disasters and other events that have potential to interrupt TMWA's available water supplies.

CHAPTER 6 FUTURE WATER RESOURCES

Introduction

This 2035WRP has demonstrated that TMWA currently and for the foreseeable future will continue to rely on the conversion of Truckee River water rights from irrigation to M&I use to meet projected growth in the TRA with limited expansion of groundwater resources in the non-TRA. In the TRA, TROA provides the ability to further utilize Truckee River water rights to meet demands up to 119,000 AF/yr in conjunction with the conversion of irrigation rights, optimization of its recharge and conjunctive use opportunities. In addition to the TROA's demands TMWA has over 20,000 AF of groundwater and over 3,000 AF of creek resources that are over and above the TROA resources as well as 8,000 AF/yr of groundwater available from the North Valleys Importation Project ("NVIP") (should resources be needed to meet new demands in the North Valleys).

This chapter discusses various water-resource management strategies that can be implemented or pursued in order to meet growth beyond the TROA supply. Discussed first are recharge and conjunctive use opportunities which take advantage of existing facilities and water resources to bolster TMWA's ability to reliably meet projected demands. The discussion focuses on future potential expansion of the NVIP, implementation of the Mt. Rose Fan Groundwater Sustainability Project, and Expanded ASR. The focus then shifts to other potential water supply projects that TMWA continues to monitor and consider for future demands beyond TROA.

Conjunctive Management Strategies with Existing Facilities and Resources

North Valleys Importation Project

NVIP is sponsored by Vidler Water Company ("Vidler"). In 2006, Vidler owned over 13,000 AF of irrigation water rights in the Honey Lake groundwater basin (referred to as the "Dedicated Water Rights"). The State Engineer had issued a ruling that the Dedicated Water Rights could be transferred interbasin for municipal use in southern Washoe County, but final permits were pending approval. Vidler had completed National Environmental Policy Act ("NEPA") review processes permitting the transportation of 8,000 AF of the Dedicated Water Rights through a pipeline to the North Valleys area of Washoe County.

Between 2006 and 2008, Washoe County entered a series of agreements with Vidler related to the interbasin water pipeline project which set forth various terms related to the construction and dedication of infrastructure, dedication of water rights, banking of water rights credits, and temporary use of Dedicated Water Rights. Washoe County was to acquire title to the Dedicated Water Rights while Vidler retained rights to sell and assign water credits for future will-serve commitments supplied by the Dedicated Water Rights.

The PLPT objected to the project, asserting that it would harm PLPT's existing and claimed water rights in the Honey Lake Valley, Smoke Creek Desert and Pyramid Lake Basins. These objections led to various litigious challenges by PLPT, which were ultimately settled pursuant to the *Pyramid Lake Paiute Tribe Fish Springs Ranch Settlement Agreement* dated May 30, 2007 ("Settlement Agreement").

Under the Settlement Agreement, construction of the NVIP project would be allowed to move forward in return for two payments from Vidler of $3.6 million each (plus interest since 2007) and the transfer of several thousand acres of land to PLPT. PLPT would then waive the claims against Vidler for impacts or injuries to existing and claimed Tribal water rights for this project. PLPT would also drop the claims against the BLM. PLPT further agreed that Vidler would have the right to pump and transfer up to 13,000 AF from the project to "the End Users for the use of the End Users for any purpose and at any location allowed by the State Engineer" and to manage the project. The Settlement Agreement further requires Vidler to pay PLPT 12 percent of the gross sales price for each acre foot of water rights in excess of the 8,000 AF.

For the settlement to be implemented in full, the United States had to authorize PLPT to waive their claims and ensure that the U.S. does not take action against Fish Springs on behalf of PLPT after enacting the full settlement. This required Congressional approval to allow PLPT to waive their claims, prohibit the U.S. from taking action on behalf of PLPT after the agreement is enacted and release the U.S. from liability for PLPT's waived claims. H.R. 3716 was signed into law on September 20, 2014 approving the Settlement Agreement.

In connection with the acquisition of the assets of the WDWR, on December 31, 2014 Washoe County assigned and TMWA assumed all of Washoe's right, title and interest in and to the Banking Agreement, Dedication Agreement and License Agreement on the terms set forth in an Assignment, Assumption and Consent Regarding Water Banking Trust Agreement.

TMWA has agreed "to hold and reserve a quantity of water rights credits (the "Water Rights Credits") equal to the amount of municipal permits issued by the State Engineer" which could be used by Vidler to satisfy water rights dedication requirements in connection with future requests for will-serve commitments. Vidler is ready to issue will-serve commitments for up to 8,000 AF of the Water Rights Credits. The remaining 5,000 AF of Water Rights Credits shall be held by TMWA and, no will-serve commitments will be issued on such remaining credits until all necessary permits have been obtained.

Vidler reserved "the exclusive beneficial interest" in all Dedicated Water Rights in excess of 8,000 AF, such excess rights defined as the "Additional Water Rights." Vidler intends to import these Additional Water Rights into the TMWA service area at the time sufficient evidence of the resource sustainability exists. Vidler reserved to itself the exclusive right to all of the capacity in the infrastructure up to 13,000 AF, "for the purpose of transporting the Dedicated Water Rights, including the Additional Water Rights and any other Vidler water rights." Vidler shall be solely responsible for all costs in upgrading, constructing and equipping project infrastructure to transport all or any portion of the Additional Water Rights, which infrastructure Vidler shall dedicate to TMWA.

Prior to the time when all of the Water Rights Credits are "in actual use for municipal service", TMWA is authorized to use some or all of the water rights associated with the Water Rights Credits not otherwise committed to will-serve commitments "for its general temporary purposes, including groundwater recharge or conjunctive use management."

TMWA's North Valleys Integration Project, an $18 million pipeline project funded by TMWA and to be reimbursed as development occurs, will be constructed in 2016 and integrate the NVIP into the North Virginia Pump System, making available the full 8,000 AF of water supply to the North Valleys.

<u>Groundwater Sustainability on the Mt. Rose Fan</u>

TMWA is enhancing groundwater resources in the Mt. Rose Fan area through conjunctive use management of surface water and groundwater. Due to dependence upon groundwater and the continued decline in water levels aggravated by the ongoing drought in this area, it is necessary to provide a supplemental source of supply for the water systems located on the upper Mt. Rose and Galena Fan areas. These areas currently rely on groundwater wells for 100 percent of their water supply and the continuing drought situation, and domestic and municipal well pumping, has severely limited the amount of natural recharge to local aquifers. With the full resources consolidated water utility available, immediate construction of the facilities to implement conjunctive use management has begun. This will improve reliability for both TMWA customers and domestic well owners by mitigating the continued decline of groundwater levels in the area.

TMWA is implementing a $7.8 million conjunctive-use plan for the Mt. Rose/Galena Fan area, consisting of three projects which will provide the ability to deliver treated surface water from the Truckee River to the area:

- Arrowcreek/Mt. Rose Conjunctive-Use Facilities
- Expanded Conjunctive-Use Facilities/ASR Program
- STMGID Conjunctive-Use Facilities

The Arrowcreek/Mt. Rose Conjunctive-Use Facilities, Phase 1 will deliver up to 1,500 gpm of surface water primarily during the winter months. This allows TMWA to not pump its production wells in the Arrowcreek and Mt. Rose water systems. These facilities consist of three booster pump stations and about 3,600 feet of 10-inch pipe on Zolezzi Lane. When installed, the project will deliver water to the Arrowcreek No. 3 Tank, located below the Thomas Creek Trail parking lot off Timberline Drive. This $2.8 million project is scheduled for construction in the summer of 2015; the facilities are planned to be operational by November of 2015.

TMWA is also expanding its ASR in this area. ASR occurs during the fall, winter and spring. The first wells scheduled to be equipped for recharge are Arrowcreek 2, Tessa West and Mt Rose 3. An additional component of the overall ASR program is Phase 2 of the Arrowcreek/Mt. Rose conjunctive-use facilities. Scheduled to be constructed in 2016-2017, Phase 2 will consist of an additional $1.2 million of system improvements. This will allow delivery of surface water into the upper portions of the Mt. Rose/Galena water system for use in recharging additional wells.

The third project, the $3.8 million STMGID Conjunctive-Use Facilities, will provide surface water primarily during the winter months for an area which primarily serves former STMGID customers, located in the vicinity of the Saddlehorn neighborhood. The facilities will be constructed in 2017/2018, benefiting TMWA customers and domestic well owners by providing surface water to protect and restore groundwater resources. The project will consist of a new booster pump station and about 8,100 feet of 10-inch pipe to be located on Arrowcreek Parkway. These facilities will deliver about 1,000 gpm to the STMGID Tanks 4 and 5 zones during the winter months.

Effective June 1, 2015, TMWA's Board of Directors adopted revisions to its rules, water rights dedication policies and Water Service Facility Charges ("WSF") for the Mt. Rose/Galena Fan area. These changes affect new development in the area. The newly adopted rules and WSF charges along with existing water rights dedication rules require developers in this area to dedicate supplemental surface water (creek) supplies when dedicating groundwater for new service in the area. Supplemental surface water resources (Whites, Thomas and/or Galena creeks) are a key component of the conjunctive resource management plan and necessary to ensure a sustainable water supply for existing customers, domestic well owners and new development in these areas.

Surface water from Whites, Thomas and Galena creeks has historically been used for agricultural irrigation. These creeks remain a key part of the regional water resources for the South Truckee Meadows. For instance, the creeks are used to augment the South TRMWF reclaimed water (purple pipe) supply. The State Engineer also permits the use of these creek rights for water service.

In order to develop supplemental surface water supplies that will provide for the long-term sustainability of the local groundwater aquifer, TMWA is implementing a plan to construct a small water treatment plant off of Whites and Thomas Creeks— this plan was approved as part of Washoe County's 2002 South Truckee Meadows Facility Plan ("STMFP"). The STMFP recognized that, "The upper treatment plant is an integral component of the recommended water supply plan. Most importantly, it will provide recharge water and/or offset winter groundwater pumping in the upper Mt. Rose fan area."

An analysis is underway which will quantify the potential yield from the creeks and groundwater resources on the Mt. Rose fan. Technical results for this analysis are pending.

Aquifer Storage and Recovery

TMWA defines ASR as the injection of treated surface water into the underground aquifer for later withdrawal. Chapter 3 provided a background of TMWA's recharge activities in the Truckee Meadows, Lemmon Valley, and Spanish Springs. ASR can increase the natural supply of groundwater by storing surface water underground when excess supply and treatment capacity exist, and by mitigating groundwater contamination. TMWA has equipped its production wells to allow for treated water to flow back into the wells under pressure during winter time operations.

As part of the overall 119,000 AF/yr supply of TROA, TMWA can pump an average of 15,950 AF/yr. TMWA can pump groundwater in excess of 15,950 AF/yr with or without combining with other water rights as long as those other water rights do not rely on storage under the TROA. In the TRA, new groundwater projects in excess of this 15,950 AF can be pumped separately or paired with water rights that do not rely on TROA storage and will not be counted against TROA's 119,000 AF demand. Chapter 3 described the management of Truckee River resources requires not only the acquisition of irrigation water rights but also increasing the amount of drought reserves to back-up the Truckee River rights during Drought Situations. TMWA backs up Truckee River rights by expanding its drought reserves by increasing upstream storage (i.e., TROA) or increasing the ability to pump more groundwater. The greater the ability to pump groundwater during a drought-year, the greater number of surface water rights that can be supported thereby expanding the number of commitments that can be made through the dedication of more surface water rights.

An additional ASR opportunity may exist with using former WDWR well facilities in Spanish Springs for recharge; there may be sufficient capacity that could be used during drought years to extract additional groundwater. The yield would be calculated by assuming that Spanish Springs would be served by Truckee River water eight months of the year and their full groundwater rights would be utilized during the four summer months for peaking. No additional well capacity would be required to operate in this manner; however, additional injection, booster and/or pressure reducing facilities may be necessary. Prior to TROA taking effect, TMWA may use any of its water rights for ASR; after TROA takes effect it will be necessary to ensure that the obligations to store water rights under TROA are fulfilled before water rights are utilized to support this project. The amount of water rights available to this project would be utilized to calculate how many surface water rights this recharge concept would support. The project is over and above TROA's 119,000 AF demand limit.

Integrated Water Management

Regional water and wastewater challenges facing the Truckee Meadows include such complex issues as ensuring sustainable water supplies to meet existing and future demands within the Truckee Meadows Service Area ("TMSA"); maintaining the appropriate water quality discharge standards and treatment capacity requirements at several of our region's wastewater treatment plants; and addressing competing needs for the region's limited water resources to meet commitments to water supply, water quality, instream flows and the environment. Many of these regional water issues are interrelated and their affects go beyond individual watershed boundaries. Solutions to one system, such as water, wastewater or flood control will likely affect the needs and costs of one or more of the other systems. In addition to being challenging, resolving many of these water issues will be expensive. Clearly, an integrated water management approach that utilizes the region's common water resources and facilities to their optimum advantage has the potential to not only reduce costs, but also increase the level of service, enhance water quality and provide environmental benefits.

To help advance solutions to these regional water management issues, a process referred to as the North Valleys Initiative ("NVI") was undertaken by the NNWPC and the WRWC from May 2008 through July 2010. The NVI process was a collaborative effort among key staff from the City of Reno, the City of Sparks, WDWR, SVGID and TMWA, designed to identify recommended solutions to many of the region's water issues.

The North Valleys is one area within our region that is expected to see an increase in population in the near future. Large tracts of land within the North Valleys have been master planned for commercial and residential development. This includes the Reno Tahoe Airport Authority ("Airport Authority") property in Stead, which is one of the largest tracts of undeveloped commercial and industrial property in the region. The Airport Authority property will be instrumental in providing a new employment center as the area develops.

Much of the area's future water supply requirements will be satisfied by the NVIP and TMWA's North Virginia pumping system. These water supply facilities augment the local groundwater resources, and both are currently available to serve the Stead and Lemmon Valley areas. With additional improvements, these facilities can also be extended to provide much needed water supplies to Cold Springs. Although these water supply sources are substantial, long-term development potential of the area may be constrained as a result of ultimate water supply and wastewater disposal limitations. Because of their proximity and similarities concerning water supply and wastewater disposal, a coordinated regional water planning effort for the Stead, Lemmon Valley and Cold Springs areas is currently being pursued.

The NVI process evaluated an alternative to traditional effluent reuse and disposal practices, referred to as potable reuse. Potable reuse is the process of purifying wastewater to such a high quality that the water can be put back into the drinking water supply. Indirect potable reuse ("IPR") is a process whereby the purified water is stored in an environmental buffer such as a lake or aquifer before re-entering the drinking water supply. The NVI process evaluated one potential IPR concept, whereby treated wastewater would be purified and recharged to replenish the local aquifer. The NVI process concluded that IPR could provide for an efficient use of water resources; defer expenditures on future water importation projects; and provide a safe, local, drought proof, reliable water supply as well as a potential solution to groundwater basin over-drafting. Potential long term accumulation of salts, public acceptance and a lack of regulatory guidance in Nevada are some of the challenges that would need to be overcome.

Presently, the NDEP has established a Reuse Steering Committee which is undertaking a comprehensive review of the reuse program for treated effluent, with a goal of providing strategic direction for future reuse in Nevada. Categories of reuse being evaluated include urban, agricultural (food and non-food crops), impoundments, environmental, industrial, groundwater recharge (non-potable) and IPR. Presently, several states including California, Florida, Montana and Texas have specific regulations for indirect potable reuse, and several additional states including North Carolina, Pennsylvania, Virginia and Washington allow IPR on a case by case basis.

IPR and groundwater replenishment must demonstrate safe, reliable water quality, practicality, affordability and public acceptance. Today, coastal communities like Orange County, California utilize reverse osmosis ("RO"), high-energy ultra-violet radiation ("UV") and peroxide treatment as part of their IPR Groundwater Replenishment System. Because RO brine disposal to the ocean is not readily available, this approach may be neither affordable nor appropriate for many inland areas like Reno. Coincident with the NVI process, the City of Reno conducted an alternative treatment demonstration project at the Reno-Stead Water Reclamation Facility for regulatory evaluation using membrane filtration ("MF"), peroxide, ozonation ("O3"), and biologically activated carbon ("BAC"). Data from Reno's MF-Peroxide-O3-BAC pilot project has shown that the following process capabilities can be accomplished:

- Reduces contaminants to very low and non-detectable concentrations;
- Avoids increasing the corrosivity of the product water, a serious concern for IPR in arsenic-rich aquifer formations;
- Significantly reduces biodegradable dissolved organic carbon ("BDOC") concentrations to minimize bio-fouling of IPR aquifer injection wells;
- Removes O3 transformation byproducts.

Compared to RO-UV-Peroxide systems found in Orange County, Reno's MF-Peroxide-O3-BAC process eliminates treatment and disposal of RO process reject water, and has the benefits of multi-barrier treatment for all major categories of contaminants of concern, provides reliability; lower capital costs; lower operating and maintenance ("O/M") costs and simpler O/M tasks; and lower energy use.

Recently, grant funds for a nation-wide study by the WaterReuse Research Foundation have been secured by a local consulting firm working in collaboration with American Water (the largest investor-owned U.S. water and wastewater utility company) to further the advancement of this promising technology. In 2016, a similar MF-Peroxide-O3-BAC demonstration project will be conducted locally at Washoe County's South TMWRF, with involvement of technical staff from Reno, Sparks, Washoe County and TMWA. The results of this effort will allow the potable reuse industry to make informed decisions on the viability of ozone-BAC to meet regulatory goals and future water supply needs.

Conceptually, an IPR project might be well suited for areas such as the North Valleys or the South Truckee Meadows. IPR in these locations could improve the utilization of existing water resources and water rights, since the Water Reclamation Facilities for these areas do not return the treated water to the Truckee River. The purified water could be recharged using infiltration basins or injection wells in areas generally isolated from domestic wells, blended with ambient groundwater, and recovered using TMWA's municipal wells after the water is retained in the aquifer for a period of months to years and has travelled a minimum distance through the ground.

There is the potential to expand the local water supplies by several thousand AF/yr through implementation of a safe, drought proof and reliable IPR project. Reported capital costs for the MF-Peroxide-O3-BAC treatment process are in the range of $5 to $10 million per MGD of treatment capacity, not including site specific costs for piping from the treatment facility to an infiltration or injection site, and development of the recharge infrastructure. This compares to $20 to $40 million per MGD of treatment capacity for an RO based treatment system where zero liquid discharge of the RO brine waste stream is required.

TMWA will continue to closely monitor national, state-wide and local advancements in the potable reuse industry to determine its potential applicability to the Truckee Meadows.

Potential Water Supply Projects

There are a number of water importation projects being pursued by private developers who may be willing to bring these water supplies to the region. Also, the water supplies provided by TROA, ASR and conjunctive use can be timed either near term or into the future without losing the opportunity to pursue those projects. These water supplies are analyzed from the standpoint of long term water quantity and water quality because if the projects are not sustainable in perpetuity, TMWA and its customers would be required to make up for such lack of water or water quality. However, to the extent these private developers find their projects to be environmentally permitable, cost effective and worth the financial risk they may take, TMWA would integrate these projects into its water resource supply mix and would accept will-serve commitments against these supplies before other supplies are fully allocated.

For this discussion it is assumed that future water resource projects will be implemented in the most economical fashion by the appropriate entity, such as Vidler, with the ability to assume the risk and invest the time and effort for permitting, design, construction, and financing of a water supply project - a function that TMWA does not currently undertake at this time due to the inherent risks of stranding investment until will-serve commitments can be sold and facility charges collected to cover the cost of developing a project.

The following is a partial list of potential water supply projects that TMWA may be able to use to expand future supplies. The following information summarizes the status of proposed water importation projects in hydrographic basins outside of the Truckee Meadows, however, detailed information is limited. The information is based on data currently available and is by no means exclusive to any new project, combination of projects, or future configuration of how the water resources could be integrated into TMWA's system.

Intermountain Water Project

Sponsored by Intermountain Water Supply, Ltd., the Intermountain Water Project ("IWP") is permitted for 3,564.1 AF/yr for municipal water from three close-in basins to supply water to the North Valleys. Interbasin transfers have been approved as follows: Bedell Flat, 368.1 AF/yr, Lower Dry Valley ("LDV"), 2,000 AF/yr, Upper Dry Valley ("UDV"), 996 AF/yr, and Newcomb Lake, 200 AF/yr. The project received a record of decision ("ROD") from BLM for a pipeline and related infrastructure from the LDV and Bedell Flat well sites to Lemmon Valley as well as an Environmental Assessment for a power line from NV Energy's transmission line on Red Rock Road to the Bedell Flat well site and pump station. Right-of-way grants and easements over private land have been secured for the LDV and Bedell Flat well sites. Private easements have also been secured for the Newcomb Lake well site and a portion of the UDV well sites.

Test wells have been drilled and pumped in LDV which indicate a sustainable yield of 25 percent more water than is currently permitted. The project can be developed in increments as demand requires, starting with Bedell Flat and moving through the five LDV well sites and thereafter to Newcomb Lake and UDV. Washoe County has issued the IWP a Special Use Permit.

Lower Smoke Creek Importation.

The Lower Smoke Creek ("LSC") project is located just north of Pyramid Lake in Basin 21 in Washoe County. Much of the water in Basin 21 is held primarily by one owner through various entities, including Bright-Holland Co., a Nevada corporation and Jackrabbit Properties LLC, a Nevada limited liability company. In the mid-2000's Jackrabbit and Bright Holland assembled water rights in Basin 21 and executed an option to sell with Granite Fox Power, LLC also known as Sempra. The option agreement at the time encompassed approximately 28,000 AF of groundwater and surface water combined. It was Sempra's intent to use the water for a $2 billion coal fired power plant within Basin 21. Subsequently, Sempra decided not to proceed with the power plant project and as a result, released its options to purchase the water. Jackrabbit and Bright Holland, in turn, executed a water development agreement with LSC Development, which intends to develop a water importation project rather than a power plant project. The first phase of the water importation project is intended to capture the water in the southern portion of Basin 21 and pipe the water to Winnemucca Ranch and other planned developments consistent with the relevant water resource plans. The second phase would extend the pipeline to transport water from the northern portion of Basin 21. Basin 21 has a yield substantiated by the USGS of 16,000 AF and is currently being adjudicated. Sempra completed extensive groundwater testing and modeling, which confirmed the long term sustainability of the water resource. LSC

Development updated the modeling to reflect a municipal water project. With this existing information, including USGS gauges in place since 1986, the abovementioned water rights will support approximately 10,500 to 14,000 AF of municipal water annually, subject to State Engineer approvals.

Other Conceptual Projects

The following project descriptions come from various water supply plans that have never made it past the concept stage. They are included to provide ideas for future water supply possibilities; little is known of the status of these projects, but economics may someday stimulate renewed interest.

Dixie Valley Ground Water Importation. This supply alternative proposes to develop ground water in Dixie Valley and transport it via a pipeline over the Stillwater Range to Lahontan Valley. The water could support growth in the Fallon area, provide irrigation water, or augment supplies in the Lahontan Valley wetlands. Water from Dixie Valley utilized in the Lahontan Valley could displace the use of Truckee River water. Water rights thereby freed-up on the Truckee River could be transferred upstream.

Humboldt Basin Ground Water Importation. The Humboldt Basin Ground Water Importation project, better known as the Gabbs Hay Company plan, proposed to develop groundwater sources in Pershing and Humboldt Counties to enhance beneficial uses for wildlife projects in the Toulon, Fernley, and Fallon areas, provide water for future growth in western Pershing County, displace Newlands Project water rights essentially freeing those rights to be utilized upstream, specifically by Truckee Meadows municipal-industrial users, or connect approximately 130 miles of gathering and transmission pipelines to deliver water to Sparks. Preliminary estimates are to produce 20,000 to 30,000 AF, which is permitted, and/or certificated.

Long Valley, California, Ground Water Recharge and Importation. Long Valley, California is located north of Reno and west of Bordertown, Nevada. The owners of Evans Ranch, Inc., have filed applications with various California governing agencies to recover an estimated 3,300 AF of surplus surface water from the Long Valley Creek system and use this water to recharge ground water supplies in the valley. The surface water would replace ground water which would be withdrawn and transported for use in the lower (Nevada) portion of Evans Ranch and/or quasi-municipal uses in developing areas in Washoe County, Nevada.

Red Rock Valley Importation. The Red Rock Valley Importation (“Red Rock”) project proposes to transport between 1,000 to 1,300 AF of water from the Red Rock groundwater basin to the north end of WLV. TMWA entered into a purchase agreement with Red Rock subject to satisfying certain conditions of supply (e.g., 1,000 AF minimum State Engineer permit) and facility construction. In January 2008 the State Engineer issued a permit for 855 AF with conditions that allow the project to expand up to 1,273 AF. Through 2008 Red Rock's project sponsors progressed with design and planning which led to filing an application for a Special Use Permit with Washoe County in December 2008. The Board of Adjustment denied the application at its March 4, 2009 meeting and the BCC also denied an appeal in May 2009.

Silver State Importation Project. Silver State Importation Project ("SSIP"), also called the Washoe County Ground Water Importation Project, is a proposal to develop ground water sources in 19 hydrographic basins in central and northern Washoe County for importation into the Truckee Meadows. The plan was originally created to provide drought year water supplies for the Truckee Meadows served by TMWA and year-round supplies to Lemmon Valley, SSV, Cold Spring Valley, Warm Springs Valley, and adjacent areas. SSIP was proposed to proceed in five stages over a 50-year period. The final project includes 372 miles of buried steel pipeline ranging in size from 14 to 60 inches, 8 pumping stations, 42 production wells, and underground terminal storage.

Purchase TCID's Share of Donner Lake Storage. The right to the water stored in Donner Lake (9,500 AF) near Truckee is owned as tenants in common by TMWA and TCID. Over the decades, numerous attempts have been made to purchase TCID's half of Donner Lake water but without success. The estimated annual yield of purchasing TCID's half of Donner Lake water is approximately 2,400 AF/yr. The reason the yield of Donner is lower than one-half of the actual volume of water that can be stored in the lake (9,500/2=4,750) is due to the facts that (1) there is a summertime lake level elevation requirement that restricts when and how much water can be released from the lake and (2) the physical outlet of the lake prevents complete release of the stored water (unless it were to be pumped out). The yield of a Donner project is only available when used in conjunction with TROA; as a standalone project the elevation and flood releases restrict the ability to use the water on an annual M&I schedule. The cost of this option is subject to negotiated purchase price with TCID.

Sierra Valley Water Rights. Since the late 1800s, a diversion ditch has carried up to 60 cfs of water for agricultural use from the Little Truckee River above Stampede Reservoir out of the Truckee Basin to Sierra Valley, California, in the Feather River basin. The Little Truckee River diversions are inversely proportional to the Sierra Valley natural runoff, i.e., the lower the available flows in the native Sierra Valley streams, the higher the diversions from the Little Truckee River. Thus, these rights have a higher drought yield than a normal year yield, but the ability to store these rights would be required.

Summary

This chapter presents the status of various ground and surface water projects. The majority of them have been reviewed and analyzed in various water resource plans over the past 20 years. The projects discussed here are not all inclusive, but are projects that have been studied in the past or continue to be considered potentially viable. The selection of the next water supply project is strictly a function of the project's yield, ease of implementation, sustainability, and financial feasibility as determined by existing regional economic conditions and market forces that would or would not favor the development of a future water supply project. It may be that in the future as new technology becomes available or the political, regulatory or public opinion changes, new projects may be developed or projects previously thought infeasible may become feasible. Specific conclusions are:

- In the TRA, TROA will provide 119,000 AF/yr, sufficient to meet the projected demands through the planning horizon.
- The NVIP place of use is in the North Valleys, the project is operational, and will yield 8,000 AF/yr.
- Plans are underway to construct creek-treatment plant(s) to help reverse declining groundwater supplies in the area and support expanded use of creek water rights for future development.
- There are several importation projects for the North Valleys area that are in various stages of permitting and/or design. Construction of these projects is subject to positive changes in economic conditions leading to increased demand for water supplies.
- TMWA will continue to closely monitor advancements in the potable reuse industry to determine its potential applicability to the Truckee Meadows.
- Over the years, numerous projects have been proposed but remain unbuilt due to lack of financing, permitting, conceptual design, institutional or regulatory constraints, etc.

CHAPTER 7 SUMMARY

Economic development in the communities in and surrounding the Truckee Meadows is the primary driver and impetus to expand the pool of available water resources to meet the needs of the greater Reno/Sparks region in southern Washoe County. Over the past several decades water resource planning in the region focused its efforts comparing smaller, incremental supply projects to the long-term water supply of the larger river settlement project: the Truckee River Operating Agreement ("TROA"). After nearly 40 years, the final components of TROA, signed on September 6, 2008, were completed in 2015 so that TROA could finally be implemented. With the implementation of TROA, and the underlying elements of the Negotiated River Settlement ratified in PL 101-618, the communities' water demands within the TRA of up to 119,000 AF/yr will be met as long as acceptable Truckee River water rights are dedicated to TMWA by future development. That is not to say work on other supply projects is discontinued. On the contrary, TMWA continues to track progress on various projects as it looks beyond TROA and the projected water needs of the region well beyond the planning horizon of this plan. The need and timing of future water supply projects will be dictated by future economic conditions and employment opportunities constrained by the availability and costs of developable land, water rights, rights-of-way, sewer treatment, Truckee River water quality, and related public infrastructure.

Introduced in the 2007 Nevada Legislative Session, SB487 proposed to create a new regional water resources entity in Washoe County. Pursuant to SB487 the cities of Reno and Sparks, the STMGID, the SVGID, TMWA, and Washoe County formed a JPA to operate the WRWC in 2008. SB487 included a change of oversight and restructuring of the RWPC into the NNWPC, in addition to an evaluation of the possibility of merging water purveyors in the Truckee Meadows. The outcome of the process lead to the successful integration of STMGID and Washoe County's water systems into TMWA on December 31, 2014. From the aspect of treating and delivering potable water to customers, the consolidation enhanced efficiencies related to the operation of water production and distribution systems. The consolidation also allows for the expanded use of surface water and reduced use of groundwater, thereby improving aquifer conditions in the various basins where TMWA operates. Although the merger expanded TMWA's planning and operational responsibilities, the addition of water systems did not burden TMWA since each system has its resources and facilities for ongoing operations. For those systems adjacent to TMWA's pre-merger service area, the enhancement in operations allowing expansion of surface water use in lieu of groundwater use is a significant benefit to TMWA's customers in those areas, particularly in the southwest portion of the Truckee Meadows hydrographic basin.

In TMWA's non-TRA, the satellite, groundwater dependent systems acquired in the merger, have resources and facilities to meet the build-out conditions established when the development was initiated. For this plan, TMWA did not contemplate plans to find additional, out-of-service-area resources for these small systems due to: the remoteness of the systems; there are no indicators of impending development adjacent to these systems; availability of groundwater resources in the hydrographic basins where these systems are located are limited, fully committed, or not available; and the costs to bring other resources to these systems presently outweighs the benefits.

Meteorologic conditions and resulting droughts are the most significant weather variables with potential to change the quantity and quality of the water supply. Studies completed by DRI indicate that while the potential for climate change to alter the timing, type of, and quantity of precipitation is possible, continued monitoring of meteorologic trends is required. Drought periods on the other hand have established historical patterns, with the most severe drought on record lasting eight years. TMWA plans for drought periods by utilizing a combination of natural river flows, groundwater pumping, releases of privately owned stored water (i.e., upstream drought reserves), and extraction of accumulated groundwater injections. TMWA manages for uncertainty of its water supply, in terms of the overall quantity and the timing of its delivery, through storage of water in upstream reservoirs and injection of treated surface water through its network of wells into aquifers in Lemmon Valley, Spanish Springs and Truckee Meadows. When river flows are available, TMWA maximizes the use of surface water resources while minimizing the use of groundwater supplies. This approach allows TMWA to meet demands with surface water, and to rest and recharge specific wells when enough surface water is available. TMWA continually assesses the potential reduction to source water supplies due to variability of weather conditions. This continual reassessment of source water supplies and management tactics is the best defense against reservoir depletion as well as unnecessary economic stress to both the utility and customer base.

TMWA's source water, both surface and ground water, is of very high quality, meeting, and in many cases, significantly better than all required drinking water standards. A Water Quality Assurance program is implemented to ensure this high standard continues to be met for current and future customers. While there is a risk to surface water reliability from turbidity and toxic spill events, TMWA has sufficient well capacity and distribution storage to meet reduced customer demands during a water quality emergency; additional actions are available to TMWA in the event of extended off-river emergencies. TMWA's WHPP provides information by which TMWA can develop and implement groundwater protection strategies to mitigate potential threats to groundwater sources, including educational outreach. The WHPP is operated voluntarily, under local jurisdiction and control, and utilizes both USEPA and NDEP guidance and criteria to provide for State endorsement. Successful examples of the WHPP working include TMWA's cooperation with NDEP and WCHD to mitigate the Sparks Solvent/Fuel Site Remediation, the Stead Solvent Site Remediation, and over the years mitigation of several leaking, underground storage tanks in and around the Truckee Meadows along with the Central Truckee Remediation District for the clean-up of PCE in the Reno/Sparks area. TMWA's Source Water Protection Program is designed to preserve and enhance available surface water and groundwater supplies and to address known and potential threats to water quality and remains adaptive to changes in USEPA, NDEP or WCHD drinking water standards and regulations.

Significant to water resource planning is the selection of a drought period to estimate the yield of TMWA's resources during Drought Situations. In years when sufficient precipitation occurs, there is no need for TMWA to pump significant amounts from its wells or release any of its privately owned stored water in upstream reservoirs since the Truckee River can supply the majority of water to meet customer demands. TMWA manages its resources to take maximum advantage of Truckee River flows while minimizing use of its reserve supplies during non-Drought Situation years. Planning for the critical-year in a drought period therefore determines the maximum amount of water demands TMWA plans for. As a result of implementing TROA and the continued dedication of river rights, TMWA is able to fully utilize TROA's demand limit of 119,000 AF. In addition, there are existing groundwater or creek resources that may be acquired or developed in the TRA over the planning horizon which provide over 140,000 AF of resources when added to TROA. During the negotiation and environmental process for TROA, its supply was designed to meet demands through the historic drought from 1987 to 1994. Despite the analysis in this plan that demonstrates under TROA operation, TMWA can withstand more severe conditions that 1987 to 1994, it is prudent for TMWA to evaluate the results of the 2015/2016 winter and the resulting 2016 runoff forecast before considering any alterations to its planning criteria and/or determining if enhanced demand-side management measures are required for the 2016 irrigation season.

At this time, Truckee River irrigation rights continue to be the major source of water supplies for the TRA. Through continued conversion and commitment to M&I use, the number of available Truckee River water rights available will meet the projected growth through the planning horizon. Noted is the fact that the water rights market is becoming more competitive as there are other demands for these water rights, such as M&I use in the Fernley area or use as dilution flows for water quality enhancement in the Lower Truckee River. Other factors discussed that are affecting the future acquisition of water rights in an open market environment include issues of ownership and finding willing sellers of the water rights which will ultimately affect the price and availability of water rights. TMWA has over 7,000 AF of resources in its Rule 7 inventory, implying a 7 to 10 year supply depending on market demands. Significant price variation for water rights between 2005 and 2010 portends the future water rights market beyond the planning horizon.

The population model used for this plan, which accounts for environmental and economic conditions, forecasts population increasing at a decreasing rate of growth between 2016 and 2060. The estimated water demand to support the projected population can be served and managed with TROA and existing groundwater resources through the planning horizon. In 2035, water will be delivered by TMWA to an estimated 475,000 persons living in the combined TRA and non-TRA service areas. The 2035 water demand projected for this plan is approximately 102,000 AF. Water demands will grow approximately 21,000 AF over the planning horizon, from approximately 81,000 AF based on typical year production forecast. TMWA has sufficient water production facilities to meet current and near-term demand; the timing of construction for new water production facilities to meet future demands will be developed in TMWA’s upcoming *2016-2035 Water Facility Plan*.

TMWA’s conservation plan contains the necessary elements to manage both the supply of its water resources as well as demand for those resources. TMWA’s conservation plan has two components: 1) SMPs are designed to reduce production and distribution losses and 2) DMPs are designed to conserve water supplies by limiting water waste, inefficient use, and overuse. TMWA’s SMPs are actions taken to maintain water resources and provide alternative sources to potable water in a cost-effective manner, as well as to ensure water is delivered to customers in an efficient manner. Once delivered, TMWA’s DMPs target customers’ watering practices in order to promote efficient use. The region experiences meteorologic droughts brought on by climatic conditions which may or may not affect TMWA’s available water supplies in any given year. If meteorologic drought conditions persist, then hydrologic drought conditions can ensue which begin to affect both natural river flows and, at times, TWMA’s water and drought reserve water supplies. Once in a Drought Situation, TMWA evaluates what actions from customers may be necessary to reduce customer demands in the event the Drought Situation lingers in successive years. As mentioned above, under TROA operations, managing drought reserves are significantly enhanced thereby reducing much of the pressure on water supplies and customers during Drought Situations. TMWA's three-stage supply Drought Situation classification system coupled with its four levels of timing of enhanced DMP activities, is directly linked to TROA operations and definitions. This system is less complicated as it is tied to TROA operations and criteria, minimizes administrative burden and costs on TMWA, and improves TMWA's ability to create more meaningful, easier to understand information campaigns that relate needed reductions in customer use to available water supplies. Based on targeted savings for the year during drought periods TMWA enhances its DMP to promote further reduction in water consumption by its customers in the event the drought situation extends for another year.

Although TMWA can continue to convert Truckee River water rights and provide for new development based on its current pool of resources in the growth prone areas of the Truckee Meadows and thus take full advantage of TROA, TMWA is active in evaluating aquifer storage and recovery and creek development projects, as well as monitoring various groundwater importation projects. The activities of the groundwater importation project sponsors are vital in order to have the next viable water resource available when demands dictate its need. In reviewing prior water plans, the number of water supply projects available for future development has decreased from a high of 20 projects to 8. The reduction in supply projects is a result of changes in conditions necessary to facilitate developing the supply project. For example, the loss in the number of potential reservoir sites is due to housing developments that have been built in the proposed reservoir site (e.g., Mogul Canyon west of Reno or Canoe Hill in the eastern foothills of Spanish Springs). The estimated supply from future water supply projects has also decreased over the past 20 years, from a high of 73,000 AF under the TROA supply scenario in 1994/1995 planning period to the current estimate of 51,000 AF from all projects including TROA supplies. These changes are due to reductions in the number of potential supply projects as permitting processes are stalled or denied and/or as a result of changes in the scope of the project. For example, the NVIP (subsequently purchased and implemented by Vidler Corporation) originally sought a permitted yield of 13,000 AF/yr. The project is currently permitted for 8,000 AF/yr, and may be expanded to 13,000 AF/yr pending commitment of the 8,000 AF and demonstration of the sustainability of the resource. Although there has been a decline in the number of potential water supply projects and in the quantity available from these projects, the conclusion to draw is that future water supply development may reach beyond TMWA's TRA and non-TRA service areas, and ultimately be costly to implement.