Gardnerville Ranchos General Improvement District Water Resource Plan

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8585.003

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GLOSSARY

Acre-feet – The amount of water that it would take to inundate one acre of land with one foot in depth of water.

Air entrainment – Air bubbles contained in water that gives the water a cloudy appearance. Given a small amount of time, the air will dissipate into the atmosphere. Air entrainment is a by-product of cascading water in water wells.

Alluvial fan – The accumulation of sediment emanating from a mountain canyon and forms a fan like formation. The thickness of the sediment is greatest at the mouth of the canyon and gradually decreases towards the valley floor.

Aquifer – Underground water bearing geologic formations of sufficient volume to support long term use. Aquifers are recharged through surface water infiltration at their higher elevations and discharge to the surface at their lower elevations through various means.

Cascading water – The result of a pumping level in a well that is below the well screen. Water entering the well screen then cascades to the pumping level. The turbulence that results contains air that becomes entrained in the water.

Cavitation – In water well pumps, cavitation occurs when air bubbles implode around the impellers. Pumps put liquid under pressure, but if the pressure of the liquid drops due to air bubbles, it begins to vaporize, just like boiling water causing physical damage to parts of the pump.

Equivalent Residential Unit (ERU) – Usually defined as a typical single family household. Within a subdivision, there is an average of 2.5 people per residence (within the GRGID).

Evapotranspiration – The combination of direct evaporation of water from the land surface (or near the surface) and transpiration of water from plants.

Groundwater discharge – Groundwater that flows under pressure to the land surface or to a water body such as a stream, wetland or pond.

Groundwater gradient – Groundwater that moves from an area of high elevation to an area of lower elevation, usually under the influence of gravity.

Groundwater recharge – Water that percolates into the ground, past the root zone and infiltrating into an aquifer.

Groundwater reservoir – The groundwater stored within a system of aquifers.

Groundwater storage – Because of their volumetric size, aquifers have the ability to store water in terms of the volume of the recharge exceeding the volume of the discharge, or vice versa, in any given year.

Hydrographic Basin – A topographic area or basin that encompasses all of the surface drainage. Within Nevada there are 232 hydrographic basins.

Max day demand or flow capacity – Within a year, the greatest amount of water used by customers (demand) in one day. Maximum flow capacity is the greatest amount of water that can be pumped by the wellfield.

Maximum Contaminant Level (MCL) – The maximum concentrations of a chemistry constituents in drinking water established by the USEPA. There are Primary Standards (primary health concerns) and Secondary Standards (aesthetic concerns).

Potentiometric map – Similar to a topographic map showing land surface elevation contours, a potentiometric map contours the elevations of aquifer system pressures (in units of feet of head), both confined and unconfined. It can be loosely defined as a water table map.

Running Annual Average – The annual average of, in this case, arsenic concentrations measured quarterly at a particular location such as an individual residence. If the average of four consecutive quarterly water samples contain an arsenic concentration above 10 ppb, the water supply is considered out of compliance.

Supplemental water rights – Usually a groundwater right that is used to supplement a surface water right. In this case the supplemental right can only be used when the surface water is no longer available. Supplemental groundwater rights can also be used to support other groundwater rights. The total ground water used cannot exceed the primary right's duty.

Total Dynamic Head – The amount of pressure (psi or feet of head) required to move groundwater from a well's pumping level to a particular location, usually a water tank. The pressure required must also overcome frictional losses in the piping. The sum of the pressure head, friction head and lift (elevation head) equal the total hydraulic head.

Transmissivity – A measure of an aquifer's permeability or the ability to transmit water in units of gallons per day per unit thickness of the aquifer. The thickness of an aquifer multiplied by it's groundwater velocity (hydraulic conductivity).

Watershed – The boundary of an area that encompasses an individual stream or river system including its tributaries.

Water Balance – An accounting of the inflow and outflow of water within a particular boundary such as a watershed, hydrographic basin or a system of aquifers.

Water table – The surface elevation of an unconfined aquifer measured in feet below land surface or as an elevation above mean sea level.

EXECUTIVE SUMMARY

The Gardnerville Ranchos General Improvement District (GRGID) commissioned Lumos & Associates, Inc. (Lumos) to develop a water resource plan for its water utility. The purpose was to provide background of its water resource status in terms of water rights, water quality concerns, current water resource availability, the effects of drought upon that resource and the future water supply outlook. This Plan also provides population projections for the next twenty years and the ability of GRGID to meet that demand.

The GRGID was formed in the early 1965 by C.E. Swift in order to develop a residential subdivision. GRGID's services include the operation and maintenance of the water system, sewer collection system, streets and street lights, storm drains, parks and recreation, and open space. As of April 2014, there are 4,143 service connections within the District.

The Carson Valley has abundant water resources as derived from the groundwater recharge derived from snowmelt processes in the Carson and Pine Nut Ranges, the influx of the Carson River and its tributaries, and from irrigation practices within the valley. The GRGID's wellfield pumps groundwater that probably originates in the Pine Nut Range and from the infiltration of Carson River water. The groundwater reservoir that supplies the wellfield is also supported by the groundwater recharge from the Carson Range and its tributary waters. The USGS estimates that in an average water year groundwater recharge from the Carson and Pine Nut Ranges is approximately 38,000 acre-feet (AF), recharge from the Carson River and its tributaries is 10,000 AF and an additional 4,500 AF from irrigation infiltration.

The GRGID owns 5,054 AF of water rights. Primary groundwater rights within the valley are approximately 47,110 AF and supplemental water rights are 48,660 AF. Groundwater water rights for domestic and municipal purposes total 38,200 AF. Non-supplemental irrigation rights total 2,900 AF. In 2011, the total basin-wide groundwater withdrawal was 20,469 AF. Since the year 2000, GRGID has utilized approximately 65% of its water rights or approximately 3,500 AF per year, on average. The water rights not used have been dedicated by developers for future growth. All of GRGID's rights are in good standing.

GRGID's wellfield was originally developed in 1965 with one well. A second was drilled in 1967. Since that time seven additional wells have been constructed. Well 3 was abandoned due to poor production and Well 7 is not used due to its poor production. Well 5 is used sparingly because of arsenic concentration exceeding the US EPA Safe Drinking Water limits and because of its high operating costs. Total production from the six main wells (1, 2, 4, 6, 8, and 9) is 6,300 gpm with Well 5 capacity at 1,200 gpm.

The Water Resource Plan has identified production rate declines in Wells 1, 2, 4, 6, and 9 that range from 10 to 50 gpm annually over the last three years which equates to a loss of 1%-5% per year. The losses appear to be due to a deepening of the pumping levels in late summer which maybe the result of the last three years of drought. Lower pumping levels result in higher energy costs as well as the lost production. Well interference between Well 1 and Well 2 is documented. This interference causes greater drawdown and consequent lower pumping water levels. These interference is managed by GRGID operations. To date water quality is very good overall. However, Well 5 frequently exceeds the arsenic concentration standard set by the State of Nevada. Wells 8 and 9 are approaching or at the arsenic MCL of 10 ppb. No other water quality standards are of any concern.

The USGS has published several extensive studies on the water resources of Carson Valley. Many of their studies have been cited and incorporated into this Water Resource Plan. No estimates of impacts from an extended drought have been forecast. Water level monitoring over the last 30 years indicate that water levels react slowly to wet and dry precipitation periods, but have fluctuated by as much as twenty-four feet. The USGS has modeled various 55-year scenarios of basin-wide pumping and the effects on groundwater levels. In the status quo scenario, water level declines of 5-20 feet could be expected within the GRGID wellfield. However, other more likely scenarios indicated that as much as 60 feet of water level decline could occur within the GRGID wellfield.

Lumos has estimated population increases within the GRGID that range from 265 to 593 new connections. These simplified projections indicate that GRGID could meet annual water demand with its existing infrastructure as long as GRGID meets the attrition policy to have every service metered by 2017. With the current decrease in water production (due to lowering water well pumping levels), meeting maximum day demands may not be possible in the year 2018 without the use of Well 5 capacity.

The Water Resource Plan considers several issues that should be considered by the Board of Trustees. The most pressing consider wellfield improvements for meeting max day demands and the deepening pumping levels, the development of a well efficiency program, and a Capital Improvement Plan. Recommendations to the Board of Trustees are also made in this respect.

1.0 INTRODUCTION

1.1 Purpose or Need for the Plan

The Gardnerville Ranchos General Improvement District (GRGID) commissioned Lumos & Associates, Inc. (Lumos) to develop a water resource plan for their water utility located in Douglas County, Nevada. GRGID's water system is totally supplied by groundwater aquifers that are recharged by snow pack infiltration and runoff from the Carson and Pine Nut Ranges. The need for the development of a water resource plan was partially determined due to current drought conditions and the obvious need for GRGID to better understand their precious groundwater resource. GRGID's service area currently contains large portions of land that will be developed and will require water service. By better understanding the quantity and quality of their groundwater resource, GRGID's Board of Trustees will be able to make strategic decisions on annexations and the best use of the resource for their service area.

1.2 Framework of the GRGID Water Resource Plan

The general framework for this Water Resource Plan begins with the history of the GRGID as provided by the District Manager, Bob Spellberg. It is followed in Section 3 by an overview of the overall hydrology of the Carson Valley including the sources of water. This sets a foundation for the sources of water that the GRGID depend upon.

Section 4 documents the current status of the water rights held by the GRGID. The Plan then discusses and analyzes data with respect to the wells, production rates, pumping performance of the wellfield, and water quality concerns. Section 5 evaluates the water resource, its origin, how it is influenced by drought, the Carson River, and other pumping. The Plan then reports on the long term impacts on the wellfield from drought and future Carson Valley urbanization as reported by the US Geological Survey in their 2012 Water Resource Investigation

Section 6 estimates urban growth projections and the current wellfield capacity to meet these future demands. Section 7 provides the water resource planning issues that should be addressed followed by Recommendations. Lumos has also provided a section on common hydrologic and engineering definitions used in this report. Finally, there are Appendices that include specific data used in the report and a section on hydrologic papers, reports and investigations specific to Carson Valley.

1.3 Living Document

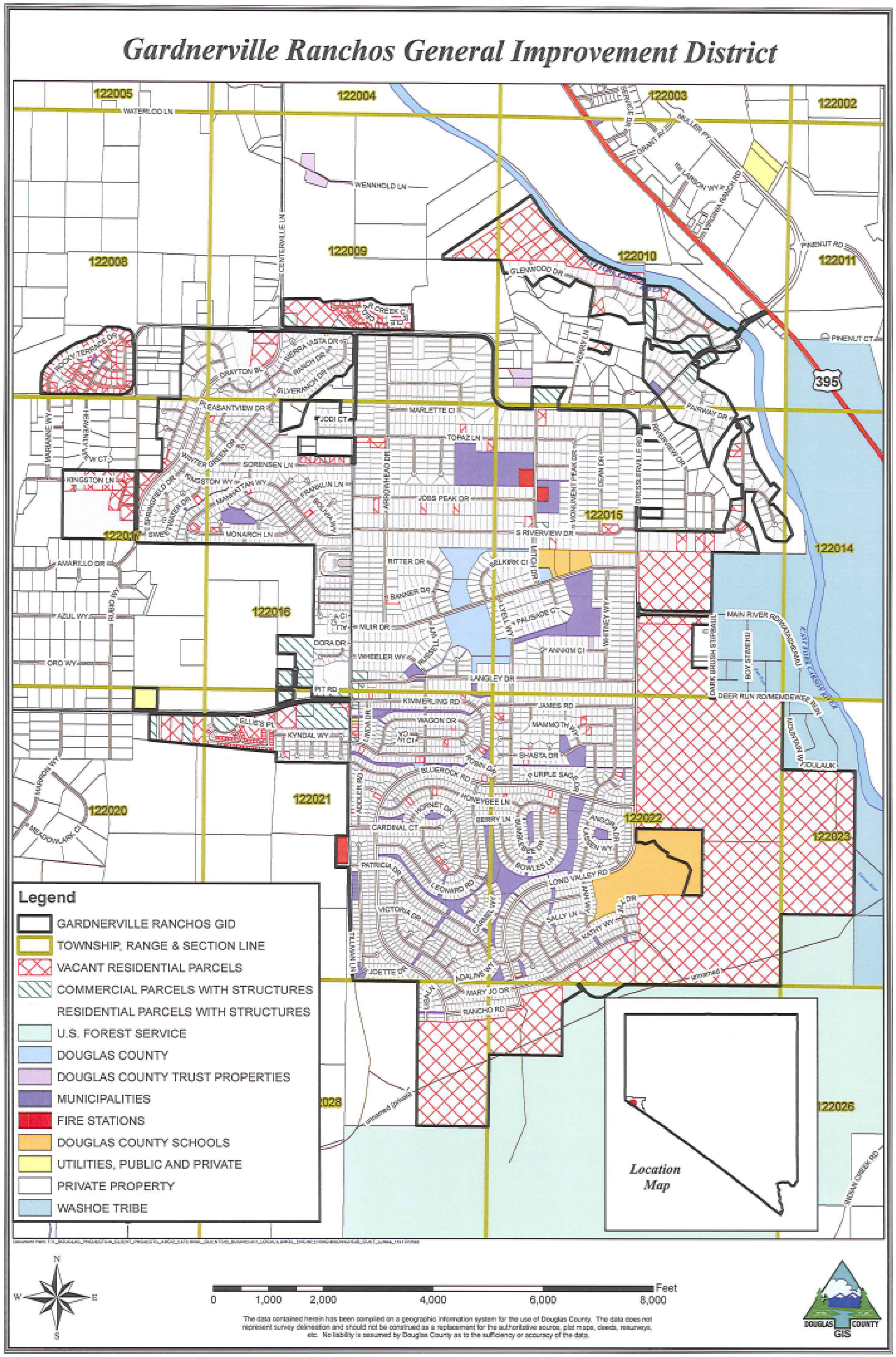
A living document is usually a type of planning document developed for future planning which is created utilizing the best available information and data at the time. Living documents require periodic updates so they can determine what assumptions made during its initial preparation may have changed causing inaccuracies in the future projections. This report is considered a living document and will require periodic updates to help track the validity of the anticipated future projections. Usually, a five year update is considered practical for a Water Resource Plan of this caliber.

2.0 GRGID HISTORY

During the mid-1960s, a gentleman by the name of C.E. (Red) Swift was interested in developing a subdivision of homes in Douglas County (County). The County required that new subdivisions be serviced by a water utility and have paved streets within the subdivision. Mr. Swift initially attempted to annex his land into the towns of Gardnerville and Minden but was unsuccessful due to the proximity to both towns. Undeterred, Mr. Swift decided to create a General Improvement District, and on April 9, 1965, the Gardnerville Ranchos General Improvement District was created to service the future residential development. GRGID's service boundary is located in the central portion of Township 12N and Range 20E (Figure 1).

The first Board of Trustees included C.E. Swift, D.A. Swift, M.K. Swift, C.N. Swift, and W.P. Bednar. The Board of Trustees worked diligently to secure grants and loans to finance and build the initial water infrastructure and paved street improvements within the boundaries of their district. On May 17, 1967, the properties within Unit 2, Unit 3, Unit 4 and the Country Club Estates (golf course area) were all annexed into GRGID. Over the years, GRGID's service boundary has continued to grow with the annexation of multiple residential and commercial subdivisions that include: Rancho Estates, Unit 5, Unit 6 (April 3, 1973), Unit 7 (July 18, 1974), Pleasantview Subdivision, Silver Ranch Estates, Sunburst Subdivision, Hidden Creek Subdivision, Rocky Terrace Subdivision, Rainshadow Ranch, Heritage Subdivision, Tillman Commercial Center, Langtree Commercial Center, 540 acres of land south and east of Long Valley Road, and several other smaller parcels.

Currently, GRGID's services include the operation and maintenance of the water system, sewer collection system, streets and street lights, storm drains, parks and recreation, and open spaces within the District's boundary. As GRGID's service boundaries continue to expand due to new annexations of land, questions are now being asked regarding the limitations of the ground water resources available for the expansion of the service area.


Gardnerville Ranchos General Improvement District
Legend
GARDNERVILLE RANCHOS GID
TOWNSHIP, RANGE & SECTION LINE
VACANT RESIDENTIAL PARCELS
COMMERCIAL PARCELS WITH STRUCTURES
RESIDENTIAL PARCELS WITH STRUCTURES
U.S. FOREST SERVICE
DOUGLAS COUNTY
DOUGLAS COUNTY TRUST PROPERTIES
MUNICIPALITIES
FIRE STATIONS
DOUGLAS COUNTY SCHOOLS
UTILITIES, PUBLIC AND PRIVATE
PRIVATE PROPERTY
WASHOE TRIBE
Location Map
122005
122004
122003
122002
122008
122009
122010
122011
122014
122015
122016
122020
122021
122022
122023
122026
WATERLOO LN
WENNHOLD LN
CENTERVILLE LN
PINENUT RD
PINENUT CT
395
PLEASANTVIEW DR
DRAYTON BL
SORENSEN LN
KINGSTON LN
MONARCH LN
MARLETTE CI
TOPAZ LN
JOBS PEAK DR
S RIVERVIEW DR
RITTER DR
BANNER DR
MUIR DR
DORA DR
WHEELER WY
LANGLEY DR
PIT RD
KIMMERLING RD
JAMES RD
WAGON DR
MAMMOTH WY
SHASTA DR
KYNDAL WY
AMARELLO DR
AZUL WY
ORO WY
BLUEROCK RD
HONEYBEE LN
BERRY LN
CARDINAL CT
PATRICIA DR
VICTORIA DR
LONG VALLEY RD
SALLY LN
KATHY WY
JOETTE DR
ADALINE WY
MARY JO DR
RANCHO RD
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DEER RUN RD
INDIAN CREEK RD
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6,000
8,000
The data contained herein has been compiled on a geographic information system for the use of Douglas County. The data does not represent survey delineation and should not be construed as a replacement for the authoritative source, plat maps, deeds, resurveys, etc. No liability is assumed by Douglas County as to the sufficiency or accuracy of the data.
DOUGLAS COUNTY GIS

3.0 REGIONAL & LOCAL HYDROGEOLOGY

3.1 Occurrence and Movement

The Carson Valley is a north trending valley that lies between the Carson Range on the west and the Pine Nut Range on the east. These ranges are composed of granites and volcanic rocks. The valley is composed of several hundred to several thousand feet of gravels, sands, silts and clays derived from these ranges. These sediments are mostly saturated with groundwater and form the alluvial aquifers that serve the population of Carson Valley. GRGID lies within the southeast portion of the Carson Valley and overlies saturated, alluvial sediments several hundreds of feet thick.

The Carson Valley aquifers contain a very large reservoir of groundwater, considered "storage". However, it is the dynamic influx of groundwater recharge and consequent discharge that dictates the nature of the groundwater system. Groundwater primarily moves due to the influence of gravity from a high elevation to a lower elevation. This change in elevation is termed a groundwater gradient. Within the "hydrographic" area, groundwater initiates as infiltrated snowmelt in the Carson Range flowing eastward to the valley floor, and from the Pine Nut Range flowing westward to the valley floor (Figure 2). The topography of the valley is generally sloped from south to north. Consequently, within the valley proper, groundwater moves northward into Eagle Valley, then eastward to the Dayton and Lahontan Valleys, generally following the Carson River.

Figure 2 was constructed by the US Geological Survey (USGS) locating and measuring water levels in wells and then extrapolating the data basin wide. The contours on the map are generated from "equal-potential" or equal elevations of groundwater levels. The map illustrates how groundwater moves within the valley. The map is useful in determining where groundwater initiates and where it discharges.

3.2 Sources of Recharge (River and Snowmelt) and Discharge

Snowmelt in the Carson and Pine Nut Ranges percolates into the mountain block and flows downward to the valley floor. Streams that emanate from these ranges also infiltrate into the ground, mostly on alluvial fans along the basin margins. This mechanism provides most of the annual recharge to the Carson Valley aquifers. Infiltration of surface water from the Carson River and flood irrigation also provides significant recharge to the groundwater system, as do periodic flooding events.

As groundwater moves northward and nears the land surface, transpiration from plants and direct evaporation occurs (termed evapotranspiration). This occurs primarily in the central valley north of Minden where wetlands occur and is a natural groundwater "discharge" mechanism. At the northern end of Carson Valley, groundwater also discharges to the Carson River where groundwater levels are at or near ground surface

Groundwater then flows to Eagle Valley and constitutes an "outflow" in terms of a Carson Valley "water balance".

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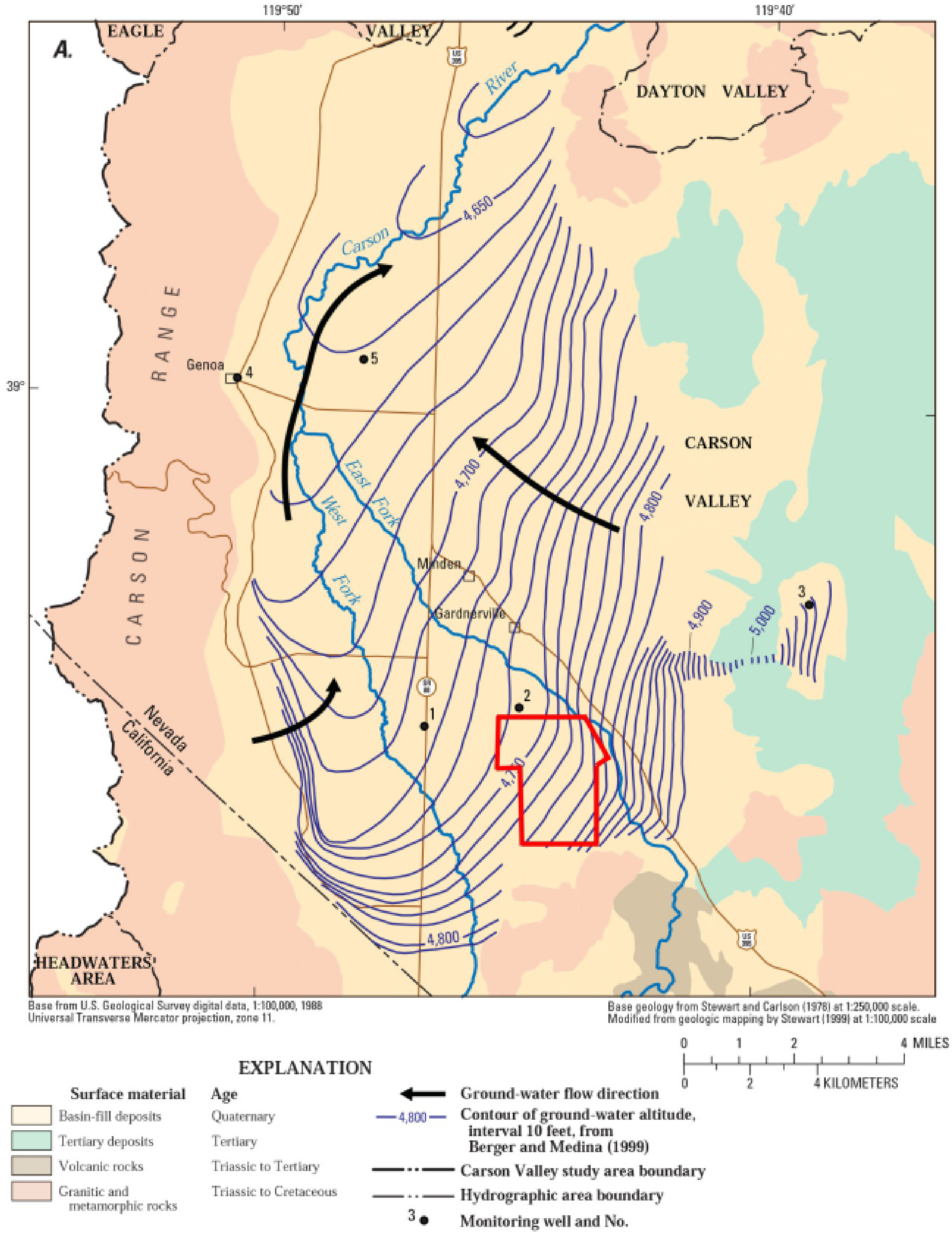

Figure 2. Groundwater levels in Carson Valley (taken from Maurer and others, 2008). The approximate GRGID boundary is shown in red.

Depths to groundwater within the GRGID wellfield vary depending on the well location. Near the Carson River floodplain and along the eastern edge of GRGID the depth to groundwater is 35 feet. In the central and west portion of GRGID and on the "Bench" the depth to groundwater is 60 feet. The difference is largely due to the land surface elevation above the Carson River. Groundwater recharge to the GRGID wellfield is mostly due to groundwater emanating from the Pine Nut Range and leakage from the East Fork of the Carson River. This is indicated by the potentiometric map or "water table" map shown in Figure 2. The water table elevations indicate a "gradient" from the Pine Nut Mountains to the GRGID wellfield.

3.3 Summary of Water Balance

The USGS has investigated the Carson Valley hydrology for several decades and has published several studies. The research indicates that the valley receives an annual average of approximately 38,000 acre-feet of groundwater recharge from precipitation (snowmelt) that infiltrates into the ground in the Carson and Pine Nut Ranges and flows underground to the valley. Annual average recharge from the Carson River is estimated to infiltrate 10,000 acre-feet, mostly in the southern portion of the valley. Recharge also occurs from irrigation practices and is estimated at an annual average of 4,500 acre-feet. These estimates amount to approximately 52,500 acre-feet of groundwater recharge to the valley's aquifers in an average year.

During 2011, the Nevada State Engineer estimated that groundwater pumping in the valley was approximately 20,000 acre-feet per year. Of this, 15,000 acre-feet was for municipal, domestic and industrial purposes and 5,000 acre-feet supported irrigation. For comparison, the GRGID pumped 3,460 acre-feet in 2013. Currently, valley-wide pumpage is less than half of the groundwater recharge to the basin. However, as will be discussed in Section 4, the permitted water rights for groundwater approximates the average annual recharge estimate.

Groundwater also discharges to specific sections of the Carson River. This largely occurs in the northern portion of Carson Valley and is estimated at 15,000 acre-feet in an average year. Evapotranspiration from non-irrigated lands is estimated at 11,000 acre-feet. And the USGS estimates that an annual average of 7,000 acre-feet of groundwater naturally moves northward from the Carson Valley into Eagle Valley. This estimate is dependent upon the amount of precipitation, flow in the Carson River, and pumpage that occurs in Carson Valley during any particular year. Eagle Valley groundwater permits are partially dependent upon this groundwater movement from Carson Valley to Eagle Valley. It is important to note that these recharge and discharge estimates are annual averages for Carson Valley and the system as a whole is very dynamic and dependent on annual climatic events.

4.0 WATER RESOURCE PRODUCTION AND MANAGEMENT

4.1 Water Rights

4.1.1 Basin background

While the physical quantity of the water resources in the Carson Valley Hydrographic Basin appear to be abundant, the adjudicated and appropriated "water rights" within the basin are also abundant. In the State of Nevada, the State Engineer's Office has jurisdiction over all appropriations of the water rights and their uses. The Carson Valley Hydrographic Basin has been elevated to a "designated basin" status by the State Engineer's Office. A basin is usually elevated to a designated status when the water rights in the basin have reached or exceeded its perennial yield. A designated basin allows the State Engineer additional authority in the administration of the water resources in the form of restricting specific uses and/or subdividing a basin for better management of the water resources.

The total volume of groundwater "water rights" permits within the Carson Valley Hydrographic Basin is 95,770 acre-feet annually (AFA). 48,660 AFA are supplemental irrigation water rights that can only be used when surface water is not available. This type of usage usually occurs during drought years. The groundwater "water rights" for domestic and municipal purposes total 38,200 AFA. Non-supplemental irrigation rights total 2,900 AFA. In 2011, the total basin-wide groundwater withdrawal was 20,469 AFA. Based on the current usage, there appears to be sufficient groundwater to supply the current demand. However, if successive years of full groundwater extraction were to occur (95,770AF), such as during successive years of drought conditions, the basin could become over drafted and the State Engineer's Office would administratively intercede.

Surface waters within the basin were adjudicated through the U.S. Federal Court in the Alpine Decree and are regulated by the Federal Watermaster. The surface waters were allocated based upon their historic "claims" and their priority in time. The Carson River flows average 351,200 AF per year and are shared by users throughout its course to the Lahontan Reservoir and the Lahontan Wildlife Area. The total volume of surface water rights for use in the Carson Valley most likely exceeds the volume of physical water. Perennial streams contribute an additional 30,000 AF of water to the Carson Valley during an average water year and are also fully appropriated.

4.1.2 Local area water right owners and current usage

A review of water right holders within one mile of the GRGID indicates that only the Carson Valley Golf Course poses any potential well pumpage interference issues. These permits have been certificated for 292 AFA. During the irrigation season, their pumpage is 1-2 AF per day (estimated). The Golf Course well is located approximately 1,600 feet from GRGID Well 1 and approximately 2,100 feet from GRGID Well 2. To date there has not been any known well interference issues documented.

4.1.3 GRGID water rights

Currently the GRGID's water rights total 5,054.4 AFA. These were acquired through the original creation of the General Improvement District and through annexation agreements. Figure 3 illustrates GRGID pumpage over the last 19 years. Water rights and the 2013 pumpage for each well are listed in Table 1. In the most recent calendar year (2013), GRGID made use of 68% of their water rights. The total rights represent current usage, existing vacant lots, future commercial development and support a portion of the future San Juan development. Appendix A contains a list of the individual water right applications (permitted or certified) with their duty, status, and associated point of diversion (i.e. Well #). Appendix A also includes a list of the supplemental groupings for the listed water rights.

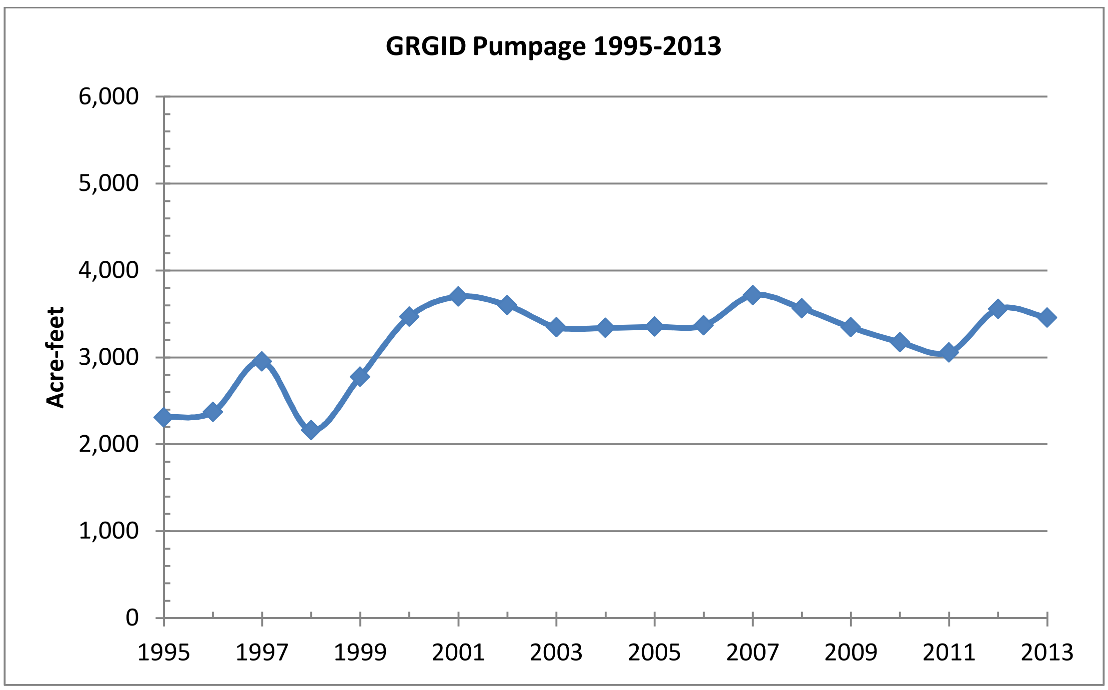

Figure 3. Groundwater pumpage during the last 19 years. As of 2014, the maximum pumpage allowed is 5054 AF.

The current water right dedication policy for development within GRGID is listed in Table 2. Water right dedication for commercial development is dependent upon the type of development and/or fixture count.

Table 1
Status of GRGID Water Rights

	Pump Capacity (gpm)	Duty (AF)	2013 pumpage (mg)	2013 pumpage (AF)	2013 % of duty
Well 1	1150	2,254	257	788	35
Well 2	1800	1,976	258	793	40
Well 4	400	1,122	170	523	47
Well 5	1200	910	0	0	0
Well 6	700	1,332	199	612	46
Well 7	135	362	0	0	0
Well 8	1350	2,857	109	335	12
Well 9	900	475	133	407	86
Totals	**5925**	**5,054**	**1,127**	**3,458**	**68**

Table 2
GRGID Water Right Dedication Requirements

Development Type	Gallons per day	Acre-Feet per year
Single Family Dwellings	1,000	1.12
Town Houses	700	0.78
Duplexes	500	0.56
Apartments	250	0.28

4.1.4 Carson Valley water right summary

While the Carson Valley Hydrographic Basin appears to contain an abundant water resource supply, currently it is also over-appropriated in terms of water right allocations. Due to the lack of full allocated use of the appropriated water rights within the basin, the basin is not currently experiencing detrimental effects. With regards to GRGID groundwater usage, the localized pumping within and adjacent to GRGID's service area, is not creating any known problems. GRGID's water rights are in good standing with the State Engineer's Office.

4.2 Water Facilities and Production

4.2.1 Water facility layout

Figure 4 is the Water System Map for GRGID which shows the locations of six operating wells and two additional wells (5 and 7) used for backup purposes. Wells 2, 6, 8, and 9 pump within the lower pressure zone and provide 4,700 gpm. Wells 1, 4, 5, and 7 pump within the upper pressure zone and provide 2,890 gpm. A booster pump is located at Long Valley Road near Bluerock Road that supports the 1.5 million gallon tank. A second booster pump is located on Tillman Road near Patricia Drive that services a 3 million gallon tank.

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GARDNERVILLE RANCHOS GENERAL IMPROVEMENT DISTRICT

FIGURE 4
WATER SYSTEM MAP

GARDNERVILLE RANCHOS DOUGLAS COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

FIGURE 4

DATE: 7/11/2014
DRAWN BY: RCG
DESIGNED BY: RCG
CHECKED BY: RCG
JOB NO.:

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4.2.2 Well inventory data sheets

GRGID's production well constructions, their pump and motor specifications, and pertinent settings are provided in Appendix B. The data sheets serve as a reference for the wells and should be circulated among the operators, engineer, and manager. Most of the entry descriptions are self-explanatory.

In reference to the data sheets, the top of the page describes the well construction and performance. The middle of the sheet describes the well location in terms of township and range, latitude and longitude, and elevation of the well head (land surface). The bottom portion of the data sheet describes the pump and motor specifications and the pump setting below the top of the casing. Updating these data sheets should be a priority any time a repair or replacement to these wells, pumps and motors is made.

Some of the items on the data sheets may need further explanation, such as "rated capacity" which is the recommended pump capacity when the well was first tested. It should be noted that the rated capacity often is reduced over the life of the well. The static water level is the water level in a well when the well is considered fully recovered from previous pumping. The pumping water level is the water level when the pump has been on for a sufficient time that the level of the water has stabilized in the well.

It is important to keep records of the static and pumping water levels in the wells as they tend to change over time. It is also necessary to know the relationship of these levels to the pump setting and the location of the well screen. A large change in the pumping level may indicate dewatering of the aquifer or that the well screen has become plugged. It is also important to ensure that the pumping level stays above the well screen in order to eliminate cascading water and air entrainment which can lead to pump cavitation and plugging of the screen intervals due to biofouling.

Specific capacity refers to the pumping rate versus drawdown in units of gallons per minute per foot of drawdown (gpm/ft). This description is dependent on the pumping rate and the length of time that the well is pumped. For example, a well pumped at 1,000 gpm for 30 minutes will have a higher specific capacity than if the well was pumped at the same rate for 24 hours because there would be greater drawdown. This "rating" should be monitored over time as a large change may indicate that the aquifer or well screen may have problems.

4.2.3 History of wells and testing

GRGID's wellfield was initiated in 1965 with Well 1 and Well 2 (1967). As development continued, Well 3 was completed in 1975 and Well 4 in 1978. During the mid-1980s, another period of development began requiring the completion of Well 5 in 1984 and Well 6 in 1989. Well 3 was later abandoned due to poor production (approximately 75 gpm).

In the early 1990s, GRGID continued a rapid growth rate that resulted in an exploration drilling program with the completion of three test wells in 1994. The first test hole was abandoned (dry) and then test wells 7A and 7B were drilled. Test Well 7A became production Well 7. Test Well 7B was drilled on the Bentley Ranch, but it was later abandoned because negotiations with the land owner could not be resolved. Well 8 was completed in 1997 and Well 9 in 2005.

In 2004, Well 2A was drilled due to the initial Well 2 losing production and unacceptable levels of sand production. In 2007, Well 1 was reconditioned with a 14" diameter liner, which was installed and gravel packed inside the original 18" diameter casing. The reconditioning of the well resulted in a higher production flow rate with less sand production. Currently, Well 4 produces unacceptable sand production and is being considered for replacement as soon as the land owner negotiations are finalized. The proposed location for the Well 4 replacement is approximately 50 feet west of the existing Well 4. However, this location will most likely cause well interference problems with Well 2 to some degree because a higher discharge is expected.

Table 3 is a list of the wellfield's documented pumping test records. The specific capacity, based upon 100 minutes of pumping at the listed flow rate, is an industry standard for initial well production ratings in units of gallons per minute per foot of drawdown (gpm/ft). The listed ratings in Table 3, compares the initial productivity for each of the wells. A specific capacity of 10-gpm/ft. or greater is considered an

Table 3
Pumping Test Data

Well	Test Date	Discharge (gpm)	Specific Capacity (gpm/ft)	Remarks
1	1977	1090	30	24hr test with variable rates up to 1995gpm
2	1985	1028	15	36hr test with step and recovery test
2	2003	1200	8	24 hour test with recovery
2A	2004	1750	18	replacement well, 54hr test with step test
4	1982	768	11	12hr variable rate test w/recovery
4	2008	743	7	24hr test with recovery
5	1984	1200	12	48hr test with step and recovery test
7	1994	235	0.6	Poor 7hr pumping test
8	1999	1200	12	48hr test with step and recovery tests
9	2005	1001	8.5	48hr test with step and recovery tests

acceptable rating for a municipal well. As discussed earlier, Well 2 was abandoned and replaced with Well 2A. Well 7 shows a very poor specific capacity of less than 1 gallon per minute per foot of drawdown.

Annual testing of specific capacity is a very useful means of tracking the production rate of wells. Calculating a "wire-to-water" efficiency during these tests will also alert the operator to any potential problems with the pump or motor and energy efficiency. Analyses of these tests have been performed and are available for inspection within the accompanying CD.

4.2.4 Well operations and pumpage

There are currently two pressure zones in the GRGID water system. Wells 1, 2, 4 and 8 supply the lower pressure zone and Wells 5, 6, 7 and 9 supply the upper pressure zone. Figure 5 displays the annual production over the last 19 years. The graph indicates that the production from the wells has been relatively consistent since 2000. When comparing the available well production to the existing production over time, the graph indicates that there is still approximately 400 million gallons per year of production available for future growth.

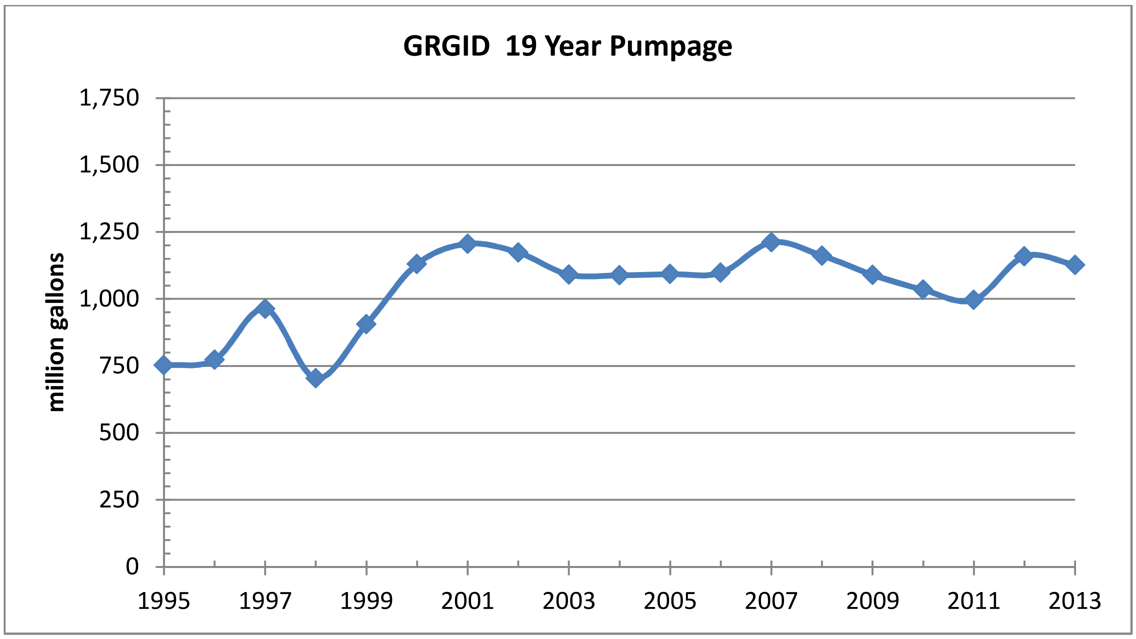


Figure 5. Annual GRGID pumpage in million gallons per year. The maximum annual pumpage allowed by the State is 1,650 million gallons.

Figure 6 displays the annual production for each well since 2009. The graph indicates that each well is pumped in a similar manner from year to year. Wells 1 and 2 provide the larger portion of water followed by Wells 4, 6, and 9. Well 8 was not pumped in 2010 and 2011 because of low demands and energy costs to operate.

Figure 7 displays the monthly production for the system during 2013. Similar to the previous years, Well 2 is predominantly pumped during the late spring through late summer and Well 1 predominately in the mid-summer through the fall. In 2013, Well 8 was mostly pumped during the winter months.

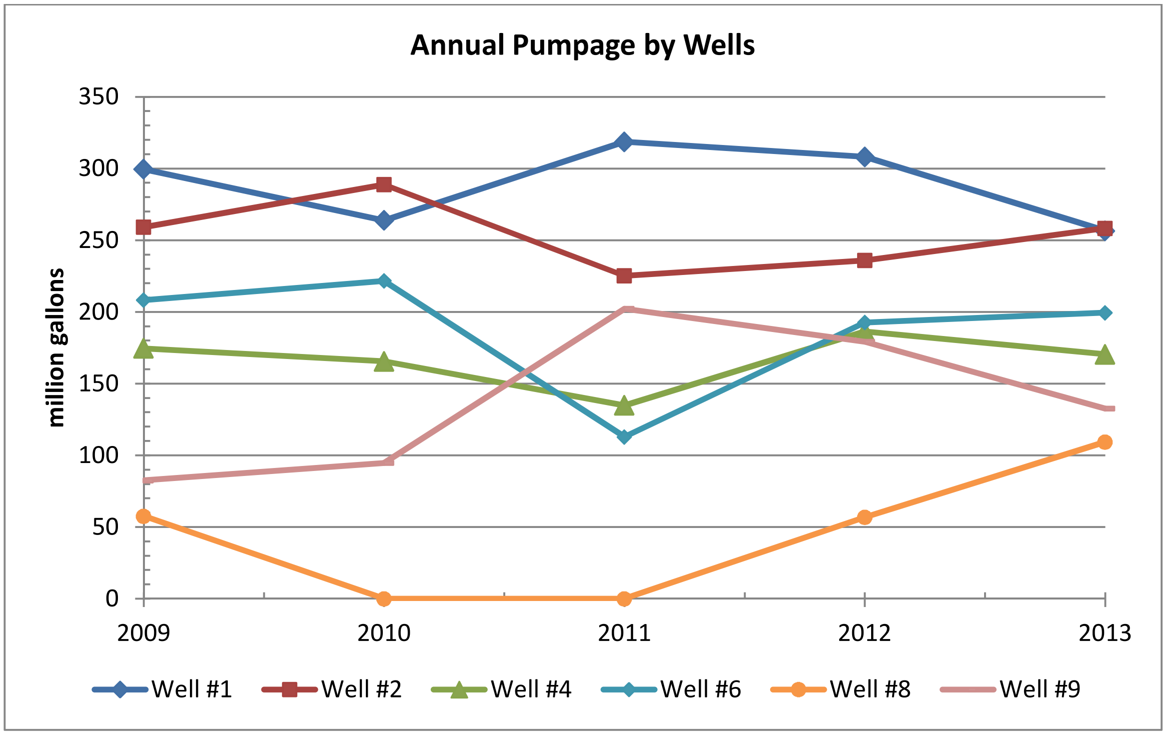


Figure 6. Annual production by well from 2009 to 2013. Well 7 was not pumped in this time frame.

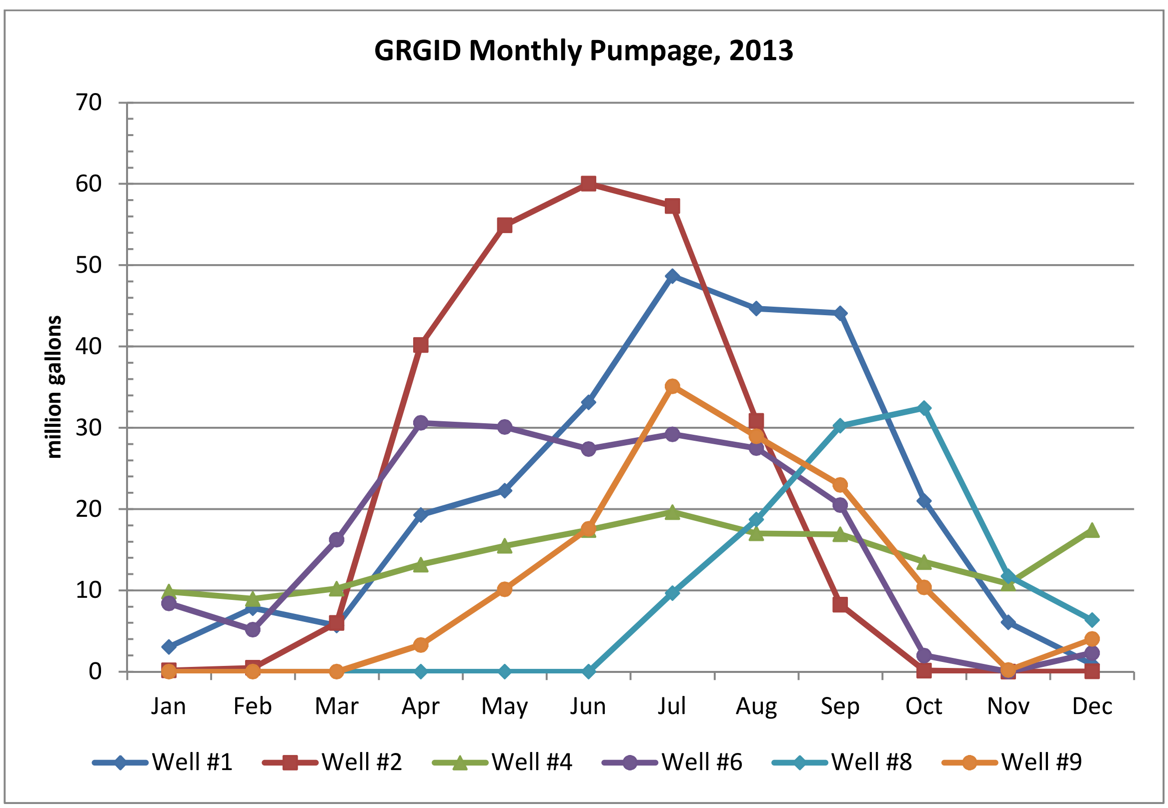


Figure 7. Monthly pumpage by well during 2013. Well 7 was not pumped.

Four of GRGID's water wells have water quality issues. Well 5 has arsenic concentrations that often exceed the Safe Drinking Water Standards. Well 4 produces sand at high production rates and also suffers from air entrainment due to pumping levels located in the screen interval resulting in cascading water. Well 7 has a low flow capacity and arsenic concentrations that exceed the Safe Drinking Water Standards. Well 8 also produces water that frequently exceeds the arsenic standard. However, it could be pumped in the summer months using the "Running Annual Average" for arsenic (see Glossary).

4.2.5 Well water level and pumping rate history

Water levels and production rate records were graphed for each well over a three-year period (2011-2013). Figure 8 illustrates the data for Well 1. As the data indicates, the pumping water levels are below the screen and therefore subject to cascading water. The pumping water level is deepening at a rate of 6 feet per year. As a result of deeper pumping water levels, the pumping rate has declined, on average, 50-gpm per year during the mid to late summer months (Figure 9). Similar charts for GRGID's primary wells are displayed in Appendix C. Table 4 summarizes the impacts that have occurred during the last three years. Wells 5, 7, and 8 are not shown as they are rarely pumped and data was not available for the analysis.

Table 4
Pumping Level and Rate of Production Declines (2011-2013)

	Rate of pumping water level increases (ft/yr)	Rate of production decline (gpm/yr)	% Rate of production decline
Well 1	6	50	3
Well 2	5	50	3
Well 4	n/a	22	5
Well 6	7.5	30	5
Well 9	4	10	1

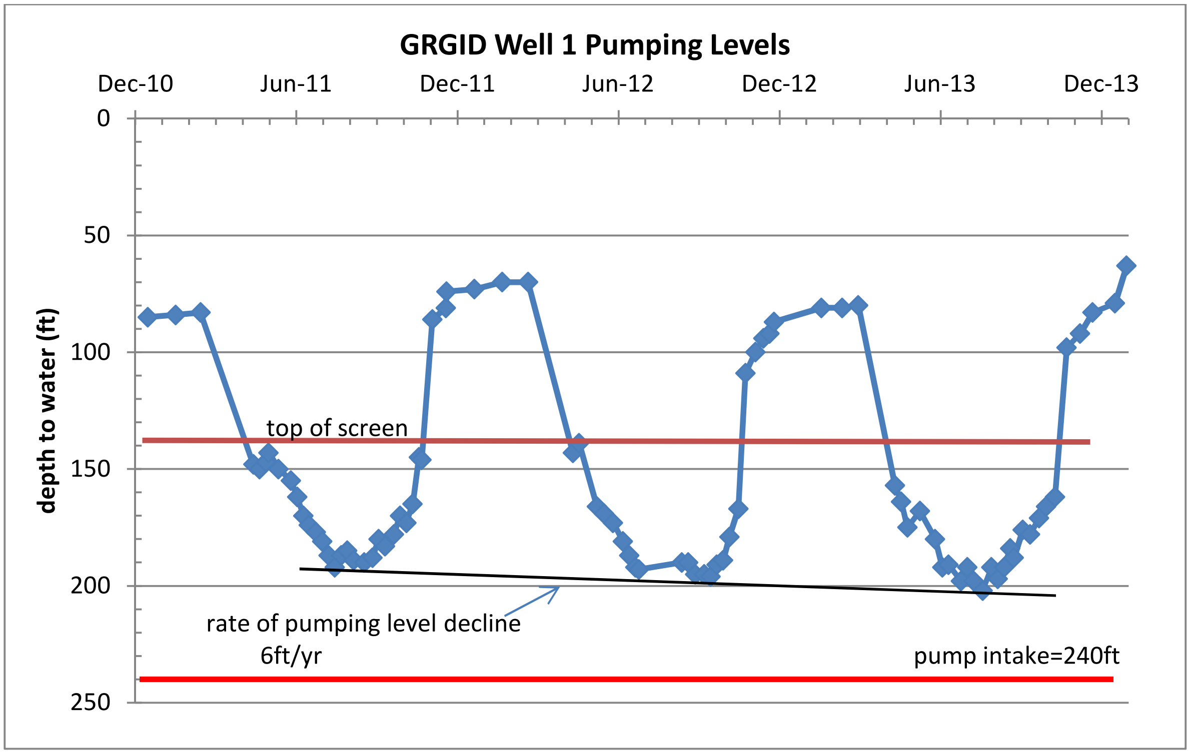


Figure 8. GRGID Well 1 pumping levels (2010 to 2013). Graph indicates a decline of 6 ft/yr.

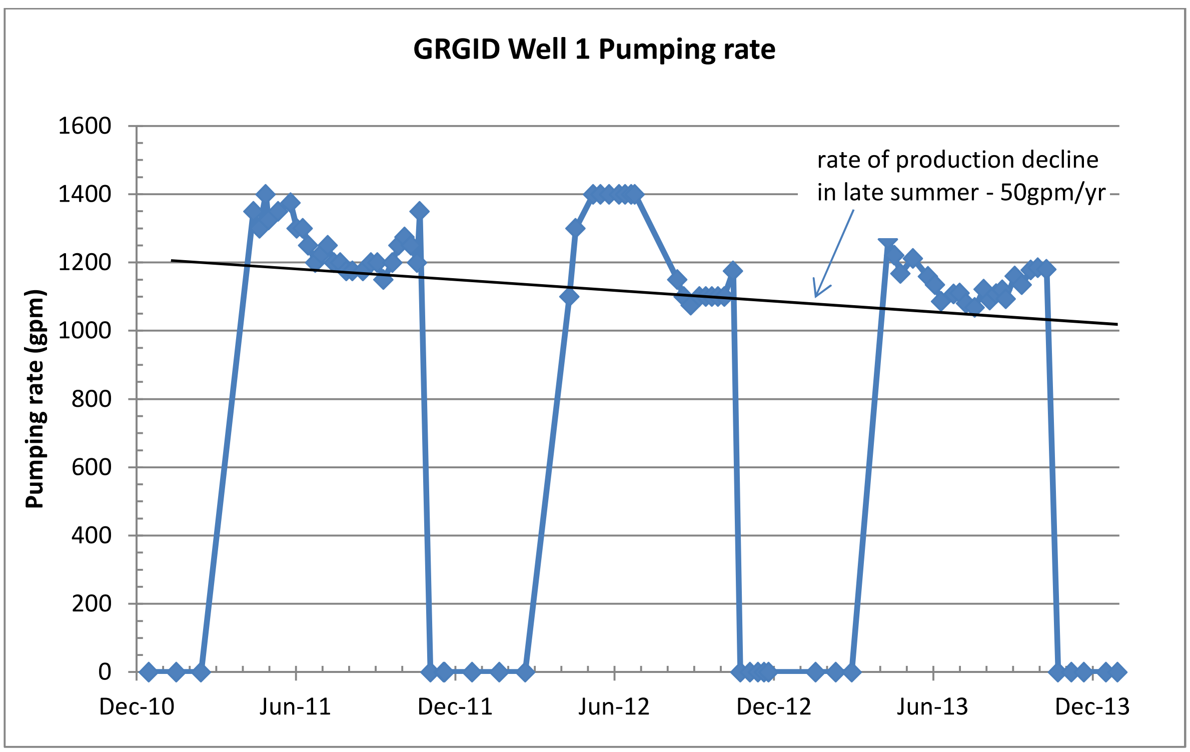


Figure 9: GRGID Well 1 pumping rate. Graph indicates an average decline of 50-gpm per year.

The declining pumping rate is due to the deeper pumping water levels in the wells. This is because with deeper pumping water levels the motor horsepower is insufficient to overcome the greater distance from the deeper water level to the ground surface **at the same pumping rate**. The result is a decrease in the production rate (see Glossary for total dynamic head). Deeper pumping water levels can be due to several causes and typically include: 1) the aquifer response to large scale pumping over time (adjusting to new equilibrium); 2) plugging of the screen intervals due to encrustation (and therefore a reduced specific capacity); and 3) a lowering of the static water level (usually the result of drought conditions or large scale pumping). To determine the exact cause of the deeper water levels would require an extensive survey. Graphs that support Table 4 can be found in Appendix C.

4.2.6 Well Interference Issues

Based upon the well data provided, Wells 1 and 2 experience well interference between the two wells when one or both are pumped. The wells are a distance of approximately 1,650 feet apart. Figure 10 displays a series of pumping and non-pumping periods for Well 1 and the drawdown response seen in Well 2, when Well 2 was not pumped during those periods of time.

In Figure 10, the top curve (red) represents the water level in Well 2 when it was not being pumped during the period of January 1 to January 10, 2013. The static water level in Well 2 fluctuates between 4 and 6 feet during specific periods of time and in unison with the operational pumping of Well 1 bottom curve (blue). This influence can also be determined by using the Theis equation and estimates of aquifer transmissivity and storativity. The calculations indicate the same response as shown in Figure 10. Using this equation also indicates that after 15 days of intermittent pumping of Well 1 (12 hours a day), 25 feet of drawdown at Well 2 could potentially occur. This well interference can become significant if both Wells 1 and 2 are operating at the same time. The GRGID staff is aware of this issue and currently operates Well 1 and Well 2 to minimize this effect.

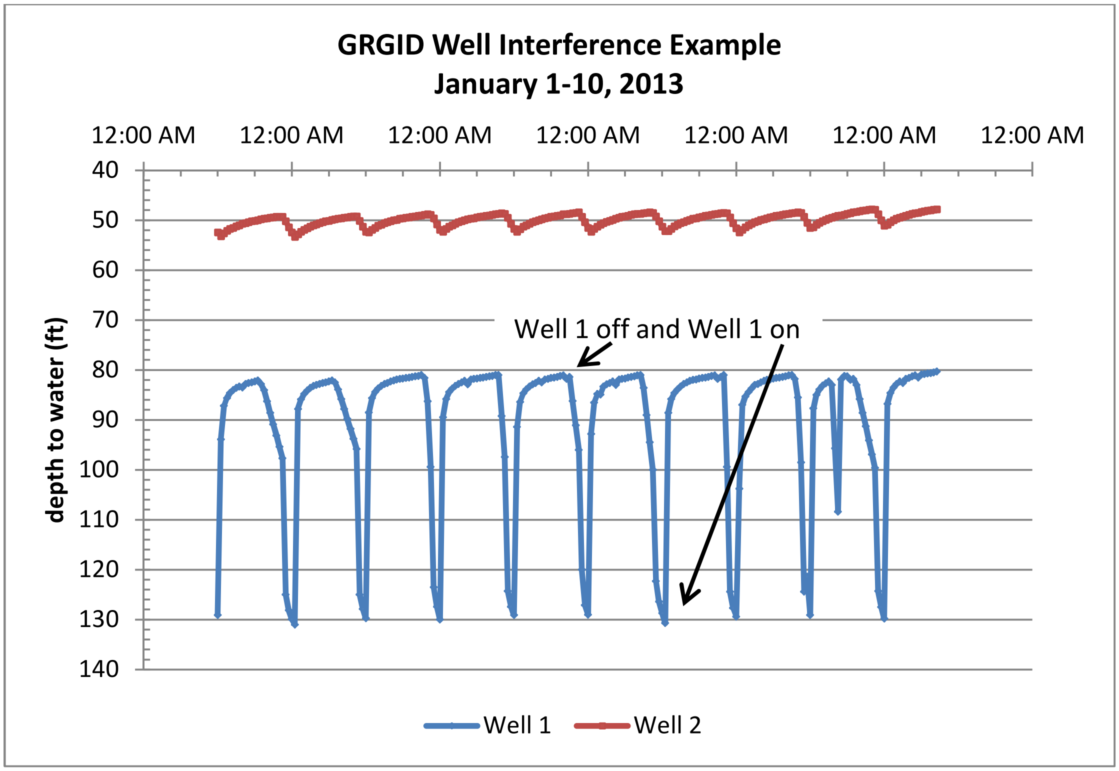


Figure 10. Display of water levels in GRGID Wells 1 and 2. Well 1 pumps intermittently and Well 2 is not pumped in this interval. Drawdown at Well 2 ranges from 4 to 6 feet in this example.

Currently, there is no data available to document water level effects in Well 4 to see if it is influenced by the pumping of Well 1 (a distance of 2,400 feet apart). Pumping and water level records indicate that Well 8 is not influenced by the pumping of Well 2. A third concern is the potential well interference from the Carson Valley Golf Course well. This well is located approximately 1,600 feet from Well 1 and 2,100 feet from Well 2. The Golf Course Well has a reported (Nevada Driller's Log) capacity of several hundreds of gallons per minute. It is screened in the same intervals as GRGID Wells 1 and 2 suggesting the same aquifer system. Consequently, there is a high degree of probability that the operation of the Golf Course Well does impact water levels in GRGID Wells 1 and 2.

4.2.7 Historical Water Quality

The State of Nevada has adopted the US EPA's Safe Drinking Water Standards. There are Primary and Secondary Standards that GRGID monitors on a quarterly, annual, and three year basis. GRGID's wells meet Primary and Secondary Standards with the exception of arsenic in a few of the wells. Table 5 displays the latest results of the inorganic constituents that could be of concern to GRGID. Appendix D lists the latest water quality results for all the key constituents.

Table 5
GRGID Water Well Chemistry, Key Constituents

Standards	1000	10	0.6	0.1	10
	TDS	**Arsenic**	**Iron**	**Manganese**	**Nitrates**
	ppm	**ppb**	ppm	ppm	ppm
Well 1					
7/31/2012	189	6	<0.05	<0.02	0.8
Well 2					
7/31/2012	177	6	<0.05	<0.02	<0.5
Well 4					
7/31/2012	168	3	<0.05	<0.02	0.6
Well 5					
11/14/2013	250	**20**	<0.05	<0.02	2
Well 6					
7/31/2012	162	5	<0.05	<0.02	1.5
Well 7					
9/29/1994	191	5	**14**	**0.19**	
Well 8					
7/31/2012	146	10	<0.05	<0.02	0.6
Well 9					
7/31/2012	178	9	<0.05	<0.02	2.2

TDS=Total Dissolved Solids

Total Dissolved Solids (TDS) is a measure (in parts per million "ppm" or milligrams per liter "mg/L") of the concentration of constituents in solution of water. The secondary standard for TDS in the State of Nevada is 1,000 ppm. As Table 5 indicates, the TDS for GRGID is excellent. Arsenic is a problem for most water systems in the western states and appears to be an issue for GRGID Wells 5, 8 and 9. To date, blending of well waters has enable GRGID to keep the Running Annual Average (RAA) for arsenic in compliance with the Primary Safe Drinking Water Standards (10 parts per billion) for the water system.

The Secondary Standards for Iron and Manganese are two constituents that are of concern among water systems in Western Nevada. A review of the last ten years of water quality samples for all GRGID wells indicates that these constituents are not prevalent. The last sample of Well 7 indicates that these Secondary standards were exceeded, but is speculated that the concentration is a result of rust and scale from the casing due to the well rarely being used. Well 7 is for back-up purposes only and is not pumped on a regular basis due to poor production capacity (135 gpm). Nitrate is a constituent that should be monitored due to the nearby Carson Valley Golf Course and historic irrigation practices in Carson Valley. To date, nitrate is not a problem.

GRGID also tests for Synthetic Organic Compounds (SOCs) and Volatile Organic Compounds (VOCs). These are compounds such as pesticides and insecticides, industrial chemicals, and disinfection by-products (derived from chlorination). They can be found in water in association with domestic products (discharged through septic tanks), farming, turf maintenance, and industrial practices. To date, there have not been any GRGID water samples that have tested in a concentration that could be of concern.

A potential source of contamination could be introduced to groundwater through the Bing Gravel Pit located adjacent to Well 5. The depth of the pit intersects the shallow water table in the area. Consequently, a chemical spill in or near the pit has the potential to impact groundwater.

5.0 WATER RESOURCE EVALUATION

5.1 Source Water Reliability

5.1.1 Summary of USGS studies

The USGS, Carson City Office, have been conducting water resource investigations for the Carson Valley since the late 1970s. Lumos reviewed many of the water resource investigations and we have provided a bibliography of the most useful reports and journals in Appendix E. Many of the reports were reviewed and used as a basis for the current Water Resource Plan. Topical subject reports that were of greater use for the GRGID water resource plan include the following:

1. Precipitation, streamflow and groundwater recharge to Carson Valley from the Pine Nut and Carson Ranges (Jeton and Maurer, 2007),
2. Streamflow, groundwater and surface water interactions in the Carson Valley (Maurer, et. al., 2009), and
3. Assessing potential effects of changes in water use in Carson Valley using a groundwater flow model (Yager, Maurer, and Mayers, 2012).

The following sub-sections describe important components and concepts for the GRGID.

5.1.2 Carson River and groundwater recharge estimates

Yager, Maurer and Mayers (2012) estimates that the Carson River recharges 32,000 AFA to the groundwater aquifers of Carson Valley. The recharge largely occurs in the southeastern portion of the basin. This study also estimates that an additional 17,000 AFA of the recharge is provide to the groundwater aquifers from irrigation ditch infiltration. While the study indicated these are averages for both the Carson River and the irrigation ditches, the quantities can vary from 25,000 AFA during drought conditions (1992) to as much as 155,000 AFA during very wet periods (1997).

The largest areas of Carson River infiltration occur along the East Fork of the Carson River on the eastern and northern edges of GRGID's service area (Maurer and Berger, 2007). This recharge greatly benefits GRGID's wellfield, especially Wells 1, 2, 4, and 8. Along the perimeter of GRGID, irrigation infiltration recharge also benefits these wells and Well 6.

5.1.3 Mountain block groundwater recharge estimates

During an average water year, groundwater recharge from all Carson Valley watersheds averages 36,000 AFA. The USGS has estimated that 20,000 AFA is from the Carson Range and 17,000 AFA is from the Pine Nut Range. During an extended drought, recharge from the watersheds can decrease by as much as 80%. Simulations predict that during extreme drought, groundwater recharge from the two ranges can be as little as 7,800 AFA (i.e. 1990-1992). During wet years (1995-1997), 76,000 AFA of recharge can occur. Modeling efforts of the Carson Valley indicate that GRGID's wellfield receives recharge from the Pine Nut Range, but no quantitative estimates have ever been reported. The recharge originates as snowmelt infiltration at the higher elevations of the Pine Nut Range.

5.1.4 Impacts of drought on the groundwater reservoir

Precipitation in the Carson and Sierra Nevada ranges provides most of the groundwater recharge to the Carson Valley, either directly through snowmelt infiltration in the mountain block or from snowmelt runoff to the Carson River and other lesser streams that emanate from these mountains. Because precipitation patterns vary annually, it is difficult to predict annual recharge based on one year. Rather, it is several years of average, above average, or below average precipitation that dictate ground water levels in Carson Valley.

Because precipitation fluctuates on an annual basis, so does recharge and consequent discharge fluxes. The impacts from these changes are moderate due to storage within the groundwater "reservoir". Years of abundant precipitation have the tendency to "fill-up" the reservoir. Drought years draw groundwater from the reservoir, which is dependent on the length and severity of the drought. Over the millennia, a dynamic "equilibrium" within the reservoir is formed.

Figure 11 illustrates how the wet and dry precipitation cycles affect groundwater levels. The blue line and left scale track groundwater levels for the Rocky Slough monitor well (located just northwest of the GRGID area on Centerville Lane). The right scale and red line tracks annual precipitation rates, taken at the Minden Airport. The bold line indicates the 100-year average precipitation of 9 inches. During the early 1980s, wetter precipitation kept groundwater levels at 15 to 20 feet. But during the drought from

1985 to 1994, water level declines occurred and a "new" equilibrium formed at approximately 30 feet. When annual precipitation increased after 1994, the water levels rose to 22 feet and represented a "new" equilibrium.

Similar to the entire Carson Valley, GRGID's wellfield is influenced by the fluctuations in precipitation and consequent groundwater recharge from the Pine Nut Range and the Carson River as well. Figure 12 displays water level measurements from GRGID Well 7 and annual precipitation from the Minden precipitation gauge. During the time period of 2004 to 2013, Well 7 saw a fluctuation in water level measurements from 96 feet to 103 feet (left vertical axis). During the same time period, the precipitation fluctuates from 3 inches to 14 inches (right vertical axis), where the average annual precipitation over the last 100-years is 9 inches. The data indicate that the water levels react slowly to above average or below average precipitation. By reviewing the graph, the time from September 2006 to September 2010 indicates that below average precipitation results in a slow water level decline that reversed in 2010 as precipitation increased.

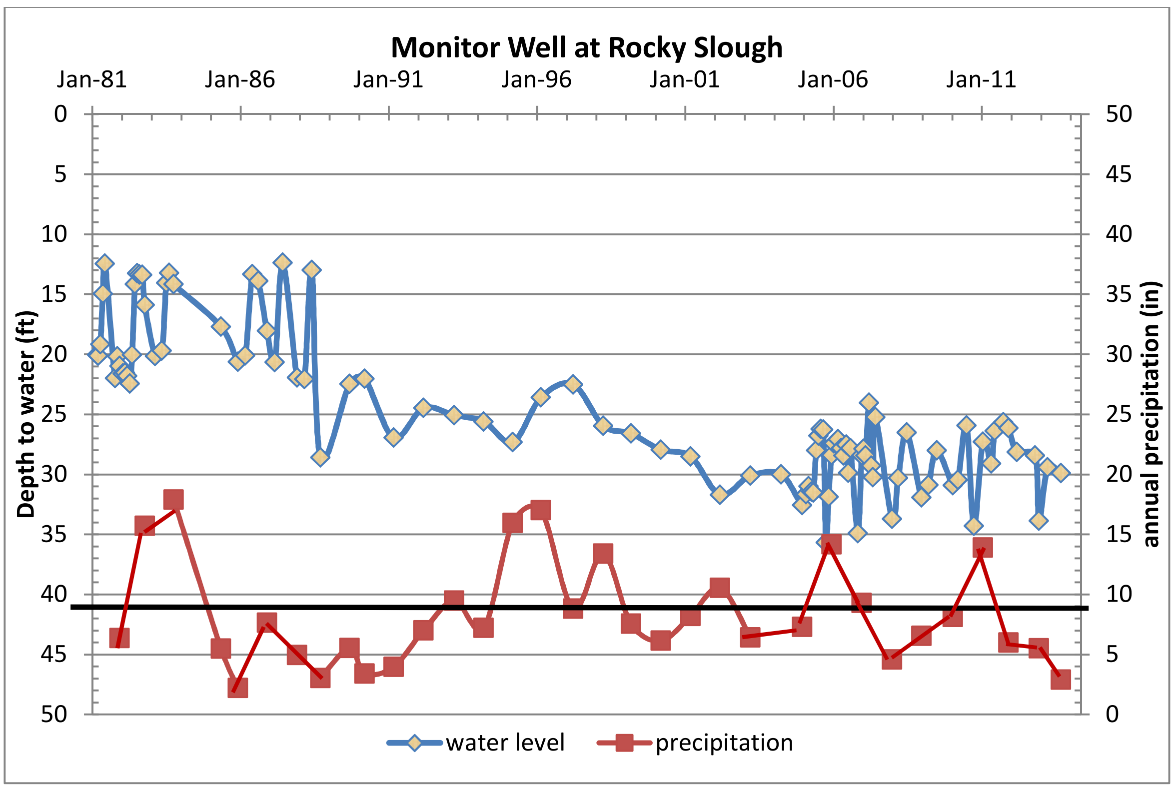


Figure 11. Monitor well located at Rocky Slough. This is northeast of the GRGID on Centerville Lane. Heavy black line indicates the average annual precipitation of 9 inches at the Minden Airport.

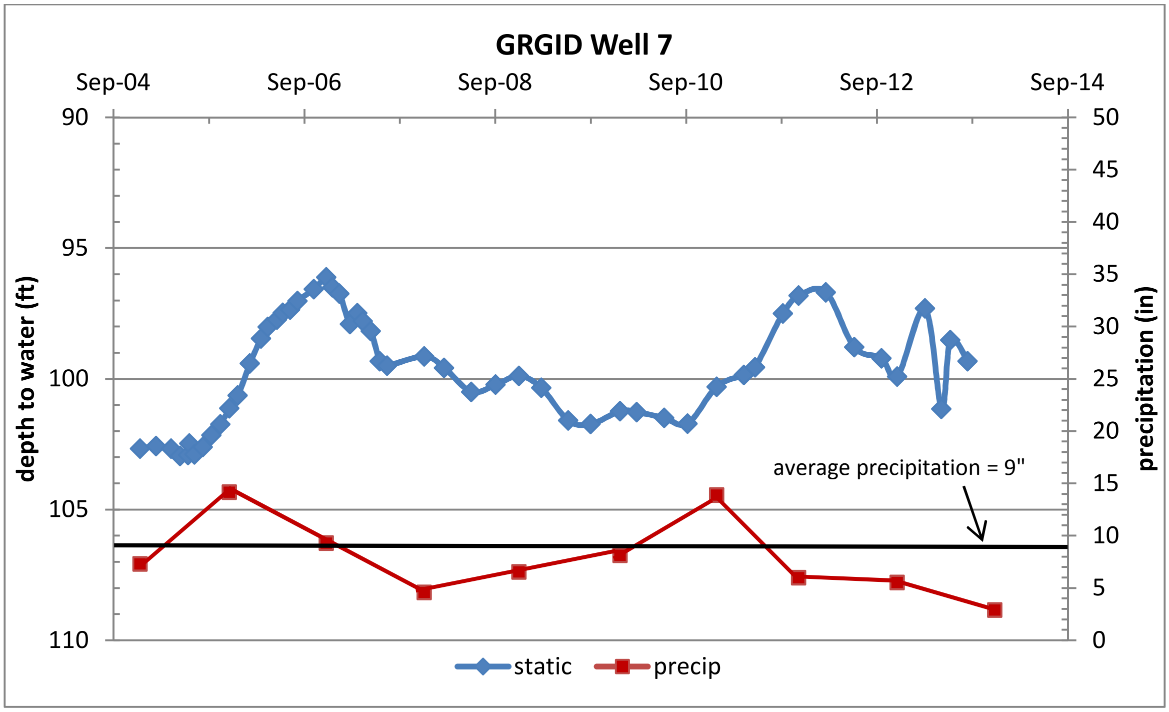


Figure 12. GRGID Well 7 water level measurements (blue) plotted against annual precipitation (red). Average annual precipitation is 9 inches at the Minden Airport (solid black line).

The water levels measured in monitor wells reflect the influence of not only precipitation derived groundwater recharge, but also the increase in pumping for municipal, and more importantly from irrigation. As the Carson River decreases its flow, so does the amount of diversions for irrigation. This relates to a decrease in groundwater recharge from infiltration. Groundwater pumping then increases to supplement the lack of surface water for irrigation.

5.1.5 Potential impacts to GRGID wellfield from other local well pumpage

Groundwater pumping for irrigation throughout the valley is 5,000 AFA during average years. During drought years, 10,000 AFA is pumped for irrigation and 3,000 AFA in wet years. Local irrigation pumping appears to be at sufficient distances from the GRGID wellfield to ensure a minimum impact. As noted in Section 4.2.6, GRGID Wells 1 and 2 respond to each other's pumping and can have a significant impact if both wells are operating at the same time. The operation of the golf course well also is suspect of influencing Wells 1 and 2, but at a lesser impact.

Figure 13 is a map (Maurer and Berger, 2007) that shows municipal, irrigation, and domestic wells for the Carson Valley. The locations are mapped as circles of varying diameter to portray their volumetric pumping. As shown, much of the municipal pumping in the valley is along the East Fork of the Carson River, including the GRGID wellfield at the most southern portion of the map. To the north and west of GRGID's service area are irrigation wells and domestic wells. As will be discussed in the next section, these wells have the potential to influence the GRGID wells should their pumping increase due to both drought and urban development. Currently, it appears that the pumping discharge does not have a significant effect.

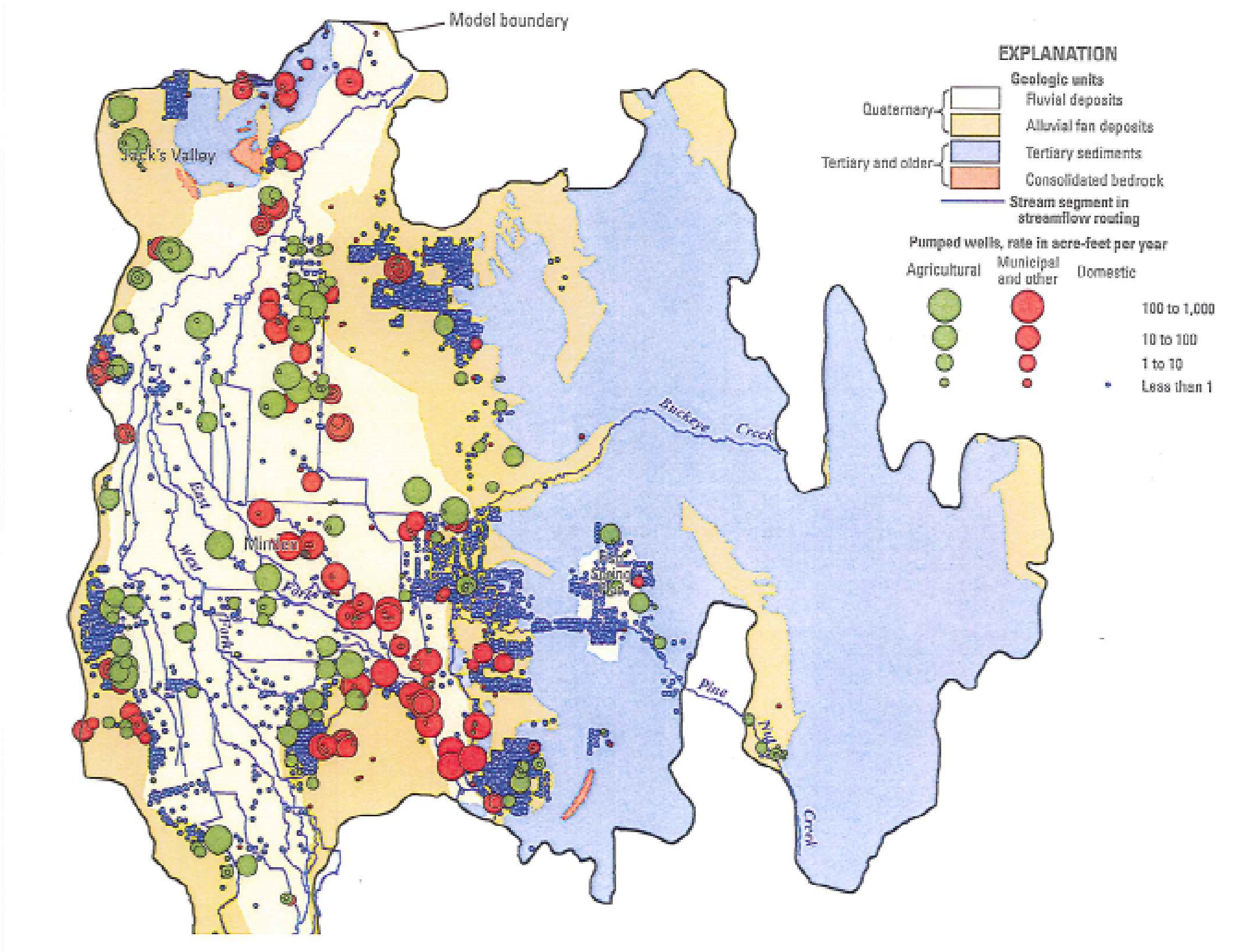


Figure 13. Location map of water wells by type and volume pumpage.

5.1.6 Results from USGS modeling study

Computer simulated groundwater flow models have been developed over the past 30 years and have become quite sophisticated and the USGS has been a leader in their development. These models are simply accounting programs that consider all aspects of geology, groundwater, surface water, precipitation, and evapotranspiration. They are constrained by the measurements, estimates, and assumptions known for the represented modeled areas, and, more importantly, by the conceptual understanding of the groundwater flow system they represent. They are frequently used as a predictive tool.

In 2012, the USGS reported on the potential effects of changes in water use in Carson Valley through the use of a groundwater flow model (Yager and others, 2012). The "Base" case scenario held all pumpage constant (23,000 acre-feet annually) while varying precipitation and river flows. This represents a "status quo" scenario. The precipitation and river flows represented 1995 to 2004 conditions (a wet to gradual dry condition) and were repeated five times to predict groundwater levels through the year 2060. The results for the groundwater model simulation are shown in Figure 14. The Figure indicates that the Gardnerville Ranchos area would experience 5-20 feet of water level decline. Most water level declines within the Carson Valley were predicted to occur on the east side.

Four other scenarios were computed to represent increases in municipal and domestic pumpage, a reduction in Carson River diversion for irrigation (where irrigated lands are converted to subdivisions), and the same precipitation patterns modeled as in the "Base" case scenario. The scenarios **increased** annual pumpage by 16,000 AF in Scenario 1 and **increased** annual pumpage by an average of 26,500 AF in Scenarios 2A, 2B and 3. These scenarios predicted **additional** water level declines of 10 feet to more than 40 feet in the existing GRGID service area. The additional pumpage was mostly due to municipal demand, including GRGID, to simulate "full build-out" of potential population growth. Therefore, total water levels for the GRGID area were predicted to decline from 15 to 60 feet based on the various scenarios.

Table 6
USGS Modeling Scenario Results and GRGID Drawdown

Scenario	Total pumping (x1,000AF/YR)	QM Pumping (AF/YR)	Drawdown (ft)	Description
Base	22.9	8.8	5-20	Status Quo (2005)
1	39.1	22.2	15-60	Projected Population
2A and 2B	50.2	34.1	15-60	Full Buildout
3	48.7	32.9	15-60+	Full Buildout with a decrease in agriculture

As shown in Figure 14, most of the municipal pumping occurs in the southeastern portion of the Valley. A portion of the increase in municipal pumping was due to the growth of GRGID's water demand. An increase of 17,000 AFA in municipal pumping equates to an increase in Carson Valley population of approximately 25,000 people in a 55-year period. An increase of 27,000 AFA of municipal pumping equates to an increase of approximately 40,000 people in same 55-year period. The annual increase would be 500 to 700 people per year and is a reasonable assumption as the Douglas County population increased approximately 20,000 from 1990 to 2000 and remains at close to 47,000 to date.

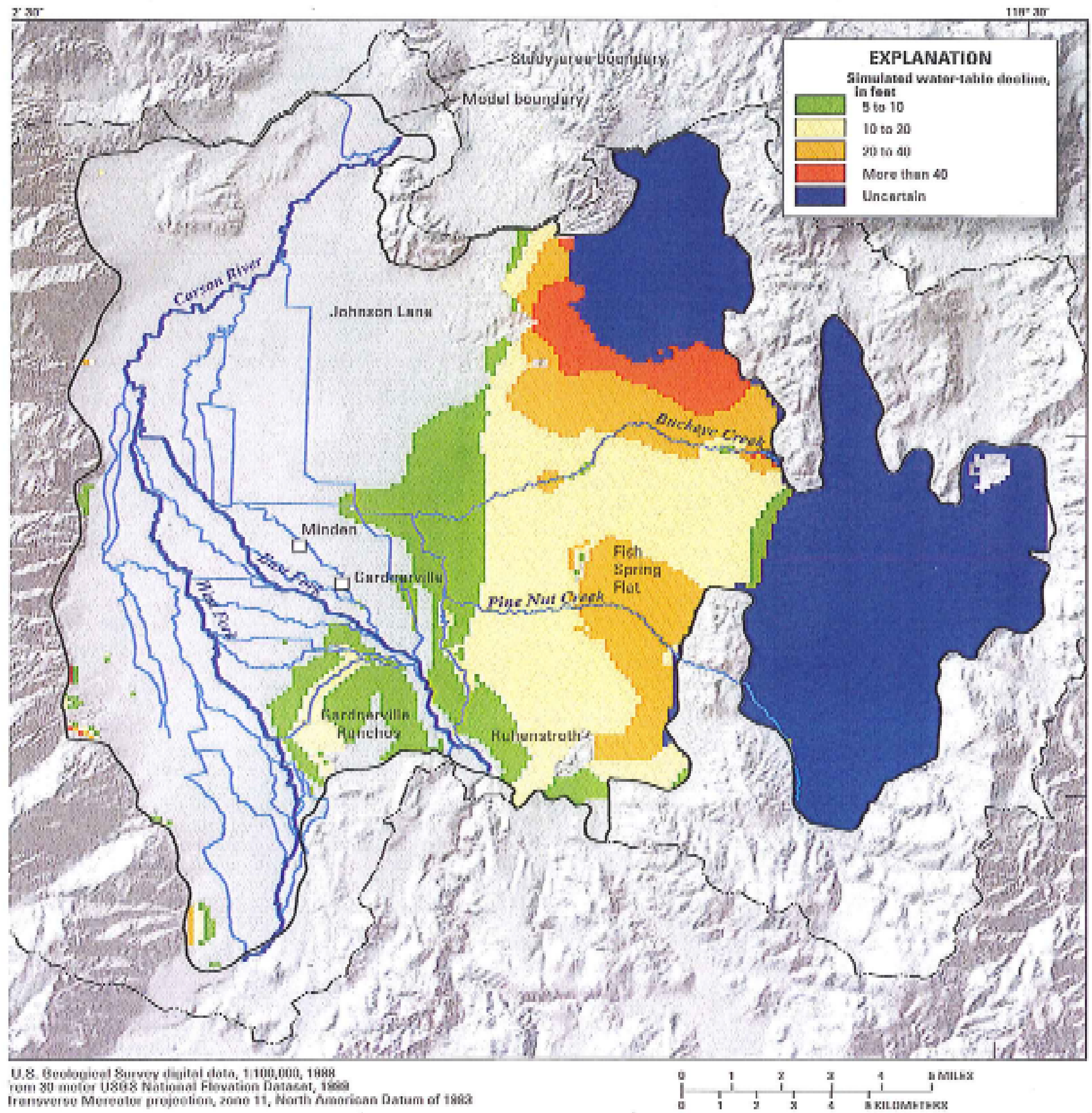


Figure 14. Simulated water level declines at year 2060 keeping pumpage constant at 2005 rates. (Yager, et al, 2012). Colored areas reflect a uniform water level decline.

5.1.7 Evaluation of current and future resource reliability

Within the Carson Valley, there is sufficient groundwater to support GRGID's allowable pumping volumes. This assumes that the historic pattern of wet and dry periods will persist into the future. However, some climate predictions indicate that while the volumetric rate of precipitation will remain the same, a shorter annual period of snow will develop (Jeton, Dettinger, and Smith, 1996). This would be of concern over the next several decades as both mountain block recharge and Carson River recharge would be less.

Modeling to the year 2060 for water level declines, as estimated by the USGS, are not a concern over the long term, but rather are a probability of future groundwater development. This can be considered a simple result of the groundwater system reaching a "new" equilibrium within the Carson Valley hydrographic water cycle. A similar situation is occurring in areas of the Reno/Sparks metropolitan area, as well as other parts of Nevada and the western United States.

Current water level declines are of a greater concern as witnessed in Wells 1, 2, 4, 6, and 9 and discussed in section 4.2.5. It is uncertain if these declines are a direct result of the current drought conditions, well hydraulic effects, or due to irrigation and municipal "over-pumping" within the southeast portion of the valley or a combination of the three. The replacement of Well 4 will help to increase production for the water system in the near future. It is even possible to see an expansion within the next 20 years to accommodate the pumping of all GRGID water rights. With proper wellfield management and monitoring, GRGID should be able to provide a reliable source of water for at least the next 20 years.

5.2 Source Water Contaminants

Arsenic concentration in Wells 5, 8, and 9 are the primary water quality concerns. There does not appear to be an upward trend in concentrations, but rather a consistent concentration (see Appendix C). As discussed in Section 4.3, the arsenic concentration in Well 5 consistently exceeds the maximum contamination level as set by the EPA for Safe Drinking Water Standard. Limited blending of Well 5 with other well water has allowed the water system to meet the Running Annual Average for arsenic when Well 5 capacity is needed in the system. Wells 8 and 9 are at or near the Standard for arsenic with no upward trends appearing to cause problem for use.

The source of arsenic is found primarily in the volcanic aquifers of the Pine Nut Range and volcanic aquifers underlying the eastern portion of the Carson Valley. Additionally, geothermal waters (such as Walley's Hot Springs) contain arsenic. This contaminant is found throughout these aquifers in varying concentrations. Therefore it will continue to be present, but can be managed through blending practices or the Running Annual Average for arsenic.

Nitrate levels found in all wells are below the Safe Drinking Water Standards. Nitrate in this case, is derived from irrigation practices in the form of fertilizers. This may be of a concern for Wells 1, 2, 4 and 8 due to their proximity to the Carson Valley Golf Course. Currently, all of these wells have very little concentrations of nitrate.

6.0 GROWTH PROJECTIONS & WATER DEMAND

6.1 Planning Period

The 20-year planning period for this water resource plan is from 2014 – 2034. Demand projections and development estimates extend to 2034. As of April 2014, the GRGID service area has an estimated 4,143 service connections. Approximately 1,609 of the service connections are metered including 40 commercial, schools, and parks and 1,569 residential metered connections. The remaining 2,534 service connections are currently non-metered. In 2006, the GRGID Board of Trustees adopted a resolution through "attrition" to begin converting the non-metered residential and commercial service connections to metered service connections utilizing the following stipulations:

- On all new construction;
- On all residential properties with title ownership transfers;
- All residential and commercial properties no later than January 03, 2017

This resolution has been helpful in the gradual transition of the non-metered service connections. A fully metered water system is mandated by January 03, 2017.

6.2 Growth Projections

The annual growth projection analysis was partly based on the Nevada State Demographer's Office, 2013 growth rate estimates for Douglas County; the 2010 U.S. Census Bureau American FactFinder for the Gardnerville Ranchos General Improvement District; and GRGID's historical growth rate based on "new home sewer service connection hookups" from 1991 - 2013.

The Nevada County Population Projections 2013 to 2032, dated October 1, 2013, prepared by the Nevada State Demographer's Office was assessed in developing the future population and service connections growth projections for the GRGID service area. Referring to Figure 1, the service area map of GRGID shows the existing vacant and occupied parcels as of April 2014. The map also shows undeveloped lands within the service area with the potential for future residential and commercial growth. The U.S. Census Bureau American FactFinder Census-Designated Place (CDP) was also used to provide past and current statistical population information for the residential homes within GRGID's service area.

The 2013 to 2032 report shows a 2013 population for Douglas County of 47,714 people. The population is expected to increase to 50,531 by 2032 going from a slight regression in growth for 2014 and 2015 to an average growth rate of 0.4% from 2016 to 2032

(Table 7). The U.S. Census Bureau American FactFinder CDP for GRGID was assessed for a 5-year period (2008 – 2012). Based on the Douglas County population and the GRGID population for 2012, GRGID service area contains approximately 23.5% of the Douglas County population. Using the average growth rate for Douglas County, the GRGID projected residential growth from 2014 to 2034 is approximately 265 new residential homes, using an average household size of 2.56.

Table 7
Oct. 2013 Douglas County Nevada State Demographer's Population Projections.

DOUGLAS COUNTY			
YEAR	TOTAL POPULATION	CHANGE PREVIOUS YEAR	PERCENTAGE CHANGE
2012	48,015		
2013	47,714	-303	-0.6%
2014	47,512	-202	-0.4%
2015	47,405	-107	-0.2%
2016	47,408	3	0.0%
2017	47,503	95	0.2%
2018	47,657	154	0.3%
2019	47,834	177	0.4%
2020	48,030	196	0.4%
2021	48,235	205	0.4%
2022	48,457	222	0.5%
2023	48,685	228	0.5%
2024	48,917	232	0.5%
2025	49,151	234	0.5%
2026	49,382	231	0.5%
2027	49,610	229	0.5%
2028	49,831	221	0.4%
2029	50,036	205	0.4%
2030	50.223	187	0.4%
2031	50,390	167	0.3%
2032	50,531	141	0.3%
2033*	50,683	152	0.3%
2034*	50,835	152	0.3%

* Inferred Growth using the State Demographic Population Projection Data.

Lumos also analyzed GRGID's historical growth rate for new home sewer service connections from 1991 to 2013. Lumos used the new home sewer service connection annual counts because they were more readily available and were well documented since 1991. Table 8 is a representation of all the historical new home sewer service connections from 1991 through 2013. In review of the data, there were several years when GRGID encountered both very high and very low counts in the number of sewer connections. Since the new home sewer service connection data contained two very high count years (1992, 1993), Lumos statistically removed these two years along with two of the very low count years prior to graphing and projecting the data. This was conducted to ensure a better "normality" of the data for the 23-year period.

Table 8
GRGID Historical Annual Sewer Hookups

YEAR	NUMBER OF NEW HOMES
1991	15
1992	199
1993	109
1994	58
1995	49
1996	24
1997	35
1998	13
1999	38
2000	33
2001	41
2002	37
2003	11
2004	43
2005	5
2006	41
2007	15
2008	8
2009	1
2010	1
2011	1
2012	0
2013	9

It should be noted that the data used to develop the growth rate for the 20-year projection is from the best available information today. If one of the proposed large residential subdivisions (i.e. San Juan Development w/ a proposal of 600+ homes) is approved, the growth projections will need to be re-assessed based on the anticipated developers timeline for build-out for the approved sub-division.

Figure 15 is a cumulative service connection graph of the data and a modified cumulative service connection graph using a yearly development average. Both graphs were projected out to 2034 using "Trendline" equations generated by Microsoft's Excel Software. Based on this analysis, GRGID should expect a residential growth rate of between 505 to 593 new homes during the growth period of 2014 to 2034. Appendix F contains a table of the reduced data used to generate the two graphs.

The two projected growth analyses for GRGID's service area over the next 20-years have generated a very broad spectrum with regard to future development of new residential homes. These growth projections estimate that the GRGID service area can expect a range of 265 (US Census data) to 593 (sewer hook-up data) new residential homes. The current estimated number of existing vacant lots, on approved parcel maps, within GRGID's service area is approximately 212, which includes both residential and commercial lots. Lumos believes that the majority of the new service connections over the next 5 to 10 years will come from development of these existing vacant lots.

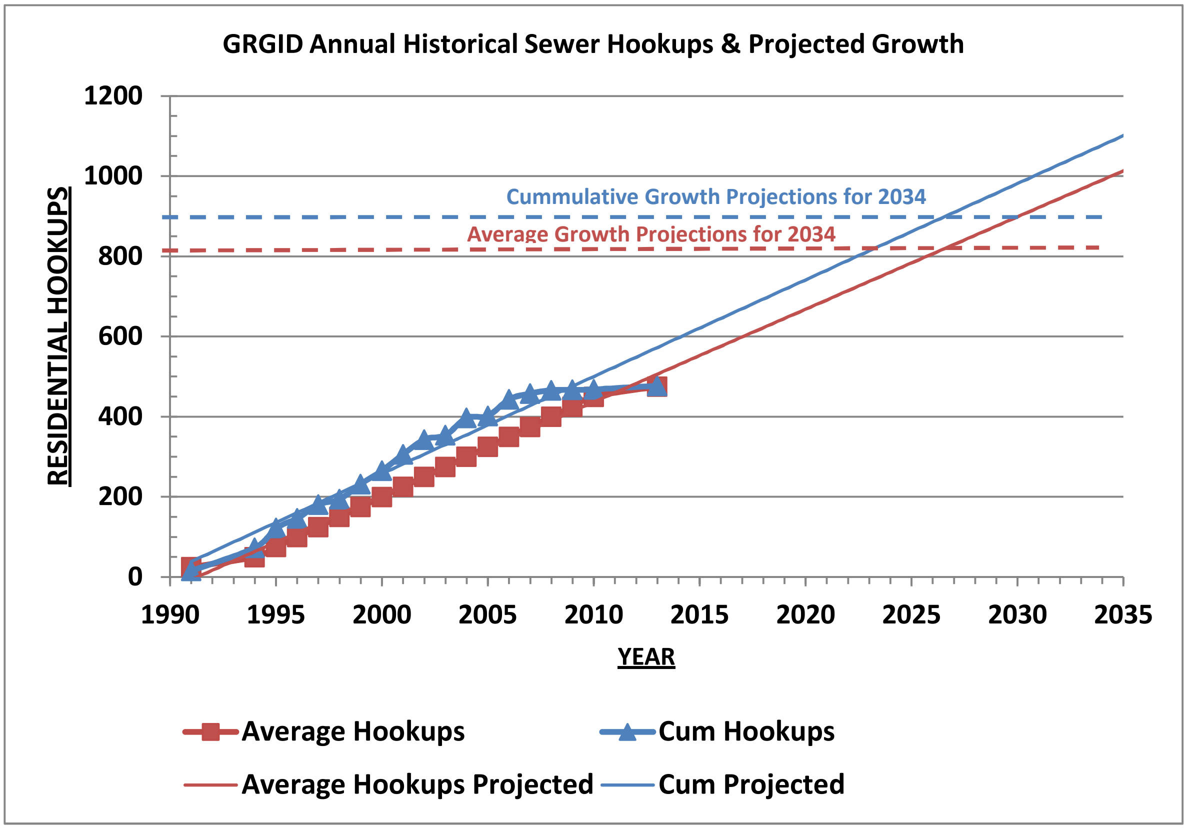


Figure 15: Graphs of the Historical Sewer Hookup Data with Growth Projections to 2034

6.3 Historical Water Use

Lumos analyzed water use for the past five years (2009 – 2013) to determine the average annual use for residential metered connections, residential non-metered connections, and commercial metered connections. Over the past five years, there has been a progressive increase in the number of metered residential connections and a decline in non-metered connections. Even with this progression, the majority of the water use in the District is still through the non-metered connections. Table 9 is a breakdown of the annual water use by each of the service connection type.

The 5 years of water use also reflects the gradual transition of non-metered connections to metered connections. Over this 5 year period, approximately 604 non-metered services changed to metered services. Based on the average annual water usage per Equivalent Residential Unit (ERU), for every converted non-meter service, GRGID conserves approximately 87,500 gallons of water. This is approximately a 31% reduction in water use for every non-metered service that was converted to a metered service. Currently, Lumos believes that the attrition of non-metered services is GRGID's best method of future water conservation for the water system.

Table 9
Annual Water Use 2009 – 2013.

YEAR	METERED CONNECTIONS	NON-METERED CONNECTIONS	METERED COMMERCIAL, SCHOOLS, PARKS	TOTAL ANNUAL USAGE
2009	179,901,120	847,359,475	62,711,000	1,089,971,595
2010	190,043,126	788,445,799	56,088,000	1,034,576,925
2011	213,555,000	731,029,507	51,542,000	996,126,507
2012	286,976,000	797,778,007	74,298,000	1,159,052,007
2013	316,418,000	736,953,758	73,421,000	1,126,792,758
Average Use Per ERU	188,014	275,468	288,618	

NOTE: ERU is an Equivalent Residential Unit (i.e. Service Connection) for the GRGID.

6.4 Projected Water Demand

Utilizing the historical water demand and growth projections for the GRGID service area, Lumos generated future water demand projections for total annual water use and maximum day flow capacity from 2014 to 2034. Because the two future growth projections contained a wide range, Lumos decided to use an average of the two growth projections, as well as the most aggressive growth rate to ensure that GRGID service area is prepared for the worst case demand scenario. Well production was based on running all of the wells for a maximum of 14 hours per day. Lumos chose this operational rate due to the need for recovery time of the wells. Because a four year analysis of well capacity identified an average yearly decline of 3%, the anticipated projected well production was decreased by 3% throughout the 20 year period. Figure 16 is a graph of the two projected annual water production demands for the next 20 years as well as the anticipated well production assuming no additional wells are put online during this period. Well 5 was not included in the projected well production due to its non-compliance issue with the Safe Drinking Water Primary Standard for arsenic (>10 ppm).

The two projected annual water production demand graphs do not show a large divergence in total water demand throughout the 20-year planning period. Future water demand is primarily based on the average annual growth rate analysis of 20 and 30 new ERUs. Future commercial water demand growth assumes an additional 7 and 11 new ERUs during the 20 year planning period. Because the Board of Trustees adopted the attrition resolution for a 100% metered water system by 2017, the model needed to convert the remaining non-metered connections to meter by January 3, 2017. By accomplishing this metered system, GRGID should anticipate a reduction in water demand up to 2017.

The projected water demand model indicates that GRGID's existing water system will not exceed the annual water demand use until sometime between 2031 and 2032. This assumes Well 5 is not used as a water source because it does not meet water quality standards for arsenic. If Well 5 is added, GRGID should be able to meet the projected water demand use through the planning period of 2034.

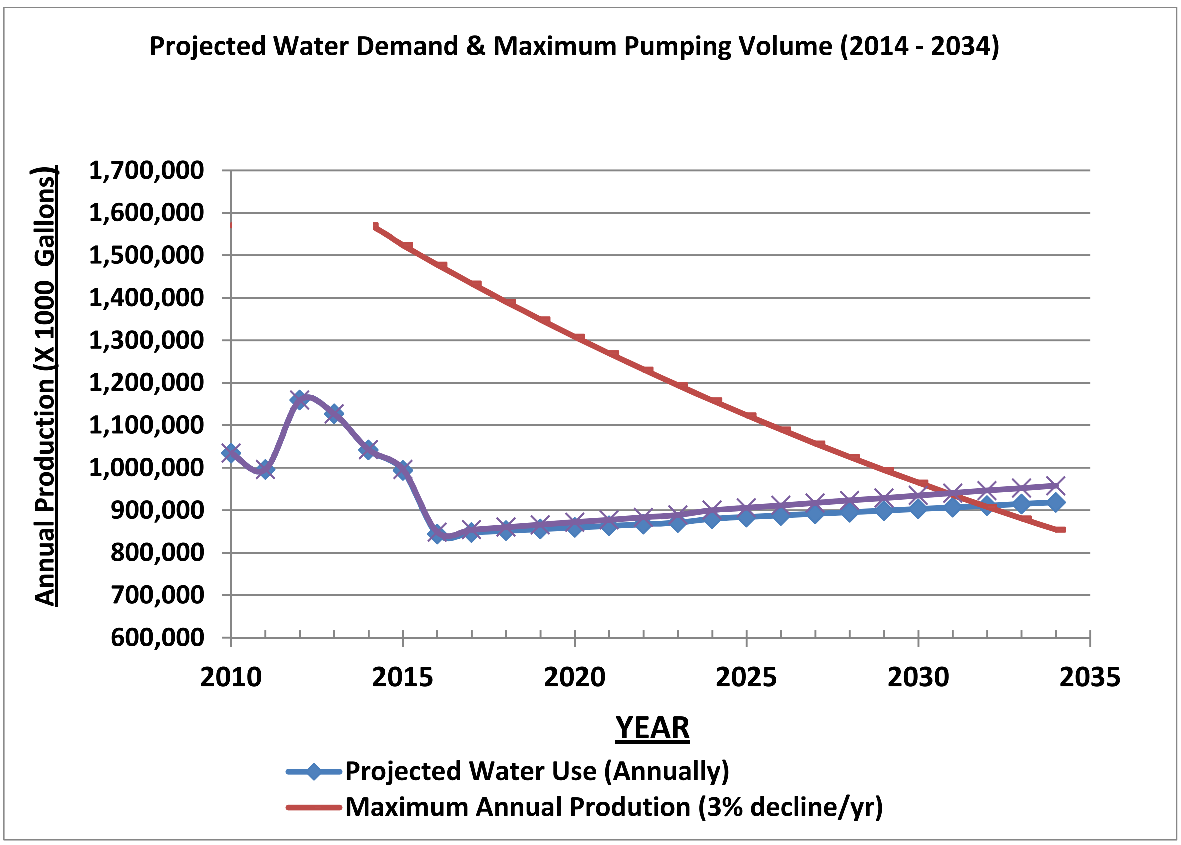


Figure 16. Projected water demand versus maximum pumping volumes.

A second projected water demand growth estimate analyzes the "maximum daily flow capacity" (in gallons per minute) based on the largest demand month per year for water use. Water usage data for non-metered connections does not exist. Therefore, the only method for determining the maximum flow capacity is by reviewing historical data with the highest monthly water use and dividing that month by the number of days in that month. Lumos analyzed three years of data (2011, 2012, and 2013) and determined that for each year, July had the highest monthly water demand. These historical flow demand rates were used to project future flow capacity demand based on a "Trendline" equation generated by Microsoft's Excel Software. The future maximum flow rate demand was then compared to the existing wellfield's flow capacity utilizing two scenarios. The first scenario included Well 5 as part of the total flow capacity, and the second scenario did not include Well 5. Similar to annual water demand, all the wells included an annual decline in flow rate of 3%. Figure 17 is a graph of the historical maximum flow capacity data, projected future maximum flow capacity, and existing wellfield's annual flow capacity. The maximum flow capacity demand model suggests that by 2018, GRGID may not have sufficient pumping capacity during the month of maximum flow demand. If Well 5 is included in the total wellfield flow capacity, GRGID should not exceed the month of maximum flow rate capacity until 2022. If GRGID's water system can comply with the Running Annual Average (RAA) for the arsenic while utilizing Well #5, then the year 2022 may be a more realistic scenario for when a new well source will need to be added to the water system.

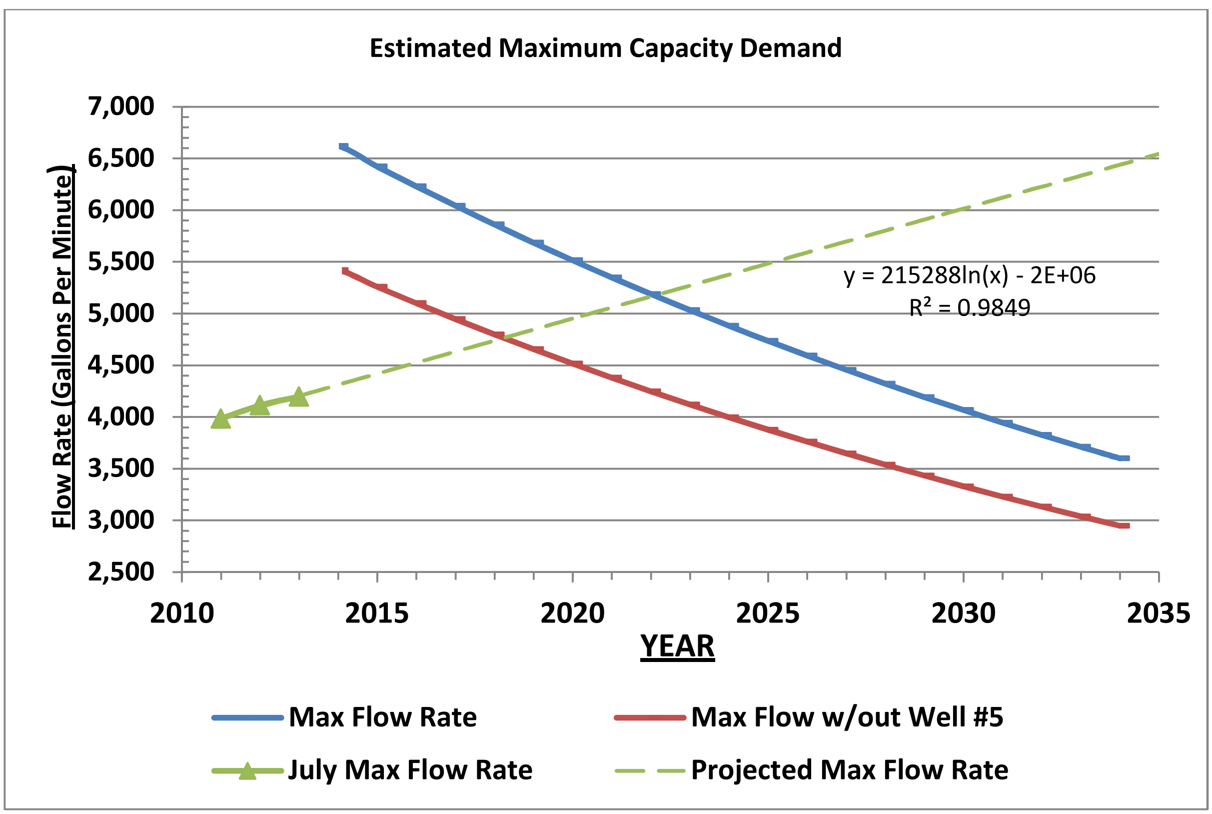


Figure 17. Estimated Maximum Daily Demands versus Capacity

6.5 Non-Revenue Water

Non-Revenue Water (NRW) is defined as the water that has been produced and is "lost" before it reaches the customer. Losses can be real (through leaks, sometimes referred to as physical losses) or apparent losses (through theft or metering inaccuracies). Most water utilities want to know what this percentage of loss is. It can be an issue for water conservation and detrimental to the finances in the water utilities and to the quality of water itself. NRW is typically measured as the volume of water "lost" as a share of net water produced. If this percentage exceeds 10% of total produced, it is normally beneficial to determine where and how these losses occur.

Since GRGID is currently only a partially metered water utility, determining NRW for the system is not possible as part of this water resource plan. Once GRGID has become a fully metered water utility and has at least three years of customer metered data, a NRW analysis can be conducted to determine if the water system has any significant losses.

7.0 WATER RESOURCE PLANNING ISSUES

7.1 Water Rights

GRGID's current water rights are in good standing with the State of Nevada. There are sufficient water rights to meet the future build-out of existing parcels. Subdivision of some of these existing parcels will require the dedication of additional water rights. It is beyond the scope of this Plan to examine the water right availability outside of the GRGID. However, a plan could be developed to reduce the dedication requirement based upon the current dedication policy (as driven by the State Engineer) and actual usage as measured by service meters.

7.2 Growth Projections and Projected Water Use

Growth projections provided for Douglas County were used to estimate potential growth within the GRGID. Using various methods, Lumos estimates that within the next twenty years, 265 to 593 new residential homes will require service. Lumos estimates that much of this growth will come from the development of 212 existing vacant lots within the Service Area Boundary over the next 5-10 years.

Metered service data has been analyzed and indicates that the average metered connection uses 188,000 gallons per year (0.6 AF/year). It is shown that as un-metered services become metered, water use decrease by as much as 31%. Therefore, when all services are metered (2017), existing usage will decrease or remain flat as new services are connected. Existing wellfield capacity is sufficient to meet these demands over this planning period. However, meeting Maximum Day Demand may be difficult within the next few years. This is because of production capacity declines that have occurred over the last three years should that rate of decline continue

7.3 Wellfield Improvements

Currently, the GRGID can easily meet water demands with its wellfield operations. However, it has been identified that in the near future, max day demands may be difficult to meet. These max day demand periods occur in the summer months and July may be the greatest demand period. It is estimated that the wellfield capacity may be insufficient to meet these demands as soon as the year 2017. Consequently, improvements must be made not only for these max day demand months, but also because urban growth will create more demand.

The GRGID is currently pursuing the acquisition of land adjacent to Well 4 for the re-drilling of this well. This well's production has been "valved-back" on its capacity because of sand issues. Additionally, its flow has been reduced because the pumping levels are below the screen and cause air entrainment (cloudy water). Air entrainment can cause cavitation at the pump impellers and thereby slowly ruining the pump. Re-drilling and other improvements made to Well 4 should enable a higher pumping rate. Well 1 could also be replaced because of its age and because it has a "sanding" issue.

In terms of future growth and wellfield expansion, one potential well site has been identified in the upper pressure zone. This is located at the far south end of the GRGID. It may be prudent to budget in the future for a test hole to determine if this site or another would serve as a future production well.

As shown in Section 4.2.5 (Well water level and pumping rate history) and 4.2.6 (Well interference issues), several of GRGID's wells have pumping water level declines and consequent pumping rate declines. It is not known if this is the result of three back-to-back years of below normal precipitation and consequent meager snowpacks or the result of over pumping the aquifers within the entire southeast portion of Carson Valley. The greatest concentration of municipal wells are within this area and include the facilities of Minden and Douglas County Public Works. Additionally, the largest grouping of irrigation wells are also located within this section of Carson Valley. Therefore, it would be prudent to further investigate the cause of these declines in water levels and production rates. It may be that individual wells will need to reduce their pumping rates or the operations may need to be changed in order to prohibit this current decline from causing excess drawdown and potential damage to these wells, pumps, and motors. It may prove that expansion of the wellfield will be necessary in the near future.

7.4 Water Quality and Potential Groundwater Pollution

In the future, Well 5 will be needed for production during peak periods of demand and with increased development within the GRGID. This well can produce 1,200 gpm and therefore would greatly assist the wellfield during periods of peak demands. This well frequently produces water that exceeds the MCL for arsenic. The well can be tested for specific aquifer zones that might be responsible for the exceedance and consequently that zone could be sealed off. This could reduce the arsenic concentration to more acceptable limits.

From the discussion in Section 4.3, arsenic appears to be the main water quality concern. Arsenic is nearing or is at the limit for Wells 8 and 9. Therefore, it would be prudent to develop an Arsenic Management Plan. This could be used to operate the wells in such a manner as to be able to commingle waters from individual wells such that delivery to individual services remain below the MCL. Alternatively, using the Running Annual Average process would result in similar compliance.

The current Wellhead Protection Plan should be reviewed and updated. These plans are normally updated on a five year basis. The review should re-evaluate any potential for pollution from the industrialized areas of the GRGID. One area of concern is the gravel pit operation located near Well 5. The operation has lowered the land surface to within five feet of the groundwater table. Therefore, any accidental chemical spill would easily contaminate the water resources of the GRGID. This potential has not been identified and therefore should be a priority for the Wellhead Protection Plan review and update.

7.5 Development of a Well Efficiency Program

Through the development of this Plan, Lumos has recognized that specific wellfield data is lacking. For example, static water levels and pumping water levels are not collected at each well on a regular basis. Further, the status of pumps and motors are not regularly monitored in terms of Wire-to-Water efficiency. This is an important aspect of wellfield management as wells that become inefficient, through normal wear and tear, become more expensive to operate at least in terms of energy costs. In fact, keeping wells running as efficient as possible results in cost savings that more than pay for the added maintenance costs in monitoring.

A simple and effective method to increase efficiency is to conduct annual "Wire-to-Water" efficiency tests. This entails running a 30-minute pumping test on the well while monitoring pumping levels, discharge rates and pressures, and power consumption. Tracking these annual tests on individual wells results in documenting the wells' efficiency and performance. This leads to the ability to accurately determine the condition of not only the well, but also the pump, motor, and a prediction of future replacement needs that can be budget for.

7.6 Future Impacts to Water Resources

As discussed in Section 5, the USGS made predictions of water level declines within Carson Valley based upon urban growth, a decrease in agricultural production (due to lands being converted to housing developments), and annual precipitation that includes both wet and dry (drought) years. The results indicate that water level declines of between 10 to 60 feet could occur over the next 55 years. It is important to recognize that this prediction pattern over the next twenty years may detrimentally impact the GRGID's wellfield such that individual well production may be reduced. In addition, urbanization within the current and future GRGID service area will be part of the growth that inadvertently creates the water level declines. Therefore, it is prudent to anticipate these impacts and develop a program to expand the wellfield within an appropriate planning horizon.

As an alternative to an expansion of GRGID well production to meet future water needs, the analysis of regional interconnections with other water systems should be evaluated. Based on the USGS report, other areas of the Carson Valley are not predicted to see the groundwater declines expected within the GRGID service area, and a shift in a portion of the production for the GRGIDs water needs may aide in the stabilization of groundwater levels within the District boundary. Additionally, coordination between water purveyors can allow for water to be managed on a broader regional basis. Thinking and planning for the long term of the entire region provides an opportunity for funds to be expended in more efficient ways than for independent systems to separately develop new facilities. For example, Douglas County, Indian Hills, Minden and Carson City found that their water quality and quantity needs could be met at less cost and more effectively by joining together in regional interconnections between their systems.

While there are benefits to such regionalization, each system must individually determine how they view their place as it relates to water resources within the Carson River Watershed and the Carson Valley itself. The GRGID must also determine if joining a regional effort provides a long term benefit to their customers or if a perceived (or actual) loss of control outweighs the benefits.

7.7 Development of a Capital Improvement Program

This Plan recommends the development and initiation of a Facility Plan that serves as a basis for a Capital Improvement Plan. In the year 2017, the water system's services will be fully metered. This will give the GRGID's District Manager and the Board of Trustees the ability to fully assess the cost of delivering water and the ability to adjust water rates to not only fund annual expenses, but also to budget future improvements. The "Water" Capital Improvement Program should consider:

- Wellfield improvements;
- Repair and replacement of infrastructure;
- Exploration for new well sites;
- Isolation of system losses and consequent repairs;
- Development and Initiation of an Arsenic Management Program; and
- Development of an Asset Management Protocol and Registry.

8.0 RECOMMENDATIONS

Lumos is making the following recommendations for the GRGID. The recommendations accepted by the Board should be prioritized.

- Proceed with replacing Well 4, but consider the plausibility of relocating it to minimize or prevent well interference with Well 1 and Well 2. As documented in Section 4.2.6, the pumping of either Well 1 or Well 2 results in creating additional drawdown in the other well. Equipping Well 4 with a transducer will determine if Well 4 is also affecting Well 1 and or 2.
- Consider replacing Well 1 in the next 5-10 years as its production is limited due to sanding issues.
- Conduct annual performance testing of wells including wire-to-water efficiency, specific capacity, pump and motor performance. This type of low budget testing will identify potential wellfield improvements that can be budgeted for and can alert the GRGID of potential production problems.
- Consider water quality zone testing in Well 5 to determine if a specific aquifer zone is creating the arsenic problem or if the arsenic is found throughout the screened aquifer section.
- Investigate more thoroughly the current production declines in identified wells (see Section 4.2.5).
- Update the Wellhead Protection Plan and its application towards industrial areas of any potential groundwater pollution.
- Investigate future water level declines identified in the USGS report (Section 5.1.6) with respect to pumping water levels in each well.
- Develop a Water Master Facility Plan that can be updated and used as a Capital Improvement Program.
- Develop an Arsenic Management Plan.
- Initiate a water level monitoring program.
- Continue to update the well data sheets after all well work activities to maintain accurate records of each well.

9.0 REFERENCES

Jeton, Anne E., Maurer, Douglas K., 2007, Precipitation and runoff simulations of the Carson Range and Pine Nut Mountains, and updated estimates of groundwater inflow and the groundwater budget for basin-fill aquifers of Carson Valley, Douglas County, Nevada and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2007-5205, 56 p.

Jeton, A.E., Dettinger, M.D., and Smith, J.L., 1996, Potential effects of climate change on streamflow, eastern and western slopes of the Sierra Nevada, California and Nevada: U.S. Geological Survey Water Resource Investigations Report, 95-4260, 49 p.

Maurer, D.K., Paul, A.P., Berger, D.L., and Mayers, C.J., 2009, Analysis of streamflow trends, ground-water and surface-water interactions, and water quality in the upper Carson River basin, Nevada and California: U.S. Geological Survey Scientific Investigation Report 2008–5238, 192 p.

Yager, R. M., Maurer, D. K., and Mayers, C.J., 2012, Assessing Potential Effects of Changes in water use with a numerical groundwater flow model of Carson Valley, Douglas County, Nevada and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2012-5262, 84 p.

APPENDICIES

A. Listing of GRGID Water Rights and Status
B. GRGID Well Construction, Pump and Motor Data Sheets
C. Rates of Production and Water Level Declines
D. Recent Water Quality Analysis of Key Constituents
E. USGS reports and investigations for the Carson Valley
F. Residential growth rate data sets

APPENDIX A

Listing of GRGID Water Rights and Status

Water Right Inventory

well	application#	Duty AFA	supplemental group	Status
1	48749	256.28	5	CER
1	48750	523.11	5	CER
1	61731	1,447.93		PER
1	73653	131.64		PER
2	48752	1,371.02	5	PER
2	69653	604.88		PER
3	48754	483.90	5	PER
4	48757	1,121.98	5	PER
5	48761	89.61	5	CER
5	55358	466.97		PER
5	55359	243.39		CER
5	55360	361.82		CER
5	60098	44.12	4	PER
5	60099	44.12	4	PER
5	60100	44.12	4	PER
5	61732	4.48		CER
5	62387	29.65		CER
CVG	61735	4.55		PER
5	65142	26.88	2	PER
5	65143	26.88	2	PER
5	64514	1.12		PER
5	65032	2.46		PER
5	65141	1.00		PER
6	55381	156.82	1	PER
6	55420	123.22	1	CER
6	61733	3.20	3	CER
6	61734	3.20	1,3	CER
6	62005	69.00	1	PER
6	62006	69.00	1	PER
6	74253	6.72	1	PER
6	76591	4.48		PER
6	74762	664.00	1	PER
6	74977	3.00	1	PER
6	76824	1.12	1	PER
7	60887	361.97		PER
8	62004	1,766.75		PER
8	64884	4.04		PER

well	application#	Duty AFA	supplemental group	Status
9	73888	19.98		PER
9	74938	0.18		PER
9	80801	350.00		PER
9	82210	300.00		PER

Group 1 Total Supplemental Duty is 1,325.48 AFA

Group 2 Total Supplemental Duty is 26.88 AFA

Group 3 Total Supplemental Duty is 3.20 AFA

Group 4 Total Supplemental Duty is 44.12 AFA

Group 5 Total Supplemental Duty is 3,811.86 AFA

Maximum pumpage is 5,054 AFA

APPENDIX B

GRGID Well Construction, Pump and Motor Inventory Data Sheets

Well Construction, Pump and Motor Data   updated May 2014

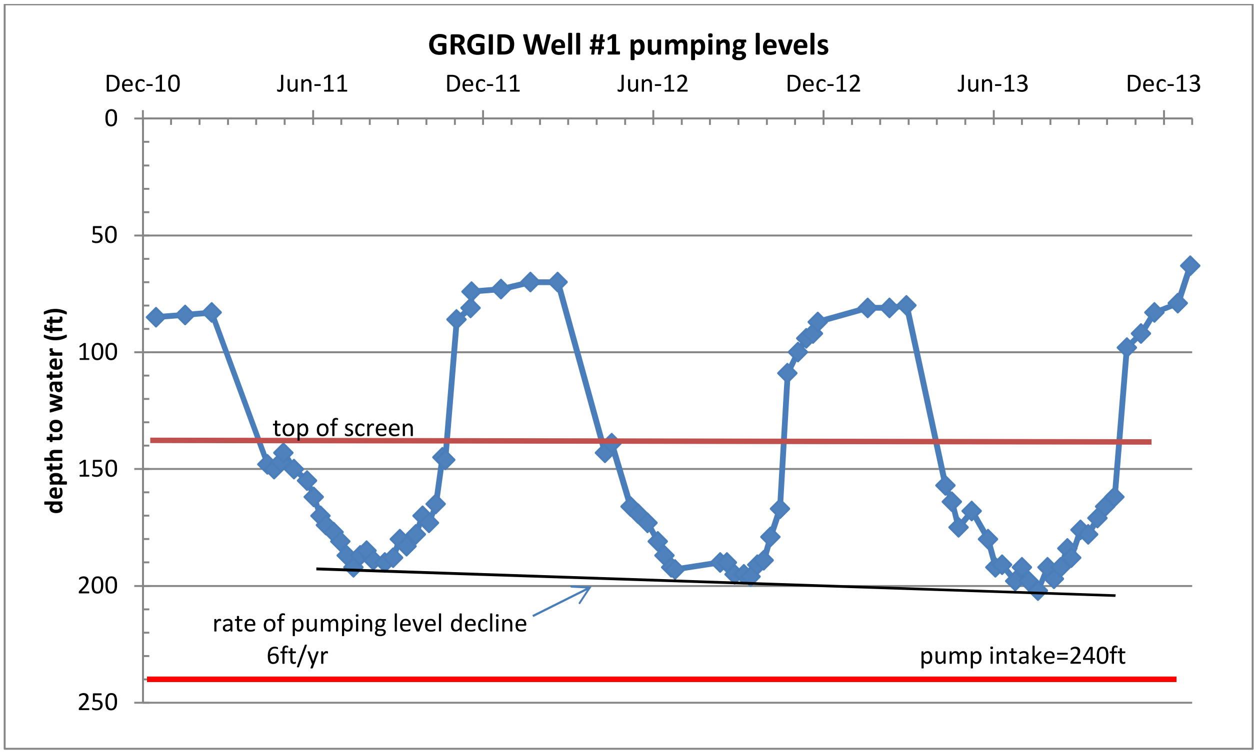
Well	1	2	4	5
Year Drilled	1965/2007	2004	1978	1984
State Log #	9832/103124	93217	18097/19471	25320
electric log	no	yes	no	
As Built	no	no	no	no
rated capacity gpm)	2250/1350	2000+	350	1200
seal depth (ft)	52	115	**none**	138
pumping level_original (ft)	70	180' @ 1800gpm		152'@1200gpm
pumping level_current (ft)	196	110	95	
original static (ft)	5	35	7	55.5
Org. specific capacity (gpm/ft)	34 @2250gpm	12 @1800gpm		12 @ 1200gpm
current specific capacity (gpm/ft)	9.5 @ 1100gpm			
casing dia. (in)	18"w/14"sleeve	16	16	16
total depth (ft)	420	670	375	450
screen from (ft)	140	270	183	200
screen to (ft)	420	650	372	450
slot size (in)	0.1	0.1	1/4 x 3"	0.2
screen type	wirewrap	wire wrap	mill slot	wire wrap
gravel pack	3/8" minus		none	1/4"x3/8"
graveled section (ft)	20'-420'	115' to 670'	none	138'-450'
T/R/Section	nene15T12R20	swse10T12R20	sene15N12E20	nene20T12R20
easting	-119.71730143	-119.72277666	-119.71700261	-119.75464457
northing	38.90947714	38.91159207	38.90334746	38.89591288
elevation, well head (ft)	~4832	~4830	~4846	~4805
recent rehab	2007-rebuilt		2008	
pump column	10" x 235'	10" x 262'	6" x 210'	8" x 200'
pump intake setting (ft)	240'	268	214	204
pump capacity (gpm)	1500	1600	600	1200
pump curve				
pump manf	National	Goulds	Goulds	Floway
pump model #	K12HC	14RJMC	8RJHC	12LKH
pump stages	7	5 x 13.6"OD	5 x 7.5"OD	6
pump set date	2007	2004	1997	1992?
motor manf.	USMotors	USMotors	Franklin	
motor HP	200	250	100	150
motor rpm	1775	1780	3600	1770
motor type	line shaft	line shaft	submersible	line shaft
motor electrical	460v 230amp	460v 292amps	460v	
motor model	AA70A	hollowshaft		
motor serial number	H020052SLG	110250v2SLH-C		
motor set date	2001	2004	1997	
discharge pressure (psi)	104	110	95	
TDH (ft)	380	450	400	360
last camera log	2007			

Well Construction, Pump and Motor Data   updated May 2014

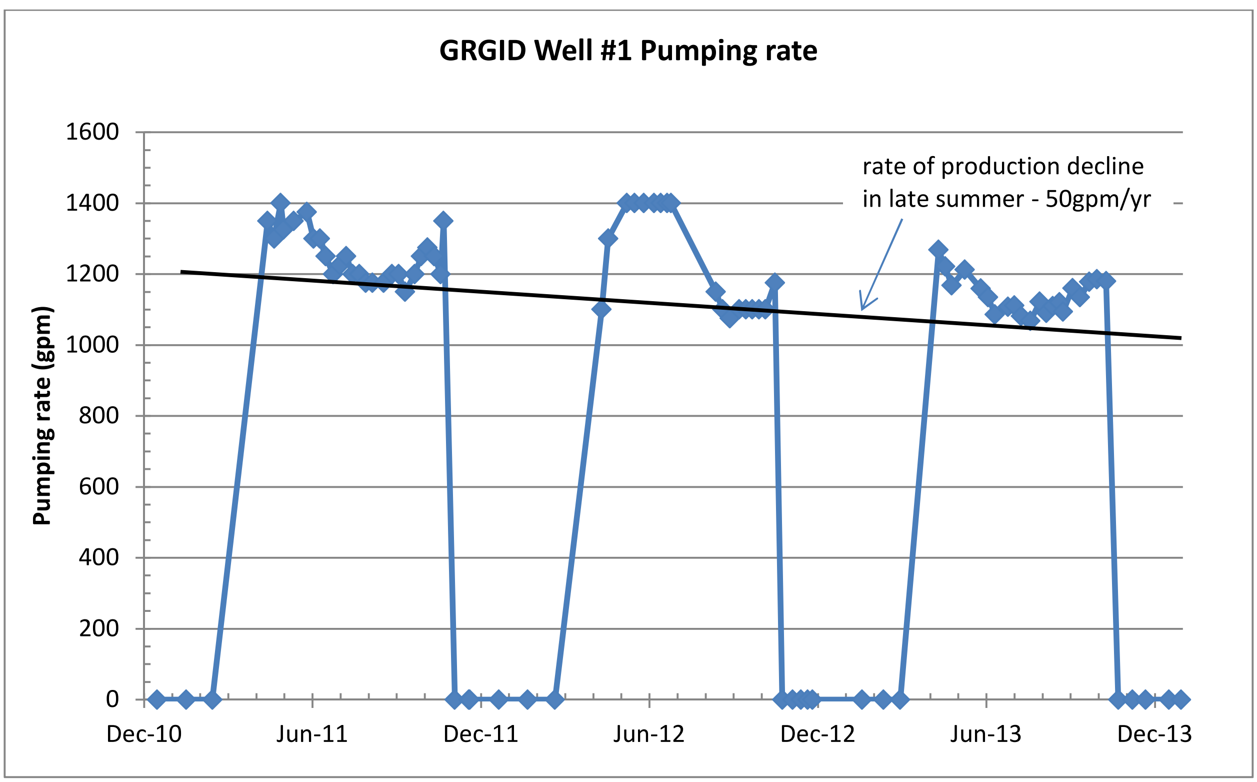
Well	6	7	8	9
Year Drilled	1989	1994	1997	2005
State Log #	32531	44114	67795	98220
electric log	no		yes	yes
As Built	no	no	no	no
rated capacity (gpm)				1000
seal depth (ft)	50	53	100	100
pumping level_original (ft)		414'@235gpm	170'@1000gpm	149' @ 1000gpm
Pumping level_current (ft)	175		175' @ 1000gpm	145' @ 845gpm
original static (ft)	45	40	46	28
Org. specific capacity (gpm/ft)		0.6 @ 235gpm	9.2 @ 1194gpm	8 @ 1000gpm
current specific capacity (gpm/ft)	7 @ 706gpm		7 @ 1050 gpm	8 @ 814gpm
casing dia. (in)	18	6	16	12
total depth (ft)	434	480	500	390
screen from (ft)	210	300/460	260	240
screen to (ft)	430	320/480	500	390
slot size (in)	0.1	1/8 x 3"	0.08	0.05
screen type	wire wrap	slot	wire wrap	wire wrap
gravel pack	1/8x1/4	yes	#4 x #8	yes
graveled section (ft)	50'-434'	53'-480'	0-500'	0-390
T/R/Section	sesw9T12R20	sese21T12R20	nenw10T12R20	swse8T12R20
easting	-119.74391699	-119.73730140	-119.73297441	-119.75887240
northing	38.91384831	38.89230296	38.91812375	38.91242917
elevation, well head (ft)	~4800	~4871	~4800	~4809
recent rehab	2006		2005	
pump column	6"x212'	3"x275'	8" x 235'	8" x 180'
pump intake setting (ft)	~216	279	245'	202
pump capacity (gpm)	700	135	1350	800
pump curve	yes		yes	yes
pump manf	Gould	Fairbanks	Floway	Weir 10"
pump model #	9RCLC	6L	12JKH	10DKH
pump stages	3 x 9"	8	7	13
pump set date	2006	1995	1999	2006
motor manf.	Franklin	Franklin	US motor	USMotor
motor HP	100	20	200	125
motor rpm	3550		1785	1780
motor type	submersible	submersible	line shaft	line shaft
motor electrical	400v 126amp		460v 228amp	460v 142amp
motor model				
motor serial number	E94		R488A-BO5-5832m	60361-1-1
motor set date	2006	1995	1999	2006
discharge pressure (psi)	95		125	116
TDH (ft)	400	410	385	414
last camera log	2006			2006

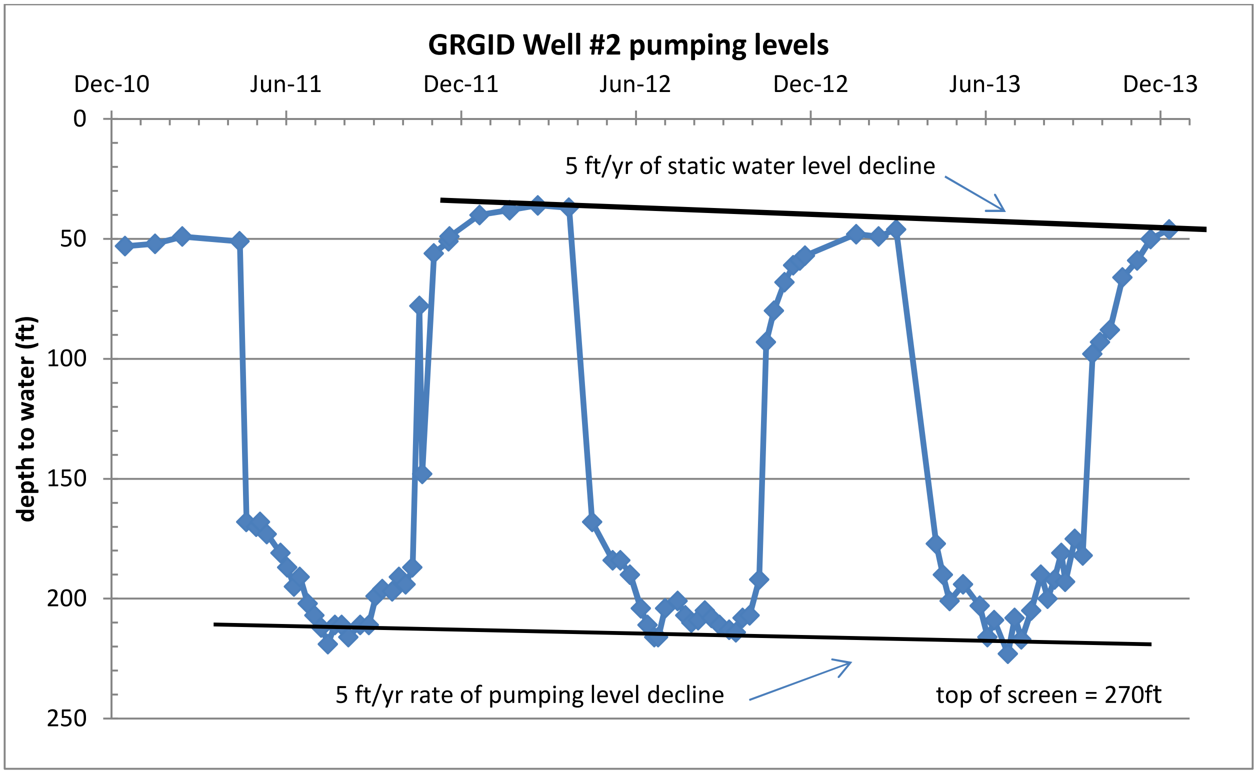
APPENDIX C

Rates of Production and Water Level Decline

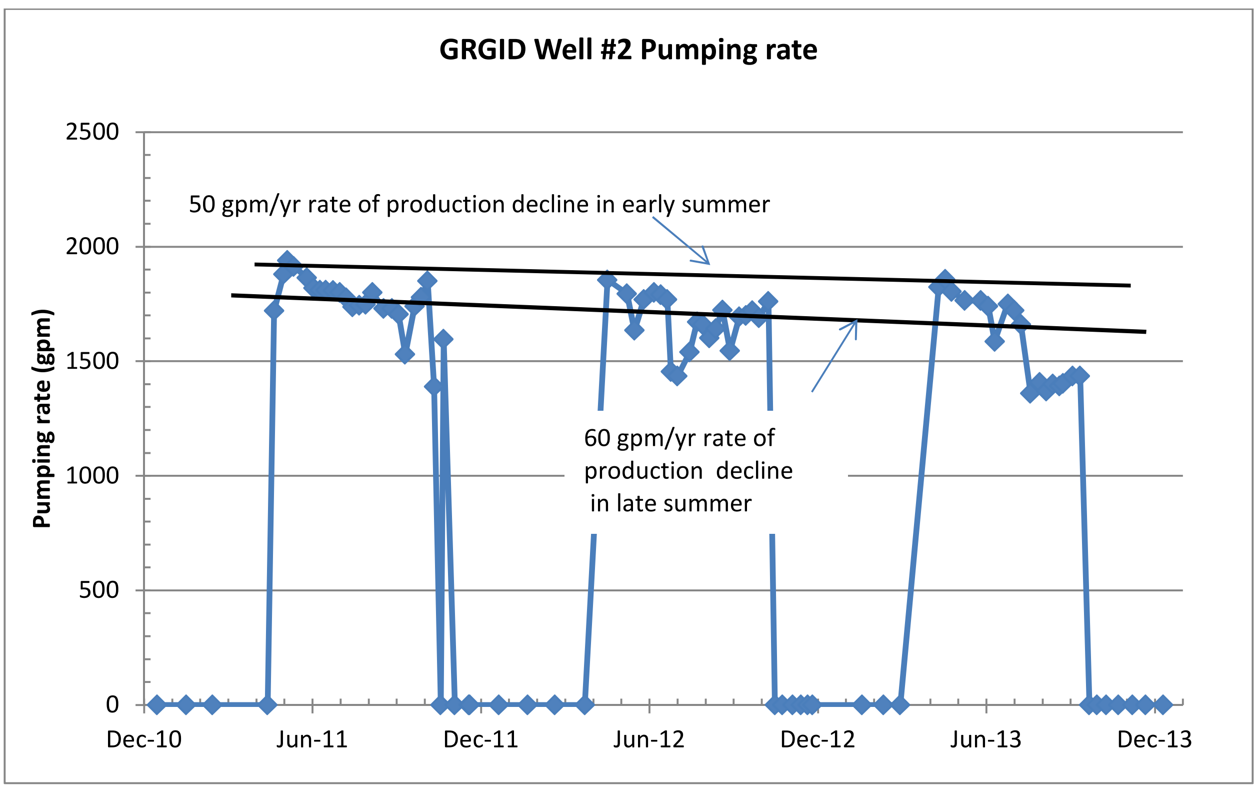


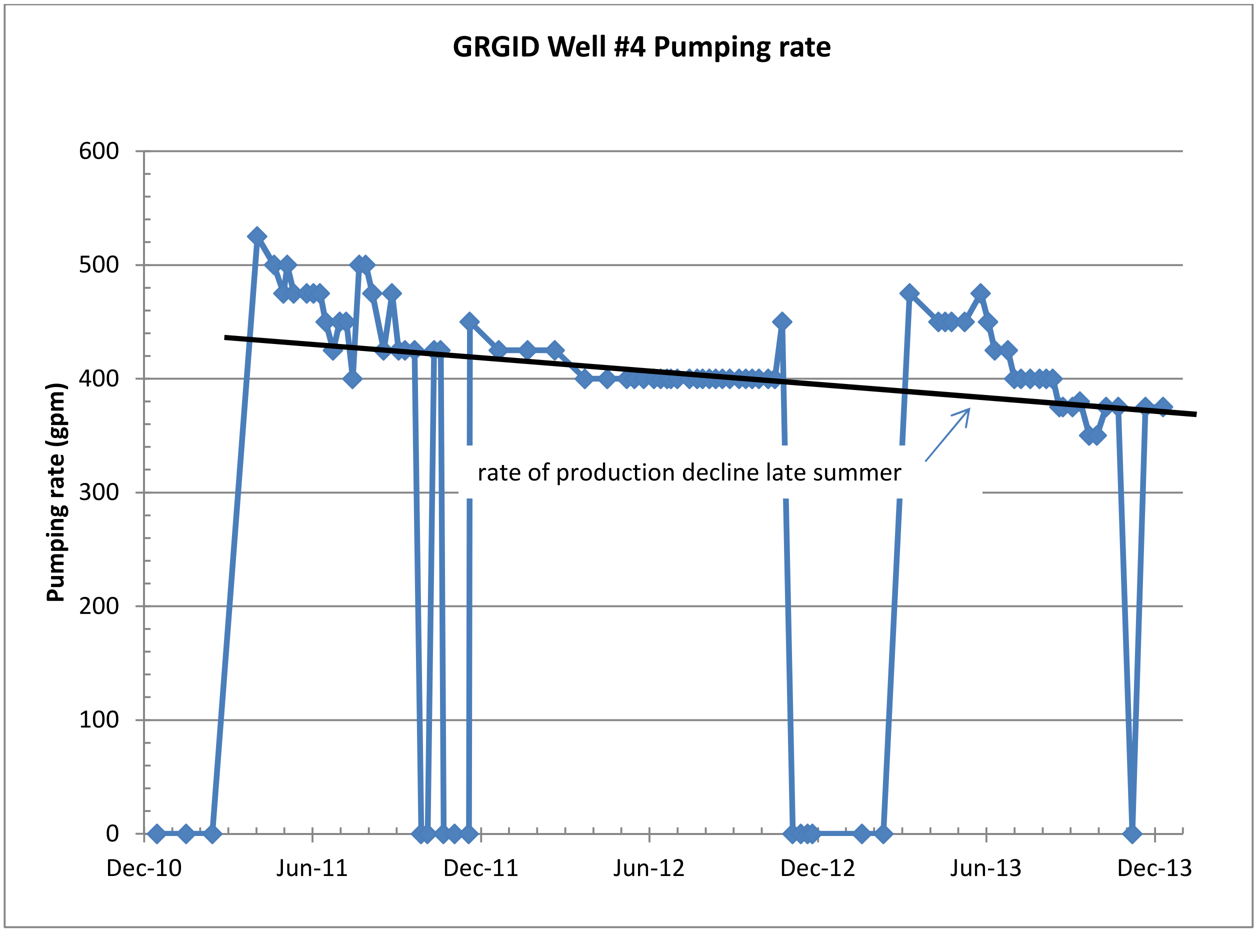
This graph shows a consistent pumping level below the screen and approaching the pump intake. Production declines are probably due to the lower pumping levels.



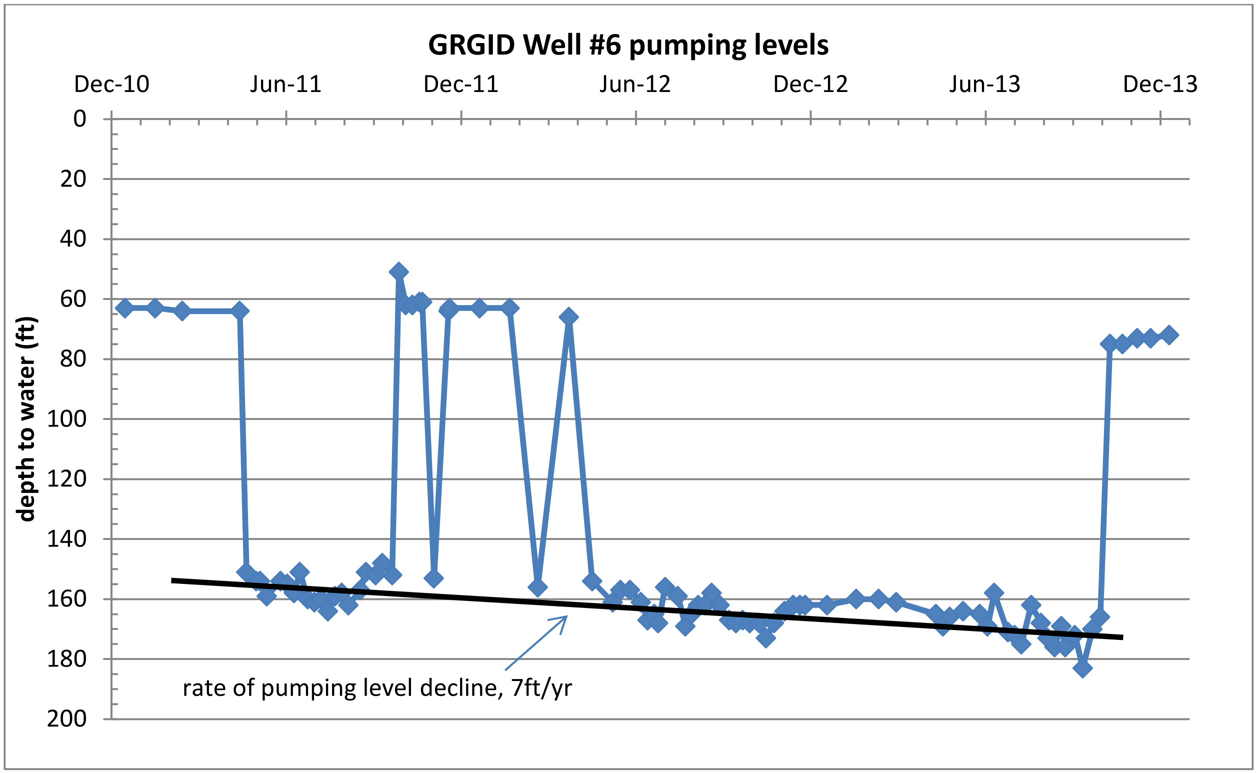


For Well #2, the pump intake is at 268 feet. The lowest pumping level in 2013 was approximately 45 feet above the pump intake.

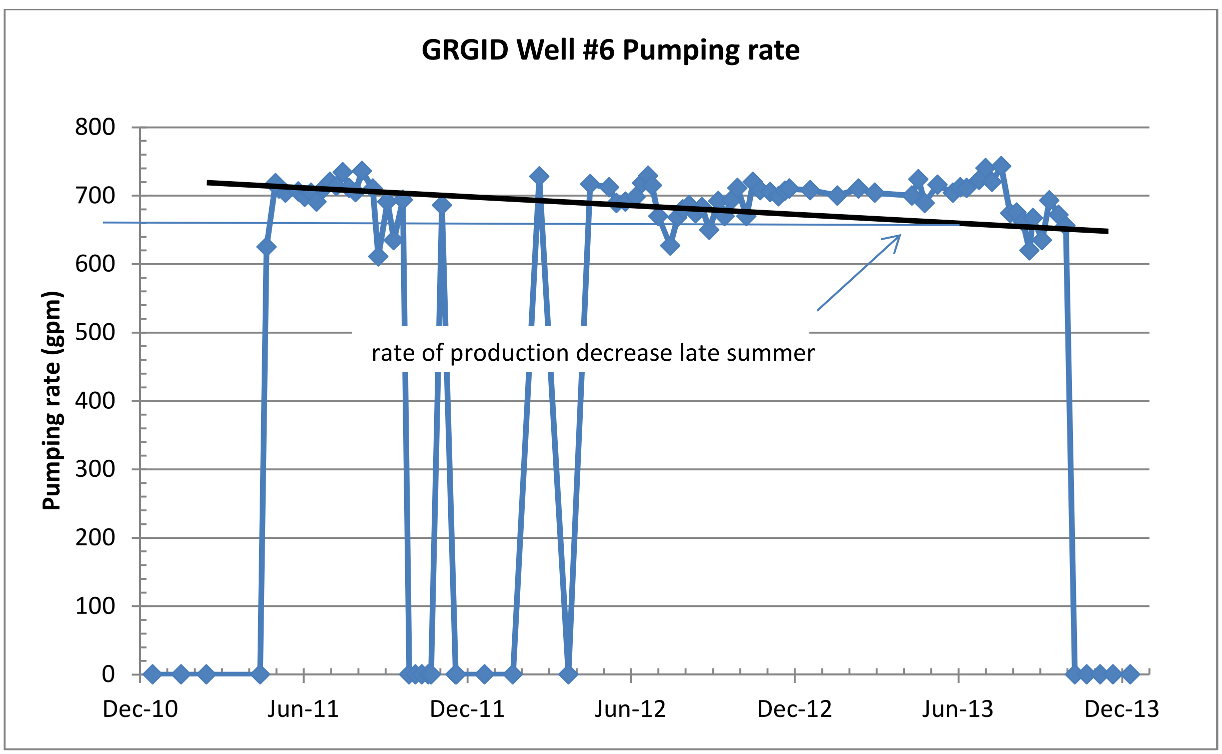


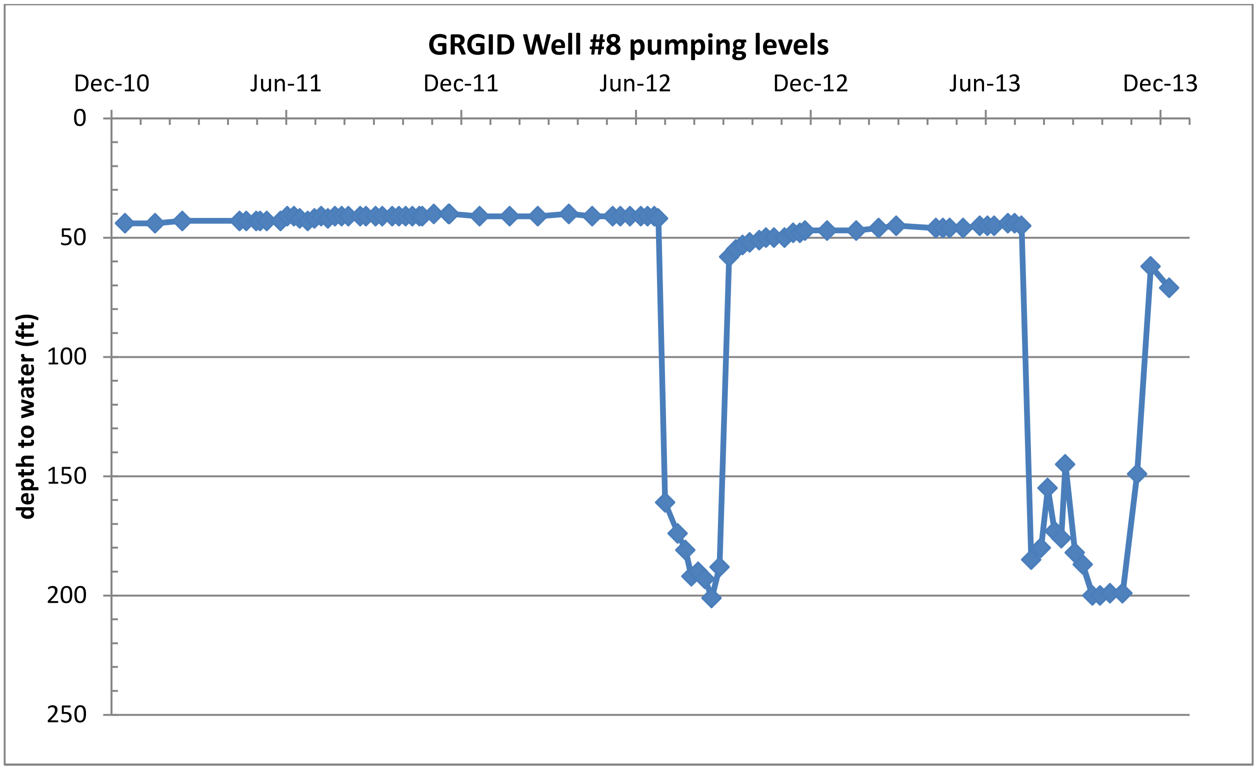


Rate of production decline in late summer (22.5gpm/yr). Water level data is not available to assess pumping level declines, if any. Also unknown is the pumping level in relation to the pump intake (set at 214 feet). Well screen begins at 183 feet.

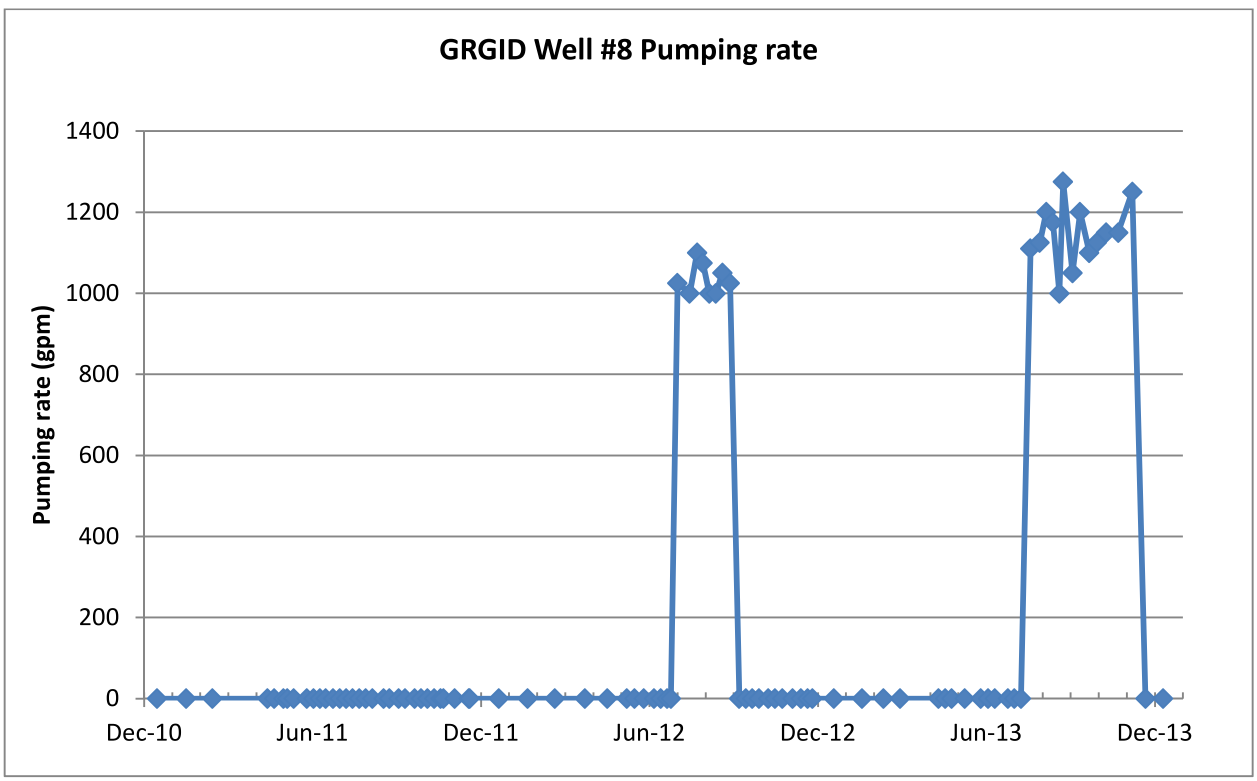


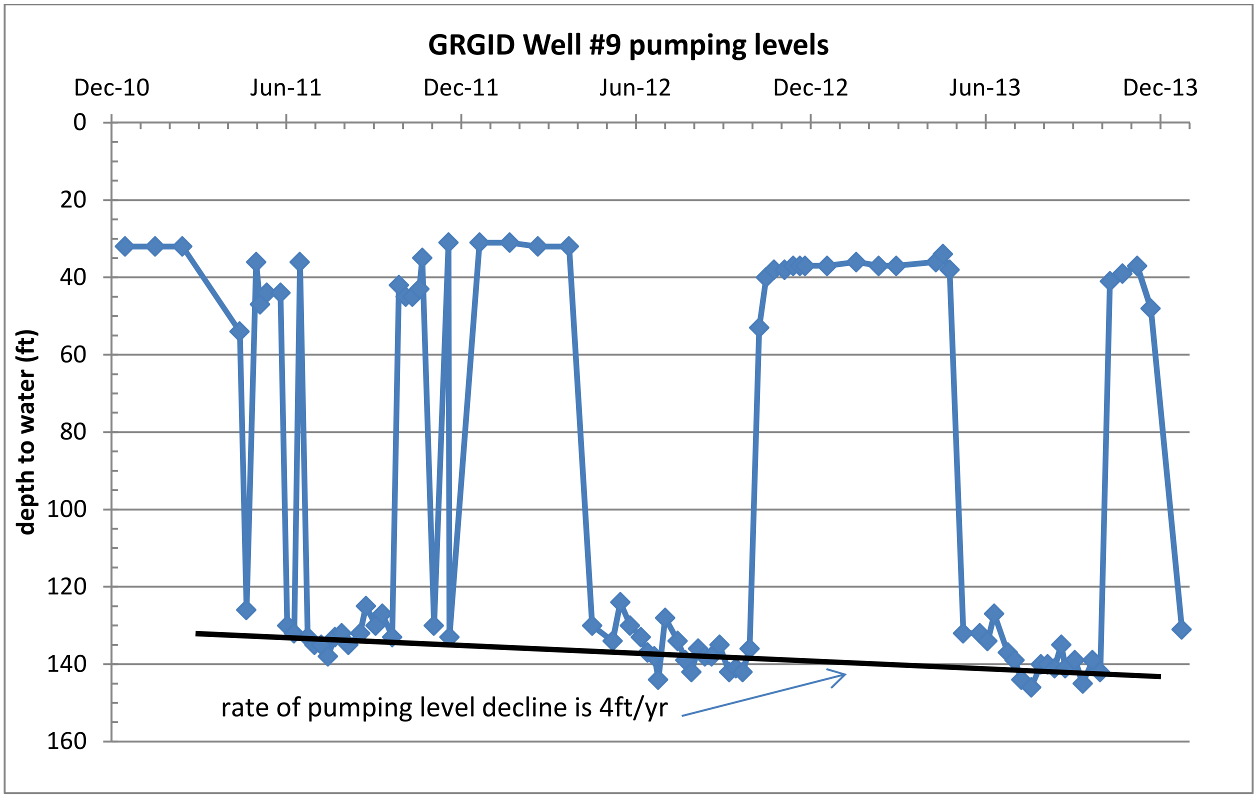
Rate of pumping level decline at 7ft/yr. Rate of production decline in late summer is 30 gpm/yr. Well #6 pump setting is approximately 216 feet. The well screen is at 210 feet.



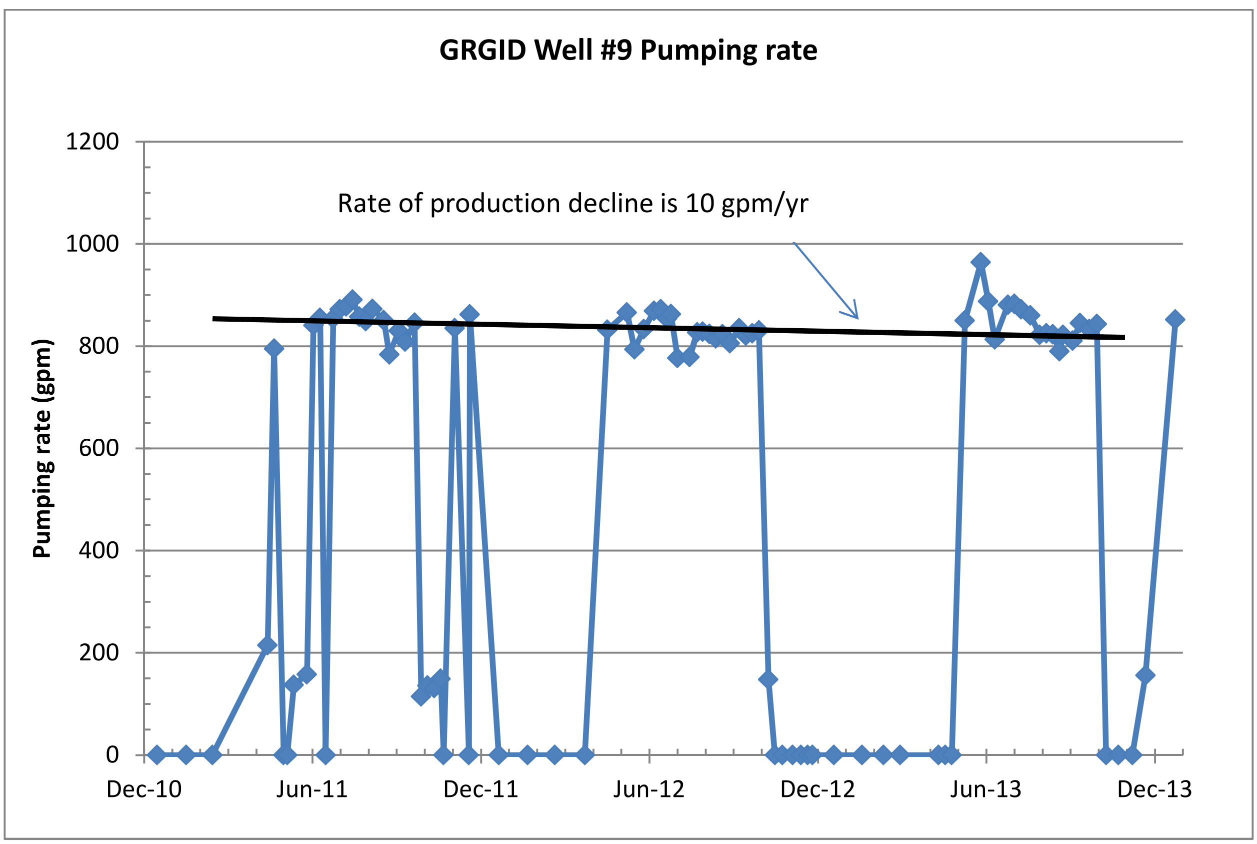


No apparent declines in production or rates. Pump setting is at 245 feet and the screen at 260 feet.





Well #9 screen is at 240 feet with the pump intake at 202ft.



APPENDIX D

Recent Water Quality Analysis of Key Constituents

Gardnerville Ranchos GID
Recent Key Water Quality Constituents

Standards	1000	10	0.6	0.1	10	n/a
Well #1	ppm	**ppb**	ppm	ppm	ppm	ppm
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
7/12/2005	192	5	0.16	<0.02	0.6	113
8/4/2010	181	6	<0.05	<0.02	0.6	111
7/31/2012	189	6	<0.05	<0.02	0.8	109
Well #2						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
3/29/2002	190		<0.05	<0.02	0.6	
9/18/2003		3			0.7	
7/11/2005	175	6	<0.05	<0.02	<0.5	106
6/26/2007	191	5	<0.05	<0.02	<0.5	120
8/4/2010	172	6	<0.05	<0.02	<0.5	105
7/31/2012	177	6	<0.05	<0.02	<0.5	105
Well #4						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
7/12/2005	158	3	<0.05	<0.02	<0.5	88
6/26/2007	156	3	<0.05	<0.02	<0.5	91
8/4/2010	156	3	<0.05	<0.02	<0.5	90
7/31/2012	168	3	<0.05	<0.02	0.6	89
Well #5						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
6/17/1985	236	<20	<0.05	<0.02	1.6	110
9/17/2003					1.7	
7/11/2005	236	**24**	<0.05	<0.02	1.8	126
9/11/2007	221	**11**	0.11	<0.02	<0.5	116
11/14/2013	250	**20**	<0.05	<0.02	2	119
Well #6						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
7/12/2005	158	4	<0.05	<0.02	1.4	100
6/26/2007	156	5	<0.05	<0.02	1	100
8/4/2010	157	5	<0.05	<0.02	1.3	99
7/31/2012	162	5	<0.05	<0.02	1.5	97

TDS=Total Dissolved Solids

	ppm	**ppb**	ppm	ppm	ppm	ppm
Well #7						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
9/29/1994	191	5	14	0.19		
Well #8						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
12/11/2003		10				
6/25/2007	146	**11**	<0.05	<0.02	<0.5	81
8/4/2010	148	**11**	<0.05	<0.02	<0.5	86
7/31/2012	146	10	<0.05	<0.02	0.6	80
Well #9						
	TDS	Arsenic	Iron	Manganese	Nitrogen	Alkalinity
6/27/2007	158	10	<0.05	<0.02	1.2	97
6/29/2007	163	9	<0.05	<0.02	1	99
8/4/2010	169	9	<0.05	<0.02	1.8	99
9/14/2011					2	
7/31/2012	178	9	<0.05	<0.02	2.2	105

TDS=Total Dissolved Solids

APPENDIX E

USGS reports and investigations for the Carson Valley

List of Relevant Carson Valley Water Resource Publications

Berger, D.L., 1987, Ground-water levels in water years 1984–86 and estimated ground-water pumpage in water years 1984–85, Carson Valley, Douglas County, Nevada: U.S. Geological Survey Open-File Report 86-539, 16 p.

Berger, D.L., 1990, Ground-water levels in water year 1987 and estimated ground-water pumpage in water years 1986–87, Carson Valley, Douglas County, Nevada: U.S. Geological Survey Open-File Report 89-70, 9 p.

Berger, D.L., and Medina, R.L., 1999, Spatial ground-water data base in Carson Valley, Douglas County, Nevada, and Alpine County, California—Development and documentation: U.S. Geological Survey Water-Resources Investigations Report 99-4188, 1 CD-ROM.

Clark, S.N., 2006, Carson Valley groundwater pumpage inventory, water year 2005: Nevada Department of Conservation and Natural Resources, Division of Water Resources, 85 p.

Dettinger, M.D., Cayan, D.R., Meyer, M.K., and Jeton, A.E., 2004, Simulated hydrologic responses to climate variations and change in the Merced, Carson, and American River Basins, Sierra Nevada, California, 1900–2099: Climate Change, v. 62, p. 283–317.

Glancy, P.A., and Katzer, T.L., 1976, Water-resources appraisal of the Carson River basin, Western Nevada: Nevada Department of Conservation and Natural Resources, Water Resources-Reconnaissance Series Report 59, 126 p.

Guitjens, J.C., and Mahannah, C.N., 1972, Upper Carson River water study, water year 1972: Max C. Fleischmann College of Agriculture, University of Nevada, Reno, Report, 94, 51 p.

Hess, G.W., and Taylor, R.L., 1999, River-operations model for the upper Carson River basin, California and Nevada: U.S. Geological Survey Water-Resources Investigations Report 98-4240, 40 p.

Jeton, A.E., Dettinger, M.D., and Smith, J.L., 1996, Potential effects of climate change on streamflow, eastern and western slopes of the Sierra Nevada, California and Nevada: U.S. Geological Survey Water Resource Investigations Report, 95-4260, 49 p.

Jeton, A.E., and Maurer, D.K., 2007, Precipitation and runoff simulations of the Carson Range and Pine Nut Mountains, and updated estimates of ground-water inflow and the ground-water budget for basin-fill aquifers of Carson Valley, Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2007-5205, 55 p.

Maurer, D.K., 1984, Gravity survey and depth to bedrock in Carson Valley, Nevada- California: U.S. Geological Survey Water-Resources Investigations Report 84-4202, 20 p.

Maurer, D.K., 1986, Geohydrology and simulated response to ground-water pumpage in Carson Valley, a river-dominated basin in Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Water-Resources Investigations Report 86-4328, 109 p.

Maurer, D.K., and Berger, D.L., 1997, Subsurface flow and water yield from watersheds tributary to Eagle Valley Hydrographic Area, west-central Nevada: U.S. Geological Survey Water-Resources Investigations Report 97-4191,56 p.

Maurer, D.K., and Berger, D.L., 2007, Water budgets and potential effects of water use changes for Carson Valley, Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2006-5305, 63 p. Available at *http://pubs.usgs.gov/sir/2006/5305/index.html*.

Maurer, D.K., Berger, D.L., Tumbusch, M.L., and Johnson, M.J., 2006, Rates of evapotranspiration, recharge from precipitation beneath selected areas of native vegetation, and streamflow gain and loss in Carson Valley, Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2005-5288, 70 p.

Maurer, D.K., and Halford, K.J., 2004, Updated estimates of the distribution of average annual precipitation in Carson Valley, 1971-2000, Douglas County, Nevada, and Alpine County, California: Journal of the Nevada Water Resources Association, v. 1, no. 1, p. 20–39.

Maurer, D.K., Paul, A.P., Berger, D.L., and Mayers, C.J., 2009, Analysis of streamflow trends, groundwater and surface water interactions, and water quality in the upper Carson River Basin, Nevada and California: U.S. Geological Survey Scientific Investigations Report 2008-5238, 192 p.

Maurer, D.K., and Peltz, L.A., 1994, Potential for, and possible effects of, artificial recharge in Carson Valley, Douglas County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 94-4126, 4 map sheets.

Maurer, D.K., Watkins, S.A., and Burrows, R.L., 2004, Updated computations and estimates of streamflows tributary to Carson Valley, Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Scientific Investigations Report 2004-5179, 29 p.

Paul, A.P., Maurer, D.E., Stollenwerk, K.G., and Welch, A.H., 2010, In-situ arsenic remediation in Carson Valley, Douglas County, west-central Nevada: U.S. Geological Survey Scientific Investigations Report 2010-5161, 24 p.

Prudic, D.E., and Wood. J.L., 1995, Results of hypothetical ground-water pumping in Carson Valley, a river-dominated basin in Douglas County, Nevada, and Alpine County, California: U.S. Geological Survey Water-Resources Investigations Report 95-4174, 29 p.

APPENDIX F

Residential growth rate data sets

GRGID Well Production (assuming 14 hrs production per day)

	Wells	Average Flow	Max Minutes Per Day	Volume Pumped per Day	Volume Pumped Annually
		(gpm)	(14 hrs)	(gal)	(gal)
	Well #1	1100	840	924,000	318,780,000
	Well #2	1400	840	1,176,000	405,720,000
	Well #4	370	840	310,800	107,226,000
	Well #6	650	840	546,000	188,370,000
	Well #8	1100	840	924,000	318,780,000
	Well #9	800	840	672,000	231,840,000
As > MCL	Well #5	1200	840	1,008,000	347,760,000
	Well #3		840		
		6620			
	Subtotal Pumped Annually			4,552,800	1,570,716,000
		Well #5 Online			1,918,476,000
		Well #2 Offline			1,164,996,000
		Well #1 Offline			1,251,936,000

Flow Rate Capacities for 20-Year Projections			
Year	Max Flow Rate from Wells (3% Decline Rate, gpm)	Max Flow Rate w/out Well 5 (gpm)	July Recorded Max Flow Rate (gpm)
2011	6620	5420	3983
2012	6620	5420	4113
2013	6620	5420	4197
2014	6620	5420	
2015	6421	5257	
2016	6229	5100	
2017	6042	4947	
2018	5861	4798	
2019	5685	4654	
2020	5514	4515	
2021	5349	4379	
2022	5188	4248	
2023	5033	4120	
2024	4882	3997	
2025	4735	3877	
2026	4593	3761	
2027	4455	3648	
2028	4322	3538	
2029	4192	3432	
2030	4066	3329	
2031	3944	3229	
2032	3826	3132	
2033	3711	3039	
2024	3600	2947	
2028	3492	2859	
2029	3387	2773	
2030	3286	2690	
2031	3187	2609	
2032	3091	2531	
2033	2999	2455	
2034	2909	2381	

GRGID HISTORICAL SEWER HOOKUPS ANNUALLY

Year	New Hookups	Cummulative	Cumm Corrected	Avg Hookups	Residential Connects
1991	15	15	15	25	3323
1994	58	73	73	50	3646
1995	49	122	122	75	3704
1996	24	146	146	100	3753
1997	35	181	181	125	3777
1998	13	194	194	150	3812
1999	38	232	232	175	3825
2000	33	265	265	200	3863
2001	41	306	306	225	3896
2002	37	343	343	250	3937
2003	11	354	354	275	3974
2004	43	397	397	300	3985
2005	5	402	402	325	4028
2006	41	443	443	350	4033
2007	15	458	458	375	4074
2008	8	466	466	400	4089
2009	1	467	467	425	4097
2010	1	468	468	450	4098
2013	9	477	477	475	4107
***	Removed the two high and low anomolies in the data set (i.e. 1992, 1993, 2011, 2012)				
1992	199	high #	Average home per year built		25
1993	109	high #			
2011	1	low #			
2012	0	low #			

Douglas County 2013 - 2034 Population Projections (Nevada State Demographer's Office)

Year	Total Population	Previous Change	GRGID 23.5% of Population	2.56 Average Household	Est. Apts	Estimate connects	Est Apts Connects	Total Resident connects	Comm., School Parks connects	Total connects
2012	48,015		11,284	4408	350	4058	45	4103	40	4143
2013	47,714	-300	11,213	4380	350	4030	45	4075	40	4115
2014	47,512	-202	11,165	4361	350	4011	45	4056	40	4096
2015	47,405	-107	11,140	4352	350	4002	45	4047	41	4088
2016	47,408	3	11,141	4352	350	4002	45	4047	41	4088
2017	47,503	95	11,163	4361	350	4011	46	4057	41	4098
2018	47,657	154	11,199	4375	350	4025	46	4071	42	4113
2019	47,834	177	11,241	4391	350	4041	46	4087	42	4129
2020	48,030	196	11,287	4409	350	4059	46	4105	42	4147
2021	48,235	205	11,335	4428	350	4078	47	4125	43	4168
2022	48,457	222	11,387	4448	350	4098	47	4145	43	4188
2023	48,685	228	11,441	4469	350	4119	47	4166	43	4209
2024	48,917	232	11,495	4490	350	4140	48	4188	44	4232
2025	49,151	234	11,550	4512	350	4162	48	4210	44	4254
2026	49,382	231	11,605	4533	350	4183	48	4231	44	4275
2027	49,610	229	11,658	4554	350	4204	49	4253	45	4298
2028	49,831	221	11,710	4574	350	4224	49	4273	45	4318
2029	50,036	205	11,758	4593	350	4243	49	4292	45	4337
2030	50,223	187	11,802	4610	350	4260	50	4310	46	4356
2031	50,390	167	11,842	4626	350	4276	50	4326	46	4372
2032	50,531	141	11,875	4639	350	4289	50	4339	46	4385
2033	50,683	152	11,911	4653	350	4303	51	4354	47	4401
2034	50,835	152	11,946	4666	350	4316	51	4367	47	4414
						New Residential Hookups:		265	Total:	272

Total Water Pumped and Usage by Customer Base

	Total Use	Meter C & S	Meter R	Non-Metered
2009	1,089,971,595	62,806,000	179,901,120	847,264,475
2010	1,034,576,925	55,931,000	190,043,126	788,602,799
2011	996,126,507	51,267,000	213,555,000	731,304,507
2012	1,159,052,007	73,383,000	286,976,000	798,693,007
2013	1,126,792,758	73,316,000	316,418,000	737,058,758

Meter C & S: Commercial, Schools and Parks.
Meter R: Residential Metered Connections
Non-Metered: Residential Non-Metered Connections

US Census and Nv. Demogaphic Population Projections (see next sheet for contiunation)
Residential Meter Change Outs and Growth Estimates

Year	Residential Meter Change outs	Change	Residential Non-metered Connects	Change	Comm School Parks	New Comm. Sch and Parks	New Residential Hookups	Total connects	Total Metered Connects
2009	926		3171		35	0	1	4132	961
2010	1085	159	3013	-158	35	0	1	4133	1120
2011	1275	190	2823	-190	36	1	1	4134	1311
2012	1444	169	2650	-173	40	4	0	4134	1484
2013	1548	104	2555	-95	40	0	9	4143	1588
2014	1760	200	2355	-200	40	0	12	4155	1800
2015	2380	600	1755	-600	41	1	20	4176	2422
2016	4155	1755	0	-1755	41	0	20	4196	4196
2017	4175	0	0	0	41	0	20	4216	4216
2018	4195	0	0	0	42	1	20	4237	4238
2019	4215	0	0	0	42	0	20	4257	4257
2020	4235	0	0	0	42	0	20	4277	4277
2021	4255	0	0	0	43	1	20	4298	4299
2022	4275	0	0	0	43	0	20	4318	4318
2023	4295	0	0	0	43	0	20	4338	4338
2024	4315	0	0	0	44	1	20	4359	4360
2025	4335	0	0	0	44	0	20	4379	4379
2026	4355	0	0	0	44	0	20	4399	4399
2027	4375	0	0	0	45	1	20	4420	4421
2028	4395	0	0	0	45	0	20	4440	4440
2029	4415	0	0	0	45	0	20	4460	4460
2030	4435	0	0	0	46	1	20	4481	4482
2031	4455	0	0	0	46	0	20	4501	4501
2032	4475	0	0	0	46	0	20	4521	4521
2033	4495	0	0	0	47	1	20	4542	4543
2034	4515	0	0	0	47	0	20	4562	4562

Note: Projected future growth of residential based on average between historic sewer hookups and State Nevada Demographer Estimate growth of 407 new residential homes between 2014 and 2034.

US Census and Nv. Demogaphic Population Projections (see previous sheet for orgination)

Existing and Projected Water Usage from Growth Projections

Existing Residential Water Use	Existing Comm Sch & Parks	Projected Residential Water Use (metered)	Projected Residential Water Use (non-metered)	Projected Commercial Water Use	Projected Schools & Parks	Toal Water Use	Year
1,027,260,595	62,711,000	0	0	0	0	1,089,971,595	2009
978,488,925	56,088,000	0	0	0	0	1,034,576,925	2010
944,584,507	51,542,000	0	0	0	0	996,126,507	2011
1,084,754,007	74,298,000	0	0	0	0	1,159,052,007	2012
1,053,371,758	73,421,000	0	0	0	0	1,126,792,758	2013
0	0	330,904,640	648,727,140	11,544,720	50,853,600	1,042,030,100	2014
0	0	447,473,320	483,446,340	11,833,338	50,853,600	993,606,598	2015
0	0	781,198,170	0	11,833,338	50,853,600	843,885,108	2016
0	0	784,958,450	0	11,833,338	50,853,600	847,645,388	2017
0	0	788,718,730	0	12,121,956	50,853,600	851,694,286	2018
0	0	792,479,010	0	12,121,956	50,853,600	855,454,566	2019
0	0	796,239,290	0	12,121,956	50,853,600	859,214,846	2020
0	0	799,999,570	0	12,410,574	50,853,600	863,263,744	2021
0	0	803,759,850	0	12,410,574	50,853,600	867,024,024	2022
0	0	807,520,130	0	12,410,574	50,853,600	870,784,304	2023
0	0	811,280,410	0	12,699,192	56,000,000	879,979,602	2024
0	0	815,040,690	0	12,699,192	56,000,000	883,739,882	2025
0	0	818,800,970	0	12,699,192	56,000,000	887,500,162	2026
0	0	822,561,250	0	12,987,810	56,000,000	891,549,060	2027
0	0	826,321,530	0	12,987,810	56,000,000	895,309,340	2028
0	0	830,081,810	0	12,987,810	56,000,000	899,069,620	2029
0	0	833,842,090	0	13,276,428	56,000,000	903,118,518	2030
0	0	837,602,370	0	13,276,428	56,000,000	906,878,798	2031
0	0	841,362,650	0	13,276,428	56,000,000	910,639,078	2032
0	0	845,122,930	0	13,565,046	56,000,000	914,687,976	2033
0	0	848,883,210	0	13,565,046	56,000,000	918,448,256	2034
		188,014	275,468	288,618	50,853,600		
		Average Usage	Average Usage	Average Usage	56,000,000		

Based on historical sewer hookups (see next sheet for continuation)

Residential Meter Change Outs and Growth Estimates

Year	Residential Metered Connects	Change	Residential Non-metered Connects	Change	Comm Schools Parks	New Comm Schools Parks	New Residential Hookups	Total Connects	Total Metered Connections
2009	926		3171		35	0	1	4132	961
2010	1085	159	3013	-158	35	0	1	4133	1120
2011	1275	190	2823	-190	36	1	1	4134	1311
2012	1444	169	2650	-173	40	4	0	4134	1484
2013	1548	104	2555	-95	40	0	9	4143	1588
2014	1763	200	2355	-200	40	0	15	4158	1803
2015	2393	600	1755	-600	41	1	30	4189	2435
2016	4178	1755	0	-1755	41	0	30	4219	4219
2017	4208	0	0	0	42	0	30	4249	4250
2018	4238	0	0	0	43	1	30	4280	4282
2019	4268	0	0	0	43	0	30	4310	4311
2020	4298	0	0	0	44	1	30	4341	4343
2021	4328	0	0	0	44	0	30	4371	4372
2022	4358	0	0	0	45	1	30	4402	4404
2023	4388	0	0	0	45	0	30	4432	4433
2024	4418	0	0	0	46	1	30	4463	4465
2025	4448	0	0	0	46	0	30	4493	4494
2026	4478	0	0	0	47	1	30	4524	4526
2027	4508	0	0	0	47	0	30	4554	4555
2028	4538	0	0	0	48	1	30	4585	4587
2029	4568	0	0	0	48	0	30	4615	4616
2030	4598	0	0	0	49	1	30	4646	4648
2031	4628	0	0	0	49	0	30	4676	4677
2032	4658	0	0	0	50	1	30	4707	4709
2033	4688	0	0	0	50	0	30	4737	4738
2034	4718	0	0	0	51	1	30	4768	4770

Note: ɔetween historic sewer hookups cummulative and average growth rate.
Estimate growth of 549 new residential homes between 2014 and 2034.

Based on historical sewer hookups (see next sheet for origination)
Existing and Projected Water Usage from Growth Projections

Existing Residential Water Use	Existing Comm School & park	Proj Resid Water Use (Metered)	Proj Resid Water Use (Non-Metered)	Projected Comm Water Use	Projected Schools and Parks	Total Water Use	Year
1,027,260,595	62,711,000	0	0	0	0	1,089,971,595	2009
978,488,925	56,088,000	0	0	0	0	1,034,576,925	2010
944,584,507	51,542,000	0	0	0	0	996,126,507	2011
1,084,754,007	74,298,000	0	0	0	0	1,159,052,007	2012
1,053,371,758	73,421,000	0	0	0	0	1,126,792,758	2013
0	0	331,468,682	648,727,140	11,544,720	50,853,600	1,042,594,142	2014
0	0	449,917,502	483,446,340	11,833,338	50,853,600	996,050,780	2015
0	0	785,522,492	0	11,833,338	50,853,600	848,209,430	2016
0	0	791,162,912	0	12,121,956	50,853,600	854,138,468	2017
0	0	796,803,332	0	12,410,574	50,853,600	860,067,506	2018
0	0	802,443,752	0	12,410,574	50,853,600	865,707,926	2019
0	0	808,084,172	0	12,699,192	50,853,600	871,636,964	2020
0	0	813,724,592	0	12,699,192	50,853,600	877,277,384	2021
0	0	819,365,012	0	12,987,810	50,853,600	883,206,422	2022
0	0	825,005,432	0	12,987,810	50,853,600	888,846,842	2023
0	0	830,645,852	0	13,276,428	56,000,000	899,922,280	2024
0	0	836,286,272	0	13,276,428	56,000,000	905,562,700	2025
0	0	841,926,692	0	13,565,046	56,000,000	911,491,738	2026
0	0	847,567,112	0	13,565,046	56,000,000	917,132,158	2027
0	0	853,207,532	0	13,853,664	56,000,000	923,061,196	2028
0	0	858,847,952	0	13,853,664	56,000,000	928,701,616	2029
0	0	864,488,372	0	14,142,282	56,000,000	934,630,654	2030
0	0	870,128,792	0	14,142,282	56,000,000	940,271,074	2031
0	0	875,769,212	0	14,430,900	56,000,000	946,200,112	2032
0	0	881,409,632	0	14,430,900	56,000,000	951,840,532	2033
0	0	887,050,052	0	14,719,518	56,000,000	957,769,570	2034
		188,014 Average Usage	275,468 Average Usage	288,618 Average Usage			