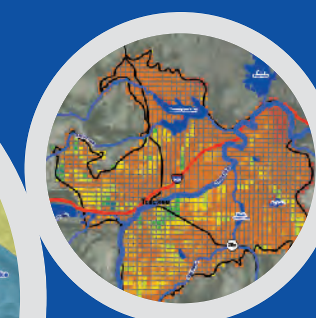
Martis Valley
Groundwater Management Plan

April, 2013



Prepared for

Northstar Community Services District

Placer County Water Agency

Truckee Donner Public Utility District

Northstar Community Services District   PCWA   TRUCKEE DONNER PUBLIC UTILITY DISTRICT

Martis Valley Groundwater Management Plan

Prepared for

Truckee Donner Public Utility District, Truckee, California

Placer County Water Agency, Auburn, California

Northstar Community Services District, Northstar, California

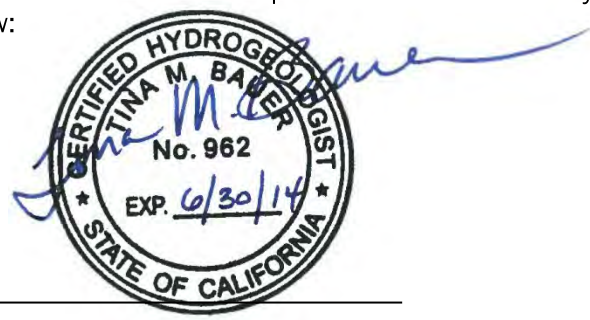
April 18, 2013

140691

MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN
NEVADA AND PLACER COUNTIES, CALIFORNIA

SIGNATURE PAGE

Signatures of principal personnel responsible for the development of the Martis Valley Groundwater Management Plan are exhibited below:



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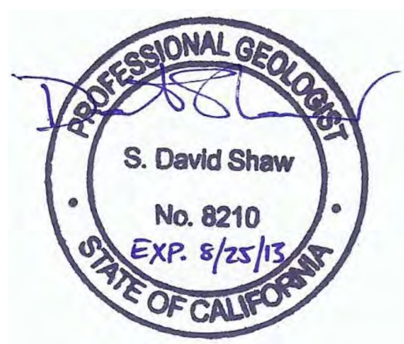

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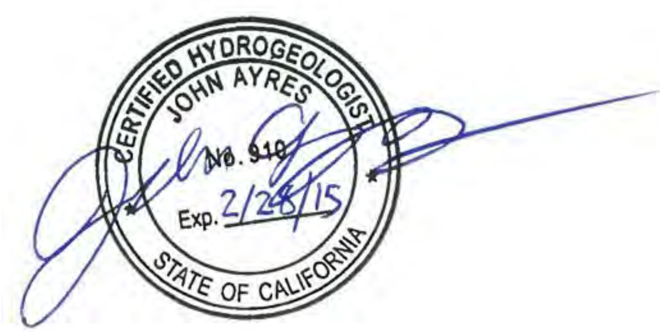

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List of Abbreviations

AB 3030	Assembly Bill 3030
ac-ft/yr	acre-feet per year
BMOs	Basin Management Objectives
CASGEM	California
cfs	cubic feet per second
CWC	California Water Code
DPH	Department of Public Health
DRI	Desert Research Institute
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment Program
GAMA	Groundwater Ambient Monitoring and Assessment
GCM	general circulation model
GMP	Groundwater Management Plan
gpm	gallons per minute
GSFLOW	Ground-water and Surface-water Flow Model
IRWMP	Integrated Regional Water Management Plan
LGA	Local Groundwater Assistance
LLNL	Lawrence Livermore National Laboratory
LRWQCB	Lahontan Regional Water Quality Control Board
LUST	leaking underground storage tank
MCL	Maximum Contaminant Level
mgd	million gallons per day
MODFLOW	Modular Three-Dimensional Finite-Difference Groundwater Flow Model
msl	mean sea level
MVGB	Martis Valley Groundwater Basin
NCSD	Northstar Community Services District
NOAA	National Oceanic and Atmospheric Association
PCWA	Placer County Water Agency
PRMS	Precipitation Runoff Modeling System
PUC	Public Utilities Commission
SB	Senate Bill
sq mi	square miles
SWG	Stakeholder Working Group
SWRCB	State Water Resources Control Board
TDPUD	Truckee Donner Public Utility District
TDS	Total Dissolved Solids
TROA	Truckee River Operating Agreement
T-TSA	Tahoe-Truckee Sanitation Agency
USACE	United States Army Corps of Engineers
USFS	United State Forest Service
USGS	United States Geologic Survey
UZF	Unsaturated Zone Flow

Section 1
Introduction

In 1992, the State Legislature enacted the California Groundwater Management Act through Assembly Bill 3030 (AB 3030) to encourage local public agencies to adopt plans to manage groundwater resources within their jurisdictions. Provisions were created in the California Water Code (CWC) Sections 10750 et.seq. to manage the safe production, quality, and proper storage of groundwater and AB 3030 codified voluntary components of a Groundwater Management Plan (GMP). In 2002, Senate Bill 1938 (SB 1938) was signed into law which amended the CWC with required components of a GMP for any public agency seeking State funds administered through the California Department of Water Resources (DWR) for groundwater projects. In 2003, DWR published *Bulletin 118 – Update 2003, California's Groundwater* which includes seven recommended components of a GMP.

This GMP includes the following components: the partner agencies' authority, physical setting including groundwater conditions, management goals and Basin Management Objectives (BMOs), and GMP implementation activities.

1.1 Purpose of the Groundwater Management Plan

The Truckee Donner Public Utility District (TDPUD), Northstar Community Services District (NCSD), and Placer County Water Agency (PCWA) have voluntarily partnered to develop the Martis Valley GMP, a collaborative planning tool that assists the partner agencies with efforts to ensure long term quality and availability of shared groundwater resources in the Martis Valley Groundwater Basin (MVGB). This GMP is a "living document" that includes an overall goal, BMOs, and implementation actions that will be periodically updated to reflect changes in groundwater management and progress in meeting its goal and objectives.

The purpose of the Martis Valley GMP is to improve the understanding and management of the groundwater resource in Martis Valley, while providing a framework for the partner agencies to align policy and implement effective and sustainable groundwater management programs.

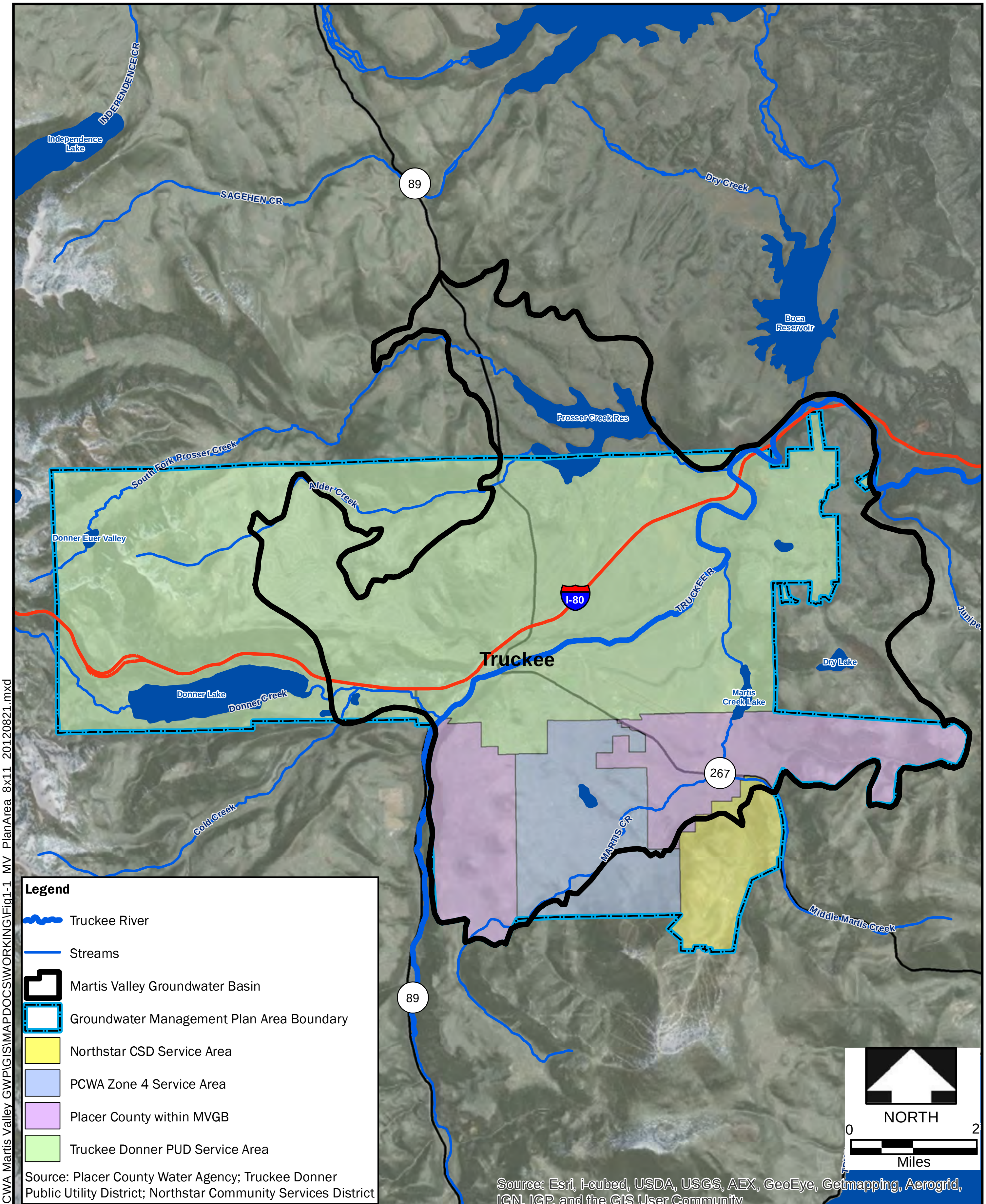
This GMP is not:

- mandatory,
- regulatory,
- an enforcement effort, or
- land use or zoning ordinances.

Older groundwater management plans by TDPUD (1995) and PCWA (1998) are herein updated by this GMP which has been designed to meet the requirements set by SB 1938, addresses the voluntary and recommended components included in AB 3030, as well as address recommendations outlined in Bulletin 118-2003. The area covered by the Martis Valley GMP, as shown in Figure 1-1, includes each partner agencies' jurisdictional boundaries within Nevada and Placer Counties.

1.2 Groundwater Management Plan Authority and Administration

Each partner agency is an authorized groundwater management agency within the meaning of CWC § 10753 (a). In April of 2011, each partner agency adopted respective resolutions of intent to develop a GMP; the resolutions are included as Appendix A.



P:\40000\140691 - PCWA Martis Valley GWP\GIS\MAPDOCS\WORKING\Fig1-1 MV PlanArea 8x11 20120821.mxd

DATE 10/18/2012	PROJECT 140691	SITE **Martis Valley, California**	**Figure 1-1**
Brown AND Caldwell		TITLE **Groundwater Management Plan Area**	

1.3 Groundwater Management Plan Development Process

During the course of preparing the GMP, various entities were involved in developing, approving, and adopting the GMP. In addition to the partner agencies, a Stakeholder Working Group (SWG) was created to provide local knowledge, data and information, opinions, and review and comment on material prepared by the GMP team. The SWG was comprised of representatives of Federal, State, and local governments, environmental and special interest groups, and local land use interests. Four SWG meetings were held with the partner agencies during GMP development. SWG participants and the agency represented are presented in Table 1-1.

Table 1-1. Stakeholder Working Group Members

Working Group Participant	Representing
Chris Bonds	Department of Water Resources, Central Region Office
Steven Springhorn	Department of Water Resources, Central Region Office
Ron Parr	DMB Highlands Group LLC
Rick Stephens	Lahontan Community Association
John Eaton	Mountain Area Preservation Foundation
Kaitlin Backlund	Mountain Area Preservation Foundation
Michael Johnson	Placer County Community Development
Marcia Beals	Tahoe Truckee Sanitation Agency
Tony Lashbrook	Town of Truckee
Jeff Boyer	Truckee River Operating Agreement
Dave Wathen	Truckee River Operating Agreement
Lisa Wallace	Truckee River Watershed Council
Kenneth Parr	United States Bureau of Reclamation
Tom Scott	United States Bureau of Reclamation
Joanne Roubique	United States Forest Service, Truckee District
Andrew Strain	Heavenly Mountain Resort/Northstar California Resort
Adam Spear	Vail Resorts
Steve Maglisceau	Marlin Atlantis/Schaffer's Mill
Tony Firenzi	Placer County Water Agency
Steven Poncelet	Truckee Donner Public Utility District
Mike Staudenmayer	Northstar Community Services District

There are five main steps in the development of a GMP, as defined under CWC §10753.2 through 10753.6, and the agencies' actions to follow them are shown in Figure 1-2 and are summarized below:

Step 1 – Provide public notification of a hearing on whether or not to adopt a resolution of intention to draft a GMP and subsequently complete a hearing on whether or not to adopt a resolution of intention to draft a GMP. Following the hearing, draft a resolution of intention to draft a GMP. The agencies provided public notification and held their respective hearings in March 2011. Copies of newspaper notifications are included in Appendix A.

Step 2 – Adopt a resolution of intention to draft a GMP and publish the resolution of intention in accordance with public notification. The partner agencies' adopted their respective resolutions of intention to develop a GMP in April 2011. The resolutions are included as Appendix A.

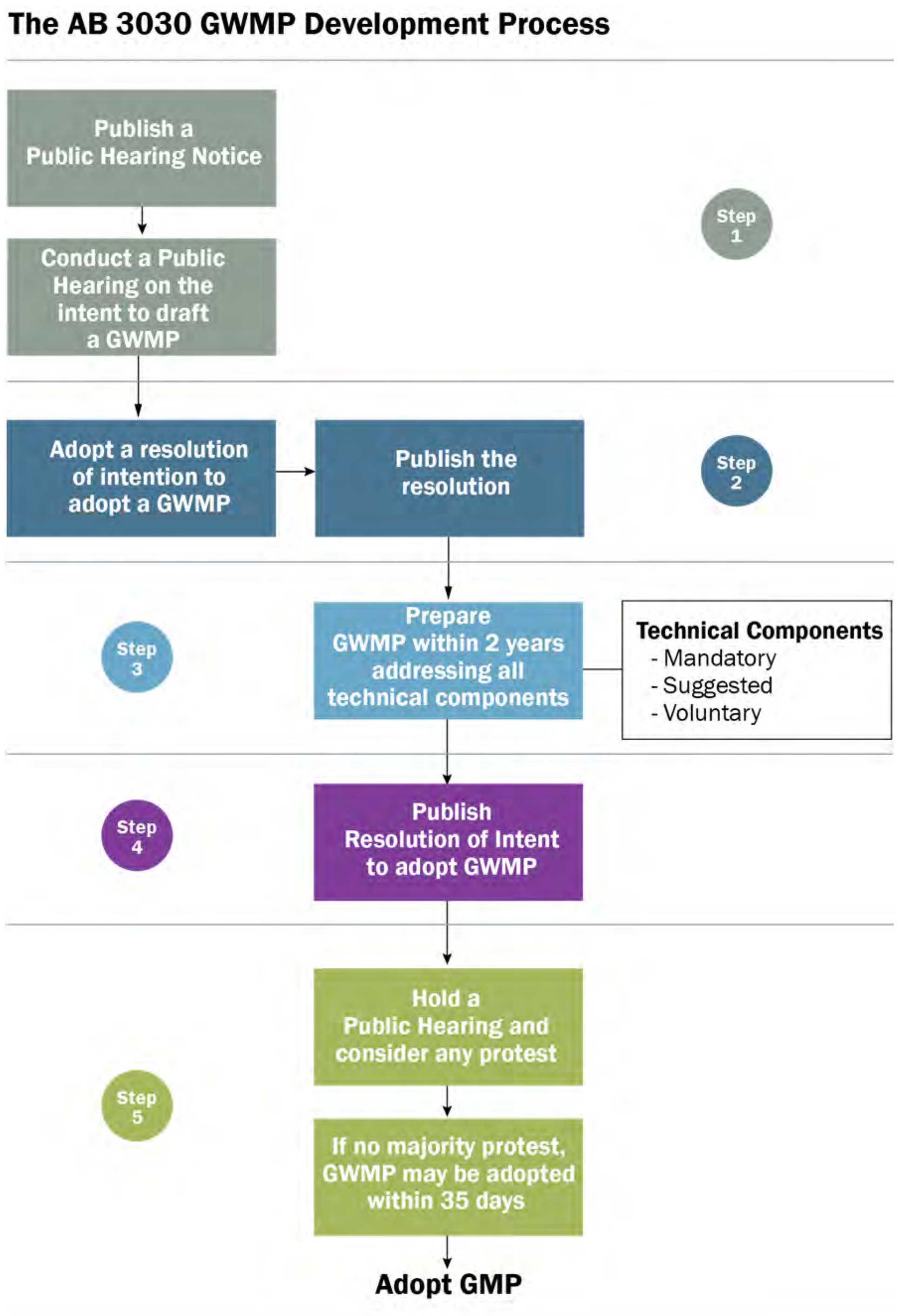


Figure 1-2. GMP Development Process

Step 3 – Prepare a draft GMP within two years of resolution of intention adoption. Provide to the public a written statement describing the manner in which interested parties may participate in developing the GMP. The agencies provided notification and held three SWG meetings where meeting attendees gave input on the GMP goal, BMOs, and implementation actions. The agencies also held a public meeting on July 20, 2011 to receive public input.

Step 4 – Provide public notification of a hearing on whether or not to adopt the GMP, followed by holding a hearing on whether or not to adopt the GMP. Public notices of the scheduled hearings were provided in the Auburn Journal and the Sierra Sun newspapers and proof of publications are included in Appendix B.

Step 5 – The plan may be adopted within 35 days after the completion of Step 4 above if protests are received for less than 50 percent of the assessed value of property in the plan area. If protests are received for greater than 50 percent of the assessed value of the property in the plan area, the plan will not be adopted. No public comments were received during the public comment period. In February 2013 each partner agency adopted the Martis Valley GMP and their respective resolutions are included in Appendix B.

1.4 Groundwater Management Goal

The GMP's goal provides the overarching purpose of the GMP, is used to identify the desired outcome of GMP implementation, is general in nature, and does not include quantitative components:

The goal of the Martis Valley GMP is to ensure long term quality and availability of groundwater in the Martis Valley Groundwater Basin.

1.5 Basin Management Objectives

The BMOs provide more specific direction to the GMP; they are generally protective of the groundwater resource and the environment, and each BMO identifies a distinct portion of the overarching goal which provides specific areas for focus. Summarized below are six primary areas that are emphasized and embodied in the BMO's that support the GMP goal:

1. **Manage groundwater to maintain established and planned uses.**

   Because the MVGB is the primary source of water to multiple users under separate jurisdictions, this objective encourages the partner agencies to pursue management of groundwater that is within their jurisdiction in order to protect existing uses.

2. **Manage groundwater use within the provisions of the Truckee River Operating Agreement.**

   The Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Settlement Act), Public Law 101-618 (1990), established entitlements to the waters of Lake Tahoe, the Truckee River and its tributaries and how the storage reservoirs of the Truckee River are operated. Section 205 of the Settlement Act directs the Secretary of the Department of the Interior to negotiate an operating agreement for the operation of Truckee River reservoirs, between California, Nevada, Sierra Pacific Power Company, Pyramid Tribe, and the United States. The operating agreement is known as the Truckee River Operating Agreement (TROA).

   This objective documents the partner agencies' commitment to continue to comply with provisions of the TROA. Some provisions in TROA apply to groundwater and water wells within the Truckee River Basin (which includes the Martis Valley) to address potential adverse impacts to surface water.

3. **Collaborate and cooperate with groundwater users and stakeholders in the MVGB.**

   Collaborating and sharing information and resources with other groundwater users in the MVGB helps promote GMP goals. This objective encourages the partner agencies to reach out to other groundwater users within the MVGB.

4. **Protect groundwater quantity and quality.**

   Groundwater performs an integral function in a watershed, one of which is satisfying water supply needs. Improving the understanding of the groundwater basin is a critical step in protecting and sustaining the Martis Valley groundwater supply.

5. **Pursue and use the best available science and technology to inform the decision making process.**

   Science and technology continue to develop new tools that may improve the understanding of the MVGB. This objective encourages the partner agencies to take actions that work with the best available science to help make informed agency decisions.

6. **Consider the environment and participate in the stewardship of groundwater resources.**

   The partner agencies are dedicated to stewardship of groundwater resources and this BMO ensures that stewardship is part of the GMP.

1.6 Plan Components

Required GMP components and their location in the GMP are summarized in Table 1-2, Voluntary GMP components and their location in the GMP are summarized in Table 1-3, and recommended GMP components and their location in the GMP are summarized in Table 1-4.

Table 1-2. Required Components and Associated Report Section

Category Required	GMP Components Required Components: (10753.7.)	Report Section
1	Establish Basin Management Objectives (BMOs)	Section 1.5
2	Include components relating to the monitoring and management of: groundwater levels, groundwater quality, and inelastic land subsidence	Section 3.4
3	Include components relating to changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin	Section 3.2
4	Include description of how recharge areas identified in the GMP substantially contribute to the replenishment of the groundwater basin	Section 2.9
5	Prepare a GMP that enables the partner agencies to work cooperatively with other public entities whose service area falls within the plan area and overlies the groundwater basin	Section 3.1 Section 3.4
6	Prepare a map that details the area of the groundwater basin, the area subject to the GMP, and the boundaries of other local agencies that overlie the basin	Section 1.1
7	Prepare a map identifying the recharge areas for the groundwater basin	Section 2.9
8	Adopt monitoring protocols that detect changes in: groundwater levels, groundwater quality, inelastic land subsidence, and surface water flow or quality that affects groundwater or groundwater pumping that affects surface water flow or quality	Section 3.4
9	If the GMP area includes areas outside a groundwater basin as defined in Bulletin 118, the partner agencies will use the required components, and geologic and hydrologic principles appropriate for the area	Throughout GMP

Table 1-3. Voluntary Components and Associated Report Section		
Category Voluntary	GMP Components Voluntary Components (10753.8.)	Report Section
1	Control of saline intrusion	Section 3.1
2	Identification and management of wellhead protection	Section 3.4
3	Regulation of the migration of contaminated groundwater	Section 3.1 Section 3.2
4	Administration of a well abandonment and well destruction program	Section 3.1
5	Mitigation of conditions of overdraft	Section 3.1
6	Replenishment of groundwater extracted by water producers	Section 3.1
7	Monitoring of groundwater levels and storage	Section 3.4
8	Facilitating conjunctive use operations	Section 3.1
9	Identification of well construction policies	Section 3.4
10	Construction and operation by the partner agencies of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	Section 3.1 Section 3.2
11	Development of relationships with state and Federal regulatory agencies	Section 3.1 Section 3.2 Section 3.5
12	Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination	Section 3.4

Table 1-4. Recommended Components and Associated Report Section		
Category Recommended	GMP Components Recommended Components (From Bulletin 118-2003 Appendix C)	Report Section
1	Document public involvement and ability of the public to participate in development of the GMP, this may include a Technical Advisory Committee (Stakeholder Working Group)	Section 1.3
2	Establish an advisory committee of stakeholders within the plan area that will help guide the development and implementation of the GMP and provide a forum for the resolution of controversial issues	Section 1.3 Section 3.1
3	Describe the area to be managed under the GMP including: • The physical structure of the aquifer system • A summary of available historical data and issues of concern related to groundwater levels, groundwater quality, inelastic land subsidence, and surface water flow or quality that effects groundwater or groundwater pumping that effects surface water flow or quality • A general discussion of historical and projected water demands and supplies	Section 2
4	Establish management objectives (MOs) for the groundwater basin subject to the GMP	Section 1.5
5	Describe the GMP's monitoring program	Section 3.4

Table 1-4. Recommended Components and Associated Report Section		
Category Recommended	GMP Components Recommended Components (From Bulletin 118-2003 Appendix C)	Report Section
6	Describe efforts to coordinate with land use, zoning, or water management planning agencies or activities	Section 3.4
7	Create a summary of monitoring locations with frequency of wells monitored	Appendix D
8	Provide periodic reports summarizing groundwater conditions and management activities including: • A summary of monitoring results, with a discussion of historical trends • A summary of management actions during the period covered by the report • A discussion of whether actions are achieving progress towards meeting BMOs • A summary of proposed management actions for the future • A summary of any GMP changes that occurred during the period covered by the report • A summary of actions taken to coordinate with other water and land agencies and other government agencies	Section 3.1
9	Provide for the periodic re-evaluation of the entire plan by the managing entity	Section 3.1

1.7 Area Covered by the GMP

The Martis Valley GMP includes the service areas of the TDPUD, PCWA, and NCSD that overlay and extend beyond the MVGB boundary, as well as the Placer County portion of the MVGB. It is important to note that at the time of GMP development, there were no other agencies within the Placer County portion of the MVGB that fall within the service area of another local agency, water corporation regulated by the Public Utility Commission (PUC), or mutual water company without the agreement of the overlying agency, as defined in the CWC (CWC § 10750.7(a)). Figure 1-1 shows the Martis Valley GMP area.

1.8 Public Outreach and Education

The partner agencies developed a Public Outreach Plan to guide development of the GMP. Public outreach included the formation of a Stakeholder Working Group to provide input on GMP development, two informative public meetings, and publically noticed public hearings (Appendix A) on the intent to draft and adopt the GMP. The Public Outreach Plan is included in Appendix C.

1.9 Groundwater Model

The partner agencies are currently collaborating with the Bureau of Reclamation (Reclamation) and their subcontractor, Desert Research Institute (DRI), to develop an integrated watershed-groundwater model in conjunction with the Martis Valley GMP. The geologic investigation conducted and documented in Section 2 of this report has been used to develop a geologic framework database, which was used to guide the conceptual and numerical model components for the hydrogeology components (groundwater model) of the integrated watershed model. The integrated watershed model is under development in parallel with the GMP and is not completed at the time of the issuance of the final GMP.

The integrated watershed model is comprised of a Precipitation Runoff Modeling System (PRMS) and Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) coupled together using an Unsaturated Zone Flow (UZF) package. PRMS is used to model surface water within the watershed, whereas MODFLOW is used to model groundwater within the MVGB. The UZF model package is a kinematic wave vadose zone model used to simulate the interaction between surface water and groundwater. Each model will be calibrated separately, and then calibrated together over a ten year period using a coupled ground-water and surface-water Flow Model (GSFLOW). Predictive model simulations will be performed using multiple general circulation model (GCM) projections of precipitation and temperature to estimate the influence of future climate on water resources within the MVGB. Calibration targets for fully coupled, GSFLOW model will include head values measured from wells, meadow and spring locations, streamflows, measured snow depth, and remotely sensed snow cover.

The integrated model's model domain will cover the entire Martis Valley Watershed, which includes the MVGB, as well as the watersheds that contribute surface water to the region, including Lake Tahoe. The model grid's cells are 300 meters by 300 meters in size. To date, DRI has used the PRMS component of the integrated modeling tool to estimate groundwater recharge across the MVGB, and is discussed in more detail in Section 2.9.

1.10 Document Organization

The Martis Valley GMP is organized into the following sections:

- Section 2 Physical Setting: describes the physical setting of Martis Valley including items such as geologic setting, land use, water sources, and well infrastructure
- Section 3 Plan Implementation: discusses the implementation actions included in the Martis Valley GMP
- Section 4 References
- Appendices

Section 2

Physical Setting

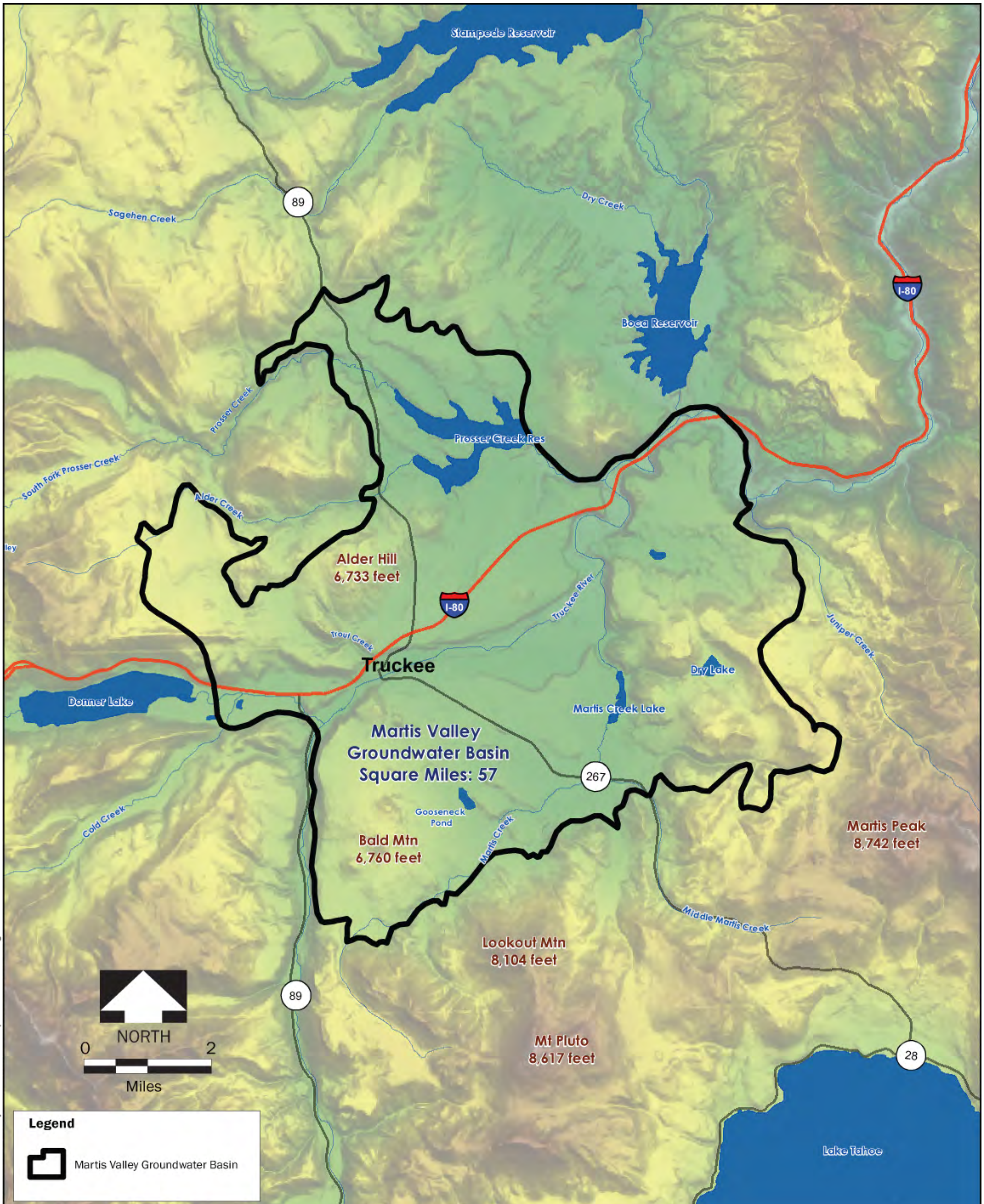
The MVGB is located in the transition zone between the Sierra Nevada and the Basin and Range Geomorphic Provinces, east of the Sierra Nevada crest and part of the larger Tahoe-Truckee River Basin of California and Nevada. Martis Valley is the principal topographic feature within the MVGB. The surrounding landscape is mountainous, underlain by volcanic and, to some extent, granitic bedrock, with apparent faulting and some portions that have been glaciated. A significant portion of the land within the MVGB boundary is privately owned with some areas managed as forest, open space and/or for recreation by special districts or agencies, including the U.S. Forest Service. This section of the GMP characterizes the physical setting of the MVGB, including: topography, climate, surface water hydrology, geology, hydrogeology, and water use.

2.1 Topography

The MVGB encompasses roughly 57 square miles, and lies within the Middle Truckee River Watershed. Elevations of the valley floor range from 5,700 to 5,900 feet above mean sea level (msl). The valley is accented by hills rising above the valley floor and mountains to the south and east of the valley. High points within or immediately adjacent to the MVGB include Bald Mountain at an elevation of 6,760 feet and Alder Hill at 6,733 feet, located on the western margin of the MVGB, and Lookout Mountain at 8,104 feet and Mt. Pluto at 8,617 feet, located on its the southern fringe. Martis Peak, further to the east, is at 8,742 feet. Figure 2-1 illustrates the MVGB location and topography.

2.2 Climate

The Tahoe-Truckee region experiences warm and dry summers, and cold, wet and snowy winters. Elevation and rain shadow play major roles in the spatial distribution of temperature and precipitation. Precipitation is highest at upper elevations in the western portion of the basin, toward the Sierra Crest, and decreases with elevation in the eastern portion of the basin (Figure 2-2). Mean annual precipitation (as snow water equivalent) ranges from approximately 30 inches below 6,500 feet to over 45 inches above 6,500 feet. Precipitation falls mostly as snow between October and April, though runoff and streamflow also responds to periodic mid-winter rain-on-snow events. Annual peak streamflow typically occurs during spring snowmelt in May or June. A small proportion of the total annual precipitation falls during brief thunderstorms in the summer months. Average monthly precipitation is shown in Figure 2-3, as recorded at the United States Forest Service (USFS) Truckee Ranger Station, near the center of the watershed (California Data Exchange Center Station TKE). Average temperatures range from daily lows of 15ºF in December and January to daily highs of 82ºF in July, as recorded at SNOTEL Station Truckee #2.



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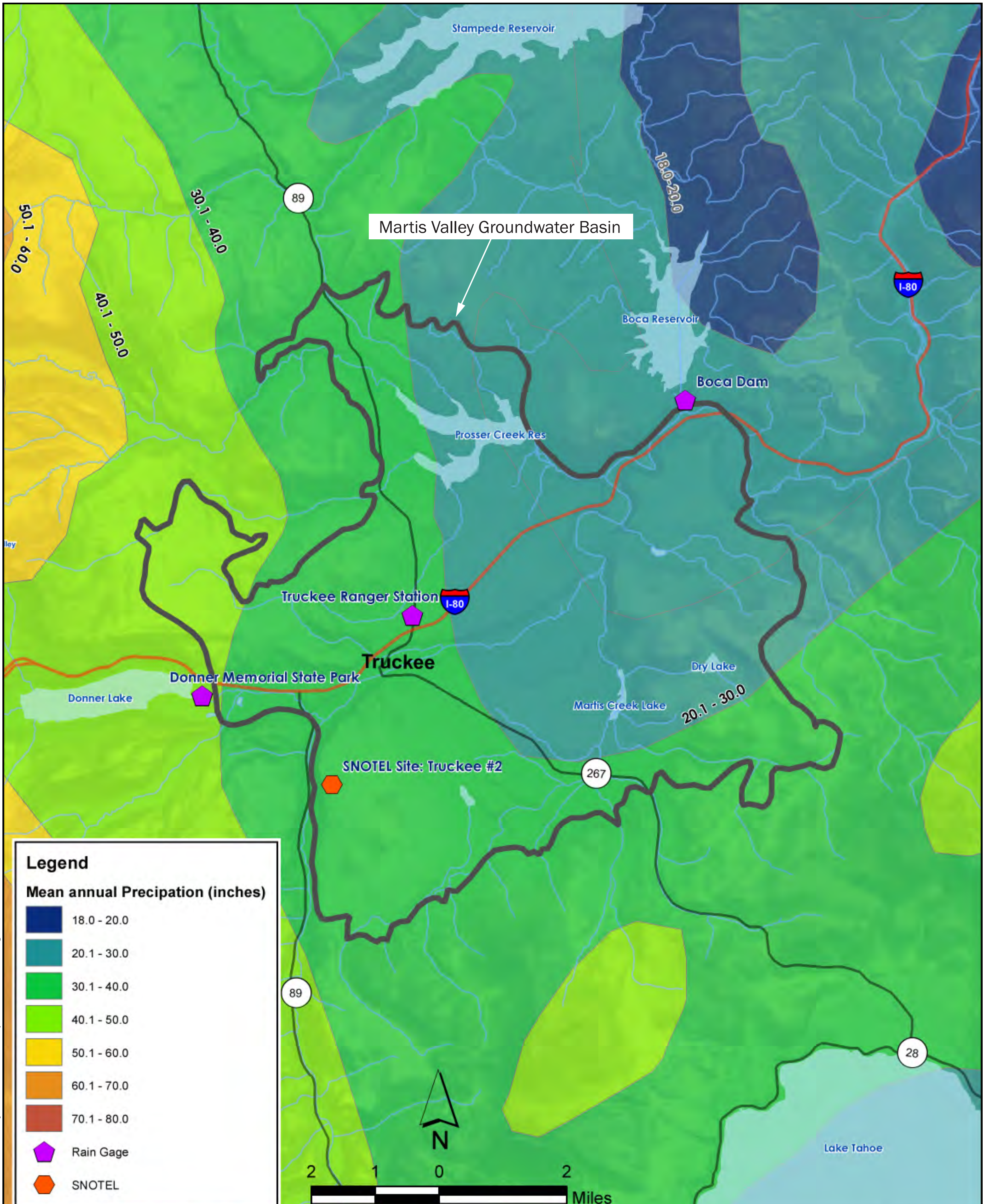
DATE 9-7-12	PROJECT 140691	SITE: Martis Valley Groundwater Basin, California	Figure 2-1
Brown and Caldwell; Balance Hydrologics, Inc.		TITLE: Groundwater Basin Location and Physiography	



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DATE	PROJECT	SITE	
9-7-12	140691	**Martis Valley Groundwater Basin, California**	**Figure 2-2**
Brown AND Caldwell; Balance Hydrologics, Inc.		TITLE: **Mean Annual Precipitation**	

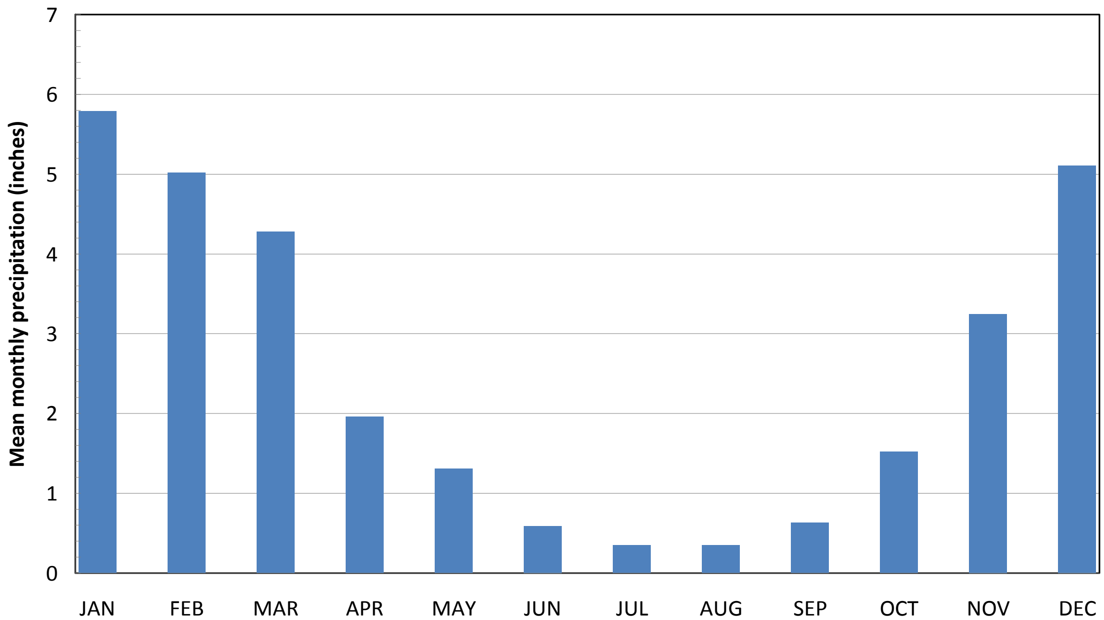


Figure 2-3. Mean Monthly Precipitation, Truckee Ranger Station, from 1904 to 1919 and 1935 to 2009

2.2.1 Climate Variability

The region experiences a wide range in climate variability. Variability is marked by periods of greater than average precipitation ('wet periods') and periods of below average precipitation or drought periods. Droughts have been historically common in the Sierra Nevada; Figure 2-4 illustrates the annual percent deviation from mean annual precipitation in Truckee and annual streamflow recorded at Farad from 1910 to 2009. The data shows that recent dry periods (periods of below average precipitation) generally have longer duration (e.g., 1971-1978, 1987-1994) than wet periods, which are typically short-lived and more extreme (e.g., 1962-1965, 1982-1983). The gray shading shows periods of incomplete annual precipitation data.

The worst drought in the 110 records of recorded streamflows at Farad was from 1987 to 1994. A similar pattern is recorded in tree-ring data since 1600 (Fritts and Gordon, 1980), with longer, more extreme droughts recorded. Lindstrom and others (2000) have described climate changes and details of wet and dry periods over the past 10,000 years, noting evidence of several dry periods when Lake Tahoe, and Donner and Independence Lakes dropped below their natural rims for consecutive years or decades (700 to 500 years ago and 200 to 100 years ago).

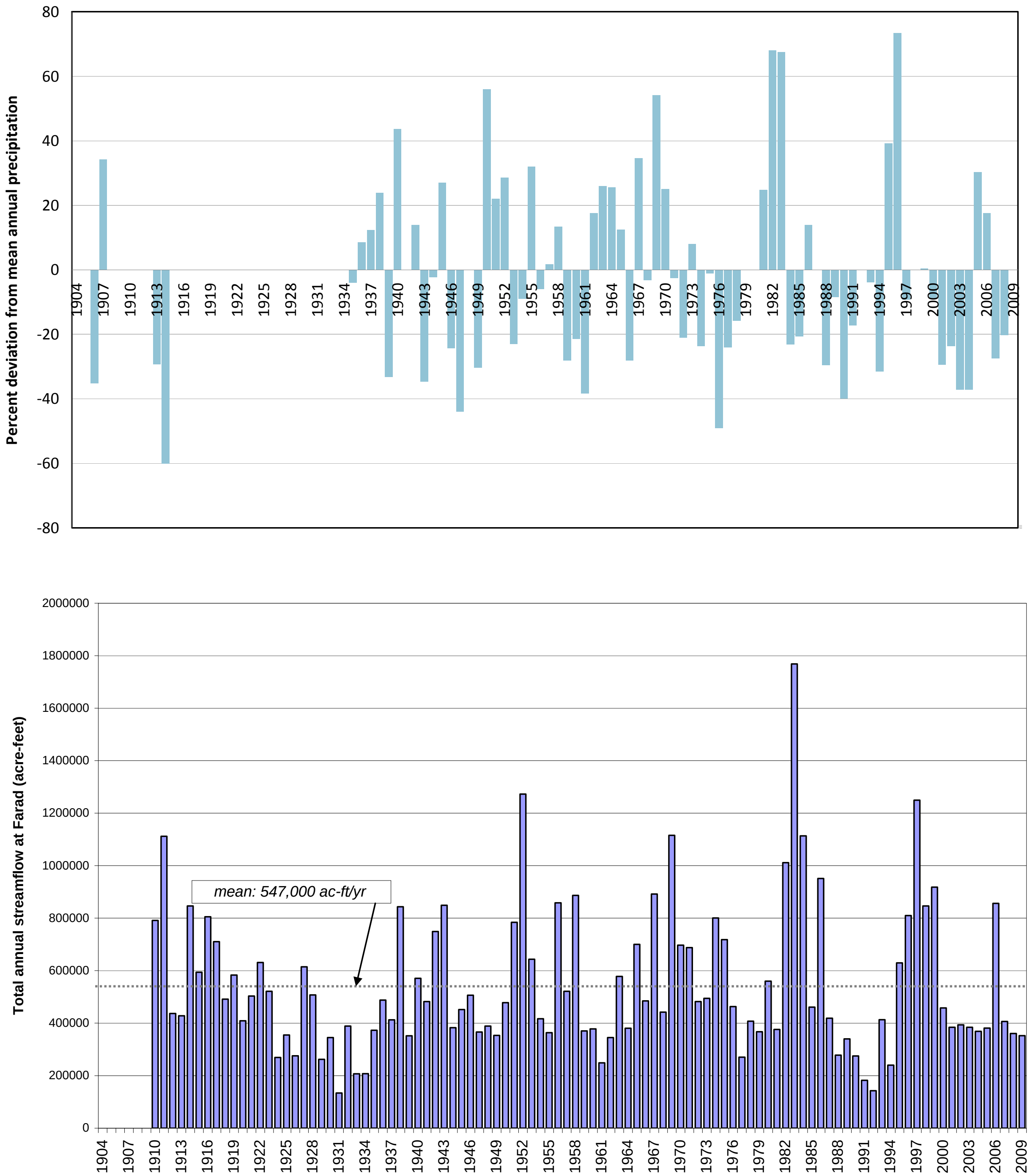


Figure 2-4. Percent Deviation from Mean Annual Precipitation at the Truckee Ranger Station and Total Annual Streamflow at Farad

2.2.2 Climate Change

The National Oceanic and Atmospheric Association (NOAA) and Coats and others (2010) have predicted a future shift from snowfall to rain in the next century in this region as a result of projected increases in average, minimum, and maximum air temperatures. Associated changes in surface water hydrology include potential increases in the frequency and magnitude of major flooding, such that more water may leave the basin as runoff, rather than infiltrating and recharging groundwater resources. NOAA has also predicted that climate change may result in increased drought frequency, and generally reduced water supplies (U.S. Bureau of Reclamation, 2011).

The U.S. Bureau of Reclamation manages water supply in the Truckee River Basin, and is undertaking a number of studies to evaluate the degree to which water supply and demand may be impacted by future changes in climate. This includes the Truckee River Basin Study, as well as funding researchers at DRI to develop an integrated groundwater, surface water, and climate change model of the MVGB.

2.3 Surface Water Hydrology

The Truckee River bisects the MVGB, with several tributaries upstream, within, and downstream of the MVGB. This section provides a brief discussion of the flow regimes of the Truckee River and the primary tributaries within the MVGB. Watershed areas are based on data available from CalAtlas, but subwatersheds shown have been modified in places for consistency with other regional studies, including the Water Quality Assessment and Modeling of the California portion of the Truckee River Basin (McGraw and others, 2001), the Truckee River Water Quality Monitoring Plan (Nichols Engineers, 2008), and the Martis Watershed Assessment (Shaw and others, 2012).

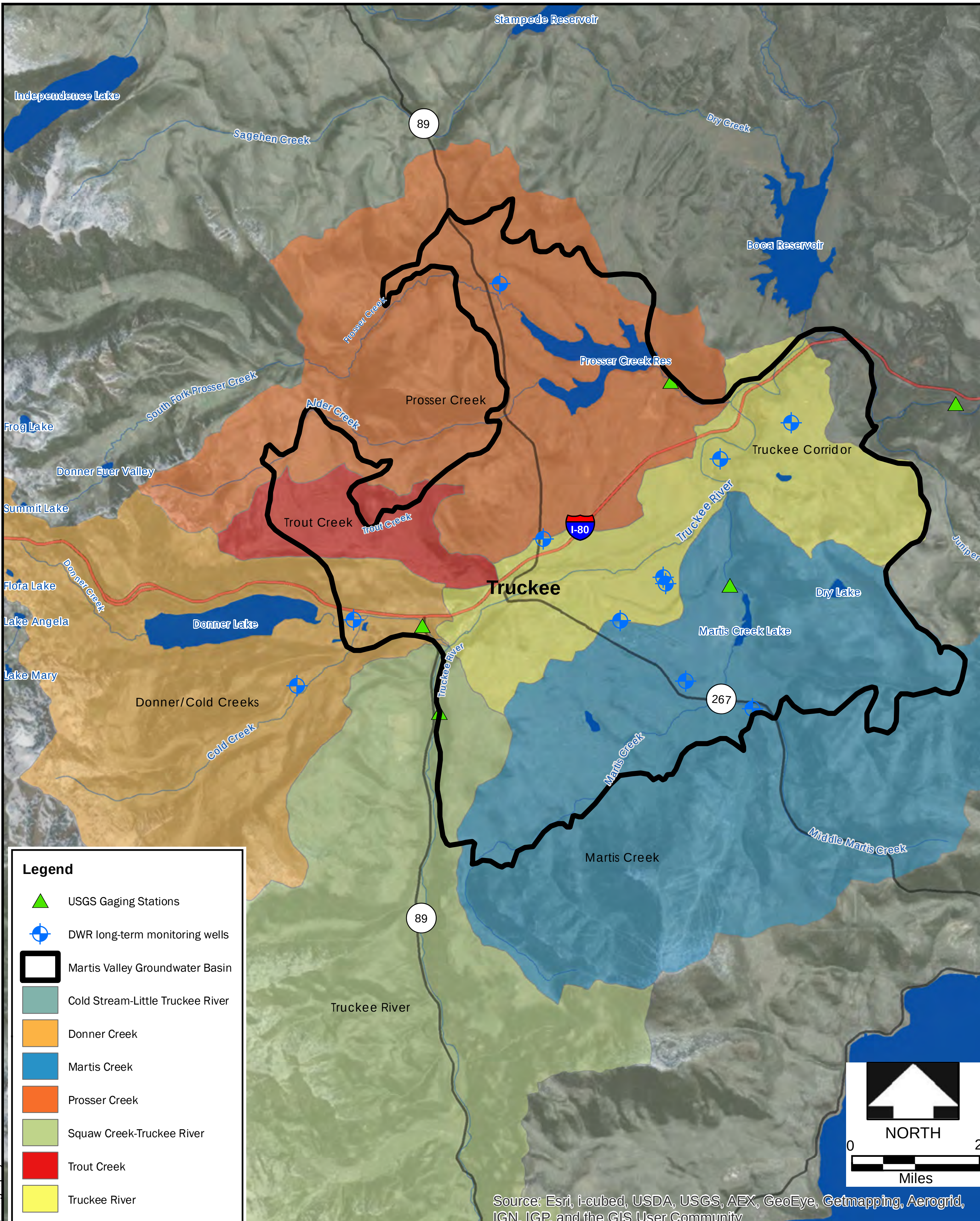
2.3.1 Truckee River

The Middle Truckee River[1] flows out of Lake Tahoe at Tahoe City with a number of tributaries contributing streamflow upstream of Martis Valley, including Bear, Squaw, Deer, Pole, Silver, and Cabin Creeks. The Truckee River then enters the MVGB near the junction of State Highway 89 and Interstate 80, flows west to east across Martis Valley before exiting the basin near Boca, just upstream of its confluence with the Little Truckee River. Main tributaries within Martis Valley are Donner, Cold[2], Trout, Martis and Prosser Creeks (Figure 2-5). Below Boca, the Truckee River descends into the Truckee Canyon before flowing through Reno and Sparks, Nevada, and terminating at Pyramid Lake.

Streamflow from Lake Tahoe, Donner Lake, Martis Creek, and Prosser Creek is controlled by major dams or impoundments, with the timing of releases and streamflows guided by a number of court decrees, agreements, and regulations that govern the flow rate from California to Nevada. These streamflow rates are known as 'Floriston Rates' and measured at Farad, California just upstream of the State line. The Truckee River is currently operated according to the Truckee River and Reservoir Operations Model (Berris and others, 2001). The Truckee River falls under the jurisdiction of TROA, which is further discussed in Section 3.2.

[1] Definitions of the Upper, Middle, and Lower Truckee River vary among numerous published studies. The definition used in this report of the "Middle Truckee River" definition used in this report conforms to nomenclature used by the California Lahontan Regional Water Quality Control Board, but differs from that used by the U.S. Bureau of Reclamation.

[2] Though it is not a direct tributary to the Truckee River, Cold Creek flows into Donner Creek below Donner Lake, approximately 1.5 miles upstream of the confluence with the Truckee River, and therefore accounts for a significant portion of the unregulated flow into the MVGB.



Martis Figure2_5_Hydrography.mxd

DATE	PROJECT	SITE	
11-2-2012	140691	**Martis Valley Groundwater Basin, California**	**Figure 2-5**
Brown AND Caldwell / Balance Hydrologics, Inc.		TITLE: **Hydrography and long-term monitoring stations**	

Table 2-1 summarizes historical monthly and average annual flow of the Truckee River and its tributaries, and Figure 2-6 correspondingly shows the average monthly streamflow at a number of gaging stations in the Truckee Basin. This data illustrates how the regulation of streamflows in the Truckee Basin alters the timing of discharge. Unregulated streams in this region tend to experience seasonal low flows in the late summer and early fall, with the bulk of total annual runoff occurring as snowmelt in May and June. This pattern is illustrated by monthly streamflow data collected at Sagehen Creek, an unregulated watershed approximately 5 miles north of the MVGB. In contrast, streams in the MVGB tend to have the total annual streamflow more uniformly distributed during the year, due to timed releases from the various impoundments.

Table 2-1. Average Monthly Streamflow on the Truckee River and Select Tributaries

	Sagehen Creek	Donner Creek below Donner Lake	Truckee River near Truckee	Prosser Creek below Prosser Dam	Martis Creek above Martis Dam	Truckee River at Boca	Truckee River at Farad
USGS Station ID	10343500	10338500	10338000	10340500		10344505	10346000
Watershed Size (sq mi)	10.5	14.3	553.0	52.9	37.2	873	932
Period of record	1953-present	1931-present	1945-present	1964-present	1959-1971; 1973-2007	2002-present	1910-present
(cfs)							
Oct	3	30	175	85	11	382	388
Nov	5	27	179	36	14	277	412
Dec	7	30	256	53	20	341	520
Jan	8	33	293	74	29	390	586
Feb	8	32	315	68	34	348	641
Mar	10	38	305	111	47	540	788
Apr	24	52	372	119	57	835	1240
May	43	86	532	190	52	1190	1680
Jun	25	45	457	112	26	900	1240
Jul	7	11	306	63	14	658	659
Aug	3	7	285	52	10	499	515
Sept	3	27	239	102	11	493	473
Mean annual (cfs)	12	35	310	89	27	571	762
Mean annual (ac-ft)	8,772	25,236	224,068	64,252	19,629	413,445	551,542

Source: U.S. Geological Survey; U.S. Army Corps of Engineers

cfs: cubic feet per second

ac-ft: acre-feet

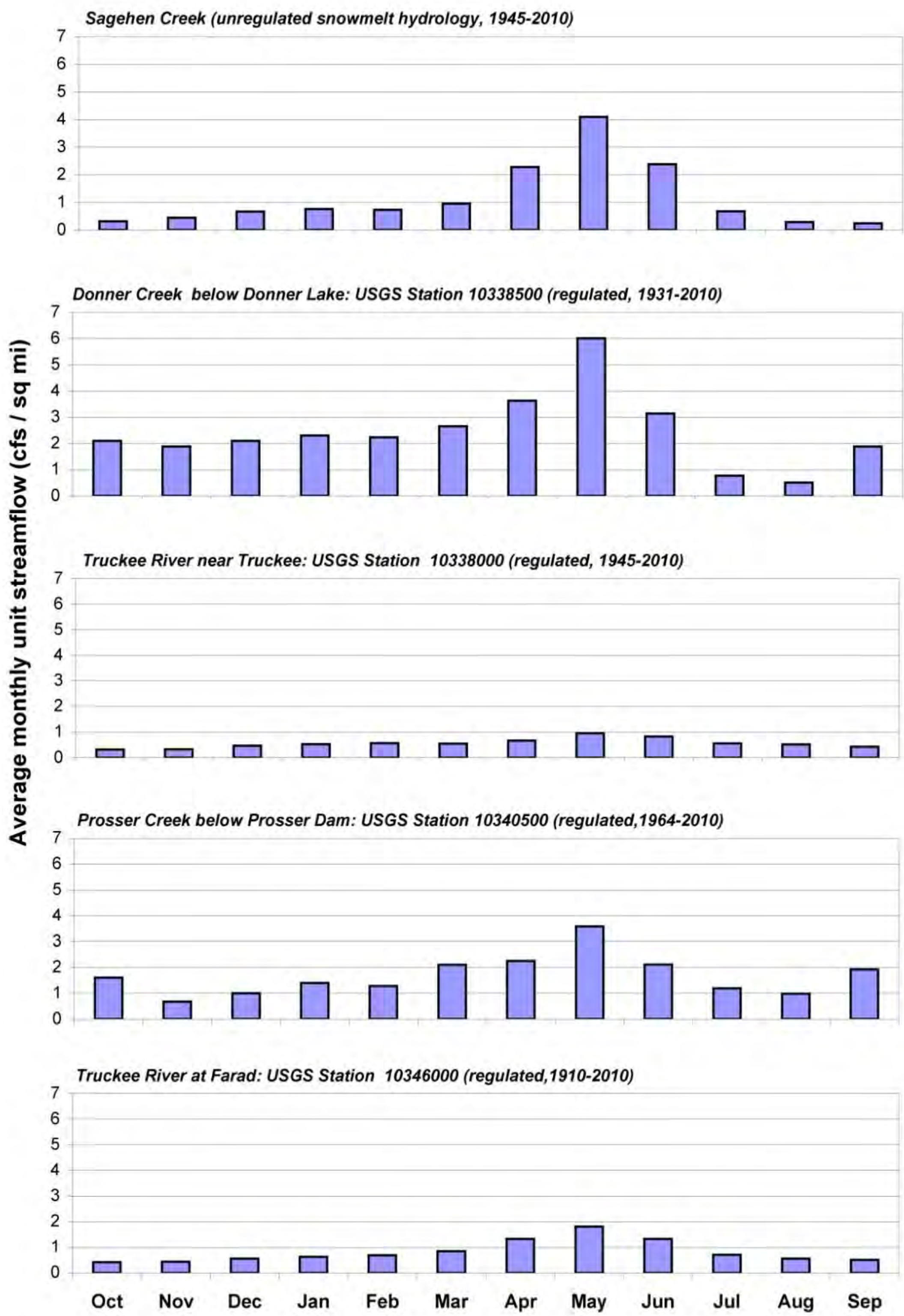


Figure 2-6. Mean Monthly Streamflows in the Middle Truckee River Watershed

2.3.2 Martis Creek

Martis Creek generally flows from south to north in the southern portion of the groundwater basin, with four named tributaries; Martis, West, Middle, and East Martis Creeks comprising the majority of its 42.7 square-mile watershed. Martis Creek Dam was completed in 1972 in order to provide storage for flood control, recreation, and potential water supply (USACE, 1985). Shortly following construction, seepage was observed in the dam face, posing a significant failure risk. As a result, the reservoir has rarely been filled to capacity, and is now maintained at a minimum pool elevation located entirely within the boundaries of the MVGB. The maximum outlet capacity of the dam is 580 cfs prior to spilling and 4,640 cfs at maximum spilling capacity. The United States Army Corps of Engineers (USACE) currently operates the dam in a ‘gates wide open’ position, such that minimal regulation or disruptions in the timing of streamflow occurs under most circumstances.

The United States Geologic Survey (USGS) maintained a streamflow gaging station on Martis Creek between Martis Dam and the Truckee River from October 1959 through September 2010, and recently transferred the gage to the USACE in October 2010. Since Martis Dam was constructed in 1972, this data has been used by the USACE, along with Martis Reservoir water level data and stage-storage information, to develop a record of inflow to Martis Reservoir. Daily reservoir inflow data is available for water years 1972 to 2008, and indicate average annual runoff into and out of the reservoir to be on the order of 19,629 acre-feet (27.1 cfs).

2.3.3 Donner and Cold Creeks

Donner Lake has a watershed area of approximately 14.3 square miles, all of which lies west of the MVGB boundary. The lake discharges into Donner Creek near the western boundary of the groundwater basin, and then flows toward the east and into the Truckee River (Figure 2-5). A dam was constructed at the lake outlet in 1928 (Berris and others, 2001) allowing for a reservoir capacity of 9,500 ac-ft. The Donner Lake dam is operated by the Nevada Energy (formerly Sierra Pacific Power Company), with a typical release season to provide flood control space from September 1 to November 15. The USGS has maintained a streamflow station on Donner Creek below Donner Lake (Station 10338500) since 1931. Average annual streamflow is 25,794 acre-feet (35.9 cfs), and Figure 2-6 illustrates the effect of dam operations on the timing of streamflow during the year.

2.3.3.1 Cold Creek

Cold Creek has a watershed area of approximately 12.5 square miles and flows from Coldstream Canyon into Donner Creek in the western portion of the groundwater basin. The confluence of these streams historically migrated across the Coldstream Canyon alluvial fan, but now both channels area confined by transportation infrastructure and historical aggregate mining operations. Cold Creek is the largest unregulated watershed that flows into the MVGB; with a runoff regime typical of a snowmelt-dominated system, with peak flows in May and June and low flows in the late summer and early fall.

A streamflow gage was installed on Cold Creek by Balance Hydrologics for the Truckee River Watershed Council in October, 2010. Cold Creek is the only significant tributary to Donner Creek between USGS gaging station 10338000 (Donner Creek at Donner Lake) and 10338700 (Donner Creek at Highway 89), therefore, historical streamflow estimates were inferred by calculating the difference in streamflow between these stations. Based on these data, average annual streamflow from Cold Creek is approximately 26,731 ac-ft (36.9 cfs).

2.3.4 Trout Creek

With a watershed area of approximately 5 square miles, Trout Creek is the only other unregulated stream (besides Cold Creek) which flows into the MVGB. The headwaters of Trout Creek are located within the Tahoe-Donner residential subdivision, part of the Town of Truckee and largely within the boundaries of the MVGB. The runoff regime is predominately snow-melt dominated, but with portions of the watershed covered with impervious surfaces such as roads and rooftops, rainfall events result in slightly more runoff and less infiltration and recharge from this watershed compared to others. A streamflow gage on Trout Creek was installed in January 2011 for the Truckee River Watershed Council so long-term streamflow statistics are not available.

2.3.5 Prosser Creek

Prosser Creek's approximately 32 square-mile watershed area includes Alder Creek and lies largely outside the MVGB. Prosser Creek Reservoir however, is entirely within the groundwater basin and is operated by the U.S. Bureau of Reclamation for water supply and flood control. Reservoir releases for flood control typically occur between September 1 and October 31 (Berris and others, 2001), as reflected in the pattern of average monthly flows depicted in Figure 2-6.

2.3.6 Truckee Corridor

The Truckee Corridor includes intervening areas that do not drain to the tributaries mentioned above. This includes the Union Creek subwatershed, which encompasses much of the Glenshire subdivision in the eastern portion of the MVGB, as well as urban and open space areas within the Town of Truckee.

2.3.7 Other impoundments

A number of small impoundments are located within the boundaries of the MVGB, including Union Mills Pond in the Glenshire subdivision, Dry Lake adjacent to the Waddle Ranch Preserve, and Gooseneck Reservoir, near the Lahontan Golf Club. Though originally constructed for cattle-grazing and/or millpond operations, these impoundments are now managed primarily for open space, recreational/aesthetic, or wildlife purposes.

2.4 Geology

The Martis Valley is located in the Sierra Nevada physiographic region, which is composed primarily of igneous and metamorphic rocks, with sedimentary rocks in its valleys. The MVGB's complex geology is dominated by sedimentary deposits left by glaciations, volcanic rocks, and faulting. A component of the Martis GMP was the development of geologic cross-sections to improve the understanding of MVGB geology and stratigraphy.

2.4.1 Geologic Database Development

Approximately 200 well logs obtained from the DWR, TDPUD, PCWA, NCSD, and the Tahoe-Truckee Sanitation Agency (T-TSA) were interpreted to better understand depths and thicknesses of the various geologic formations comprising the MVGB. The filtered geologic and selected well data were entered into an ESRI ArcGIS Geodatabase, a spatially-referenced database. The benefit of the Geodatabase allowed a visual representation of the geologic data and was also used as the geologic framework for the DRI groundwater model that provides consistency between the GMP geologic interpretation and the groundwater model.

The geochronology and stratigraphic relationships of water-bearing formations was based on Birkeland's (1961; 1963; 1964) work, as well as subsequent investigations by Latham (1985), and Hydro-Search (1995), and mapping published by Saucedo (2005) and Melody (2009). The stratigraphic relationships, lithologies, and formation locations described in these studies, as well as through field observations, formed the basis for the designation of the primary hydrostratigraphic units, as displayed in Figure 2-7. Figure 2-8 shows the approximate locations of wells used to develop the geologic database.

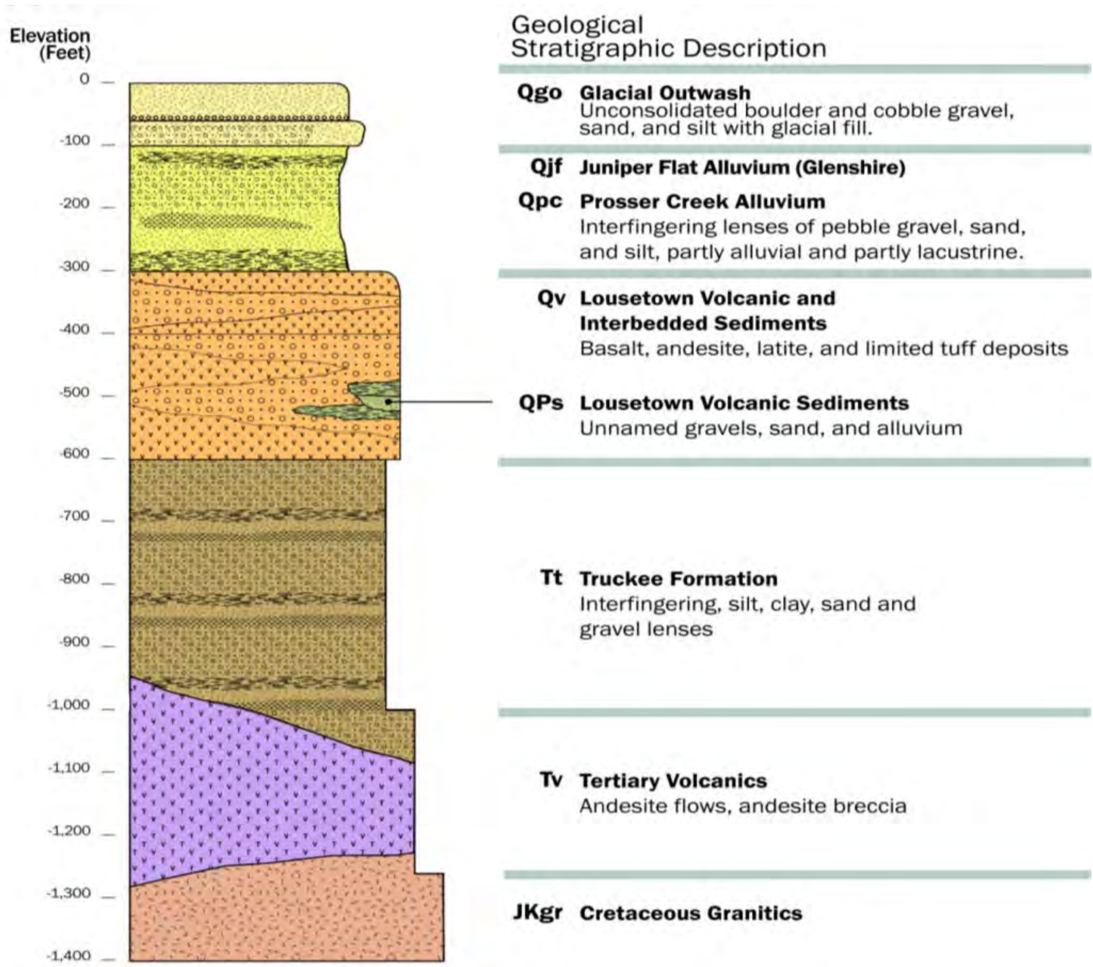
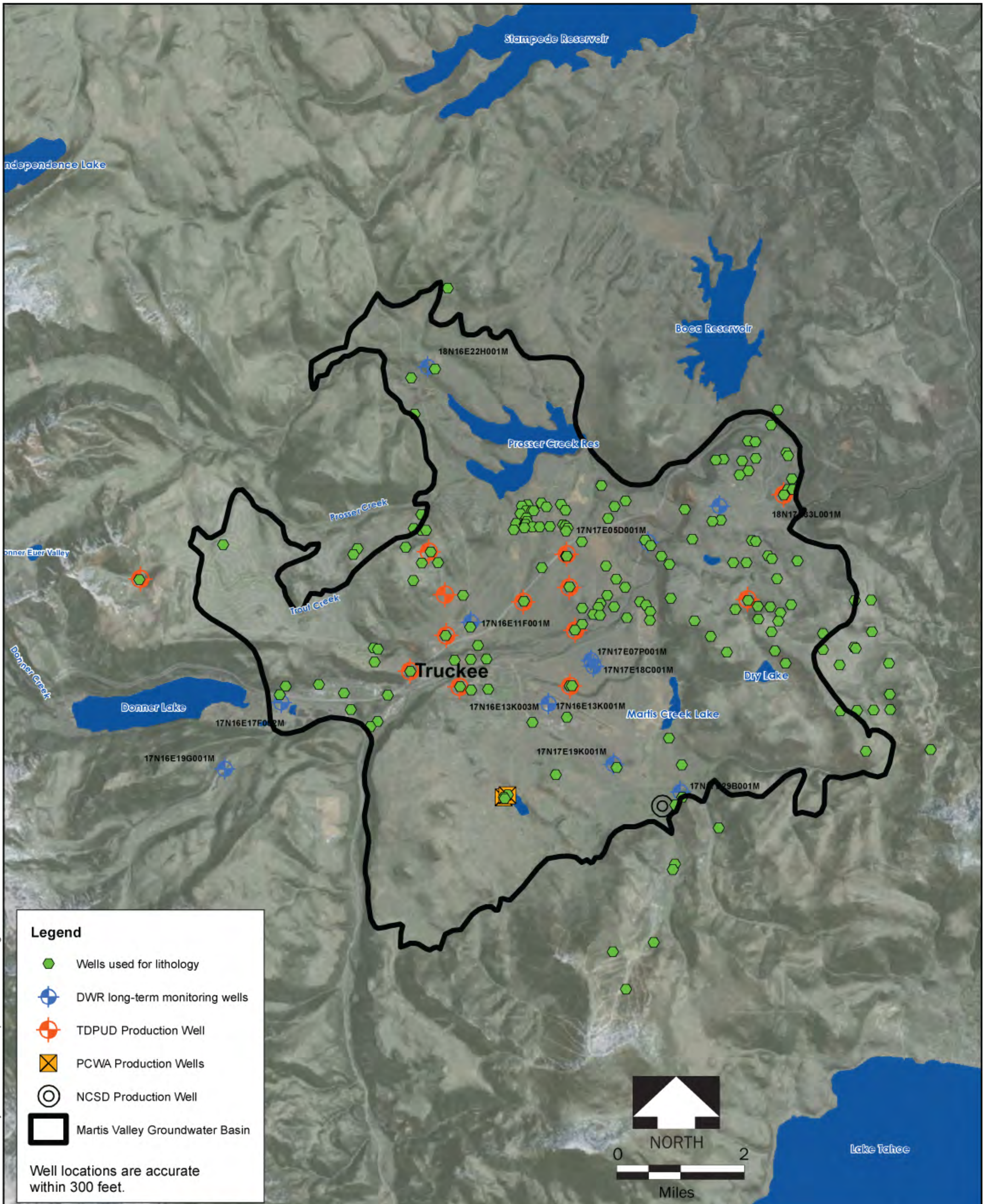


Figure 2-7. Stratigraphic Column showing Primary Hydrostratigraphic Units

Stratigraphic interpretations shown in Figure 2-7 and in Section 2.4.3 (below) are consistent with published geologic maps of the basin (Birkeland, 1961; Birkeland, 1963; Saucedo, 2005; Melody, 2009), and delineate four primary water-bearing stratigraphic units that make up the aquifer, and underlying rocks that are considered to be relatively water-limited (see Figure 2-9). The primary units shown in Figure 2-7 include a number of subunits mapped by previous investigators and shown on Figure 2-9 and noted in parenthesis with the descriptions below. When available, information regarding potentially confining (fine grained) or water-bearing (coarse) subunits are also delineated. Following well log interpretation, three representative geologic cross-sections were located and developed. Figure 2-9 shows the cross-section locations; Figure 2-10 shows cross-section A-A'; Figure 2-11 shows cross-section B-B', and Figure 2-12 shows cross-section C-C'.

It should be noted that Figure 2-9, a geologic map of the MVGB and surrounding areas, is based on published geologic mapping by Saucedo (2005), Melody (2009), and Saucedo and Wagner (1992). The Saucedo and Wagner (2009) mapping was completed at a statewide scale and is therefore, less precise than other portions of the map and geological cross-sections. Accordingly, portions of the geologic map in Figure 2-9 do not correspond to the more detailed geological mapping and cross-sections.



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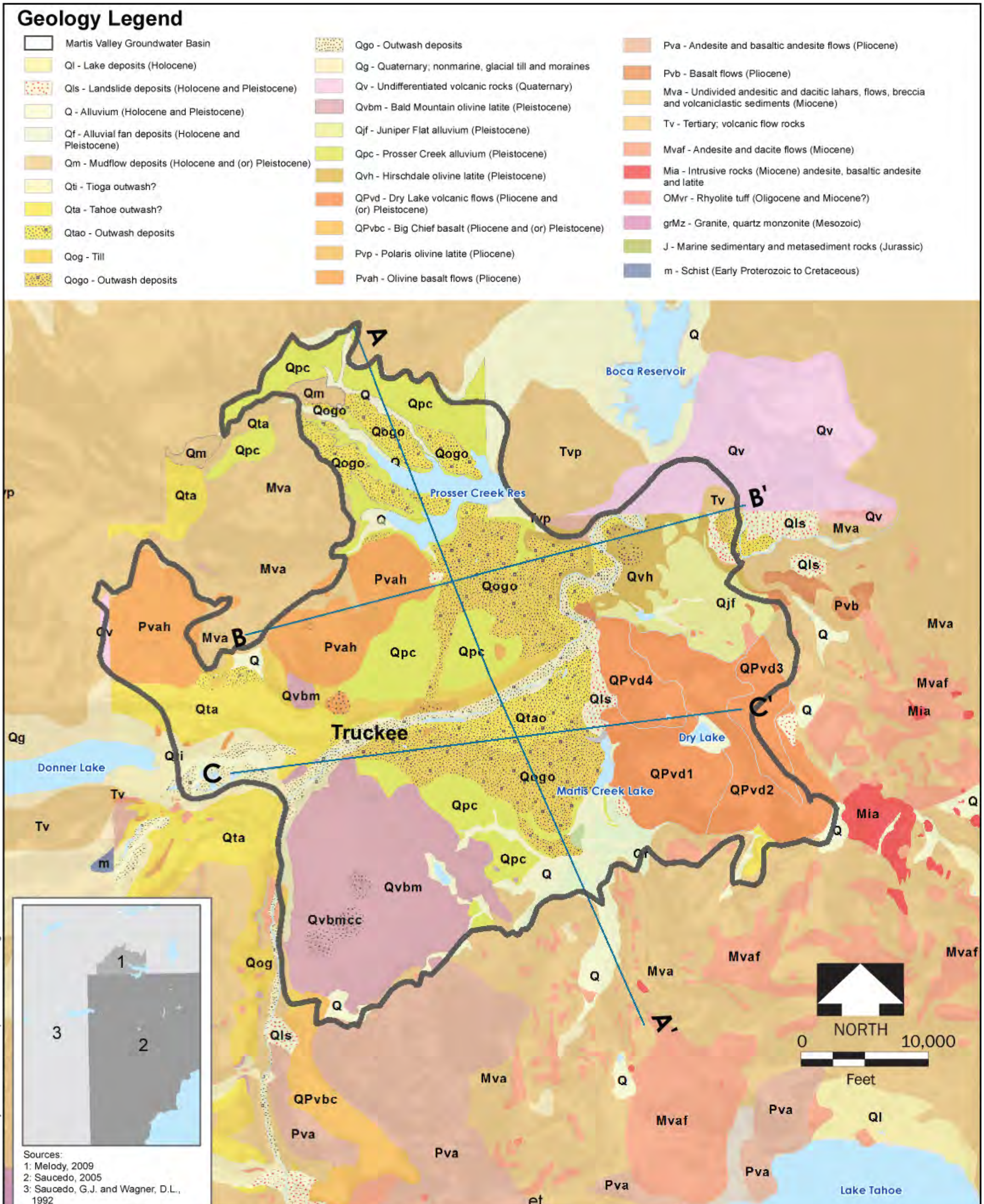
DATE	PROJECT	SITE	
9-7-12	140691	Martis Valley Groundwater Basin, California	Figure 2-8
Brown AND Caldwell / Balance Hydrologics, Inc.		TITLE: Well Locations	



DATE	PROJECT	SITE
9-19-12	140691	Martis Valley Groundwater Basin, California

Brown and Caldwell

Balance Hydrologics, Inc.

TITLE

Geology and Cross-section Locations

Figure 2-9

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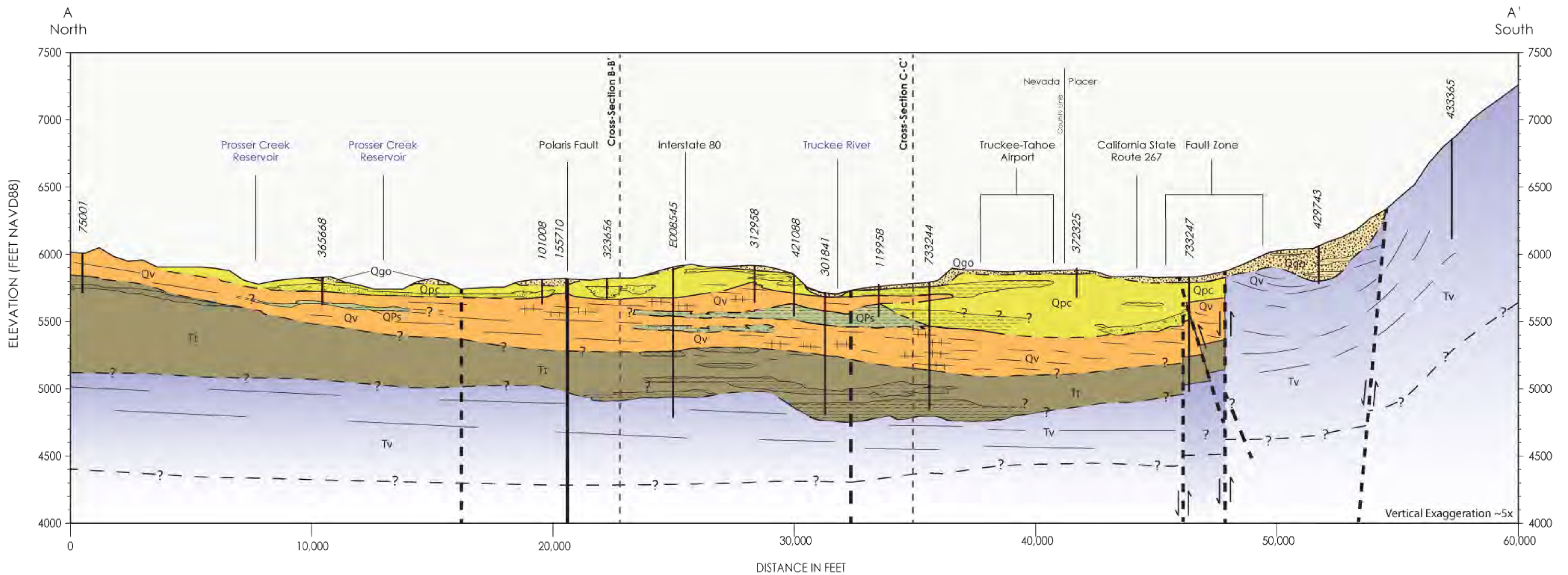

NOTES:
1. Approximate vertical exaggeration = 5x.
2. Elevation profile developed from 30-meter digital elevation model, downloaded from National Elevation Dataset (http://seamless.usgs.gov/index.php).
3. Well log locations are approximate within 600 feet.
4. Fault locations are approximate, based on Saucedo, "Geologic Map of Lake Tahoe Basin," 2005 and Hunter and others, 2011.
5. Surficial geology inferred from Saucedo, 2005.
6. Significant sand, gravel, and clay beds shown where noted in well logs.
7. Fracture zones shown where noted in well logs.

References:
Birkeland, P.W., 1963 Pleistocene History of the Truckee area, north of Lake Tahoe, California, Geological Society of America Bulletin, v. 64, p. 1453-1464.
Hunter, L.E., Howle, J.F., Rose, R.S., and Bawden, G.W., 2011, LiDAR – assisted identification of an active fault near Truckee, California, Bulletin of the Seismological Society of America, v. 101, n. 3, p. 1162-1181.
Latham, T.S., 1985, Stratigraphy, structure, and geochemistry of Plio-Pleistocene volcanic rocks of the western Basin and Range Province, near Truckee, California, unpublished doctoral dissertation, University of California, Davis, 341 p.
Melody, A., 2009, Active faulting and Quaternary paleohydrology of the Truckee Fault Zone north of Truckee, California, MS Thesis, Humboldt State University, Humboldt, CA 71 p.
Saucedo, G.J., 2005, Geologic Map of Lake Tahoe Basin, California and Nevada, California Geological Survey Regional Geologic Map Series, Map No. 4, 1:100,000 scale.

Legend

- Qg — Glacial Till/Moraine
- Qgo — Glacial Outwash deposits
- Qpc — Prosser Creek alluvium (Pleistocene)
- Qv — Lousetown Volcanics (Pleistocene)
- QPs — Lousetown Interbedded Sediments (Unnamed gravels, sand and alluvium) (Pliocene and (or) Pleistocene)
- Tt — Truckee Formation (Lake and Stream Deposits)
- Tv — Tertiary Volcanics
- Sands and Gravels
- Clay Bed
- Tuff/Ash
- Interbedded Basalt and Andesite Basalt
- Fracture Zone
- Lithologic Contact
- — ? — Inferred Lithologic Contact
- Fault, direction of displacement (dashed where inferred)
- 429743 Well log

SITE
Martis Valley Groundwater Basin, California

TITLE
Cross-section A-A'

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PROJECT 140691

Figure 2-10

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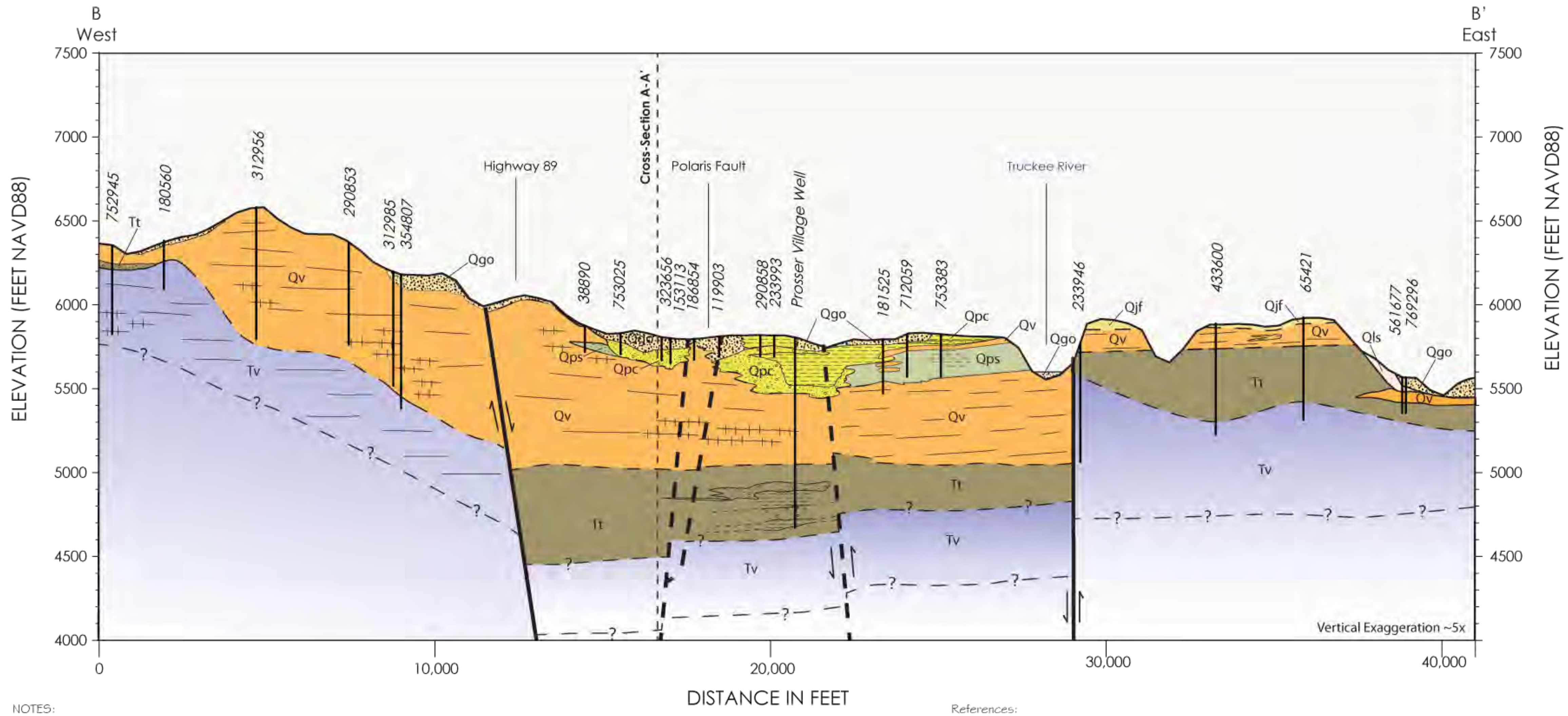
Source: ©2011 Balance Hydrologics, Inc.



NOTES:
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- Qls — Landslide deposits
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- Qpc — Prosser Creek alluvium (Pleistocene)
- Qv — Lousetown Volcanics (Pleistocene)
- QPs — Lousetown Interbedded Sediments (Unnamed gravels, sand and alluvium) (Pliocene and (or) Pleistocene)
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- Fracture Zone
- Lithologic Contact
- — ? — Inferred Lithologic Contact
- Fault, direction of displacement (dashed where inferred)
- 429743 — Well log

Source: ©2011 Balance Hydrologics, Inc.

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SITE
Martis Valley Groundwater Basin, California

TITLE
Cross-section B-B'

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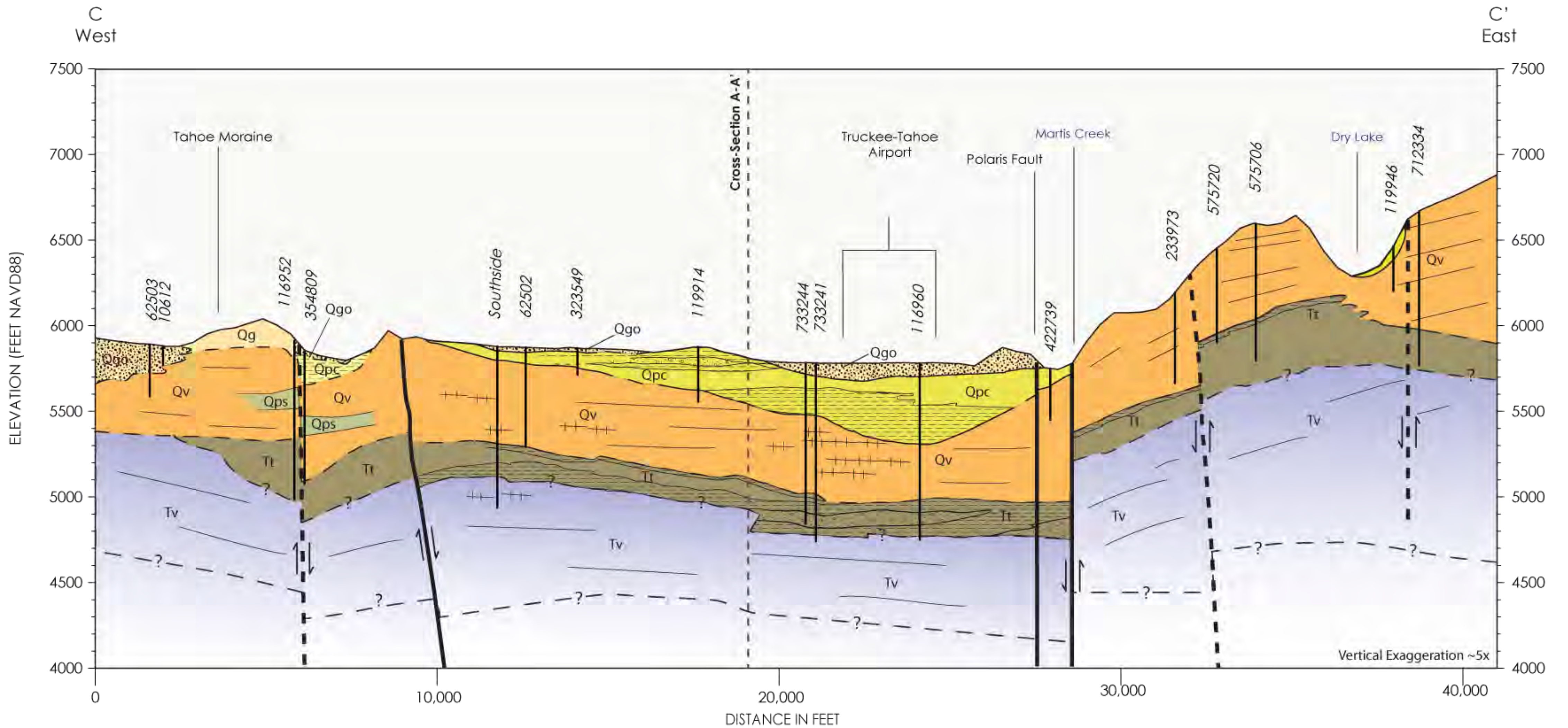
Figure 2-11



NOTES:

1. Approximate vertical exaggeration = 5x.
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- Tv — Tertiary Volcanics
- Sands and Gravels
- Clay Bed
- Tuff/Ash
- Interbedded Basalt and Andesite Basalt
- Fracture Zone
- Lithologic Contact
- —?— Inferred Lithologic Contact
- Fault, direction of displacement (dashed where inferred)
- 429743 Well log

SITE
Martis Valley Groundwater Basin, California

TITLE
Cross-section C-C'

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PROJECT 140691

Figure 2-12

2.4.2 Stratigraphy

The uplift along the faults that created the MVGB probably began during the late Pliocene and into the early Pleistocene, with relatively low-permeability Tertiary volcanics forming the bottom of the basin (considered basement rocks in this report). Prior to and throughout the middle Pliocene, the sedimentary material of the Truckee Formation was deposited in the MVGB, directly overlying andesite tuff breccias, andesite flows, and intrusive rocks of Tertiary age. Following deformation, the general topography of the Martis Valley was probably somewhat similar to today's topography (Birkeland, 1963), with the Truckee River flowing out of the MVGB near where it does today, cutting a canyon through the pre-Pleistocene rocks of the Carson Range.

During the Pleistocene, a series of volcanic flows occurred in the regional Truckee area. At least 20 distinct flows have been recognized (Birkeland, 1961), mostly (but not exclusively) consisting of fine-grained latites and basalts, and are noted as being fairly local in extent. Flows found in the MVGB include the Dry Lake Flows (QPvd), the Bald Mountain olivine latite (Qvbm), Alder Hill Basalt, Polaris olivine latite, and Hirschdale olivine latite. Collectively, these units are referred to as Lousetown volcanics (Qv) based on Birkeland's (1963) correlation to other Lousetown flows in the Carson Range. Also included within the in the Lousetown Formation are interbedded Lousetown sediments (Qps); fluvial (stream) and lacustrine (lake) deposits accumulating, and thereby raising land surface elevation, in the valley between flow events.

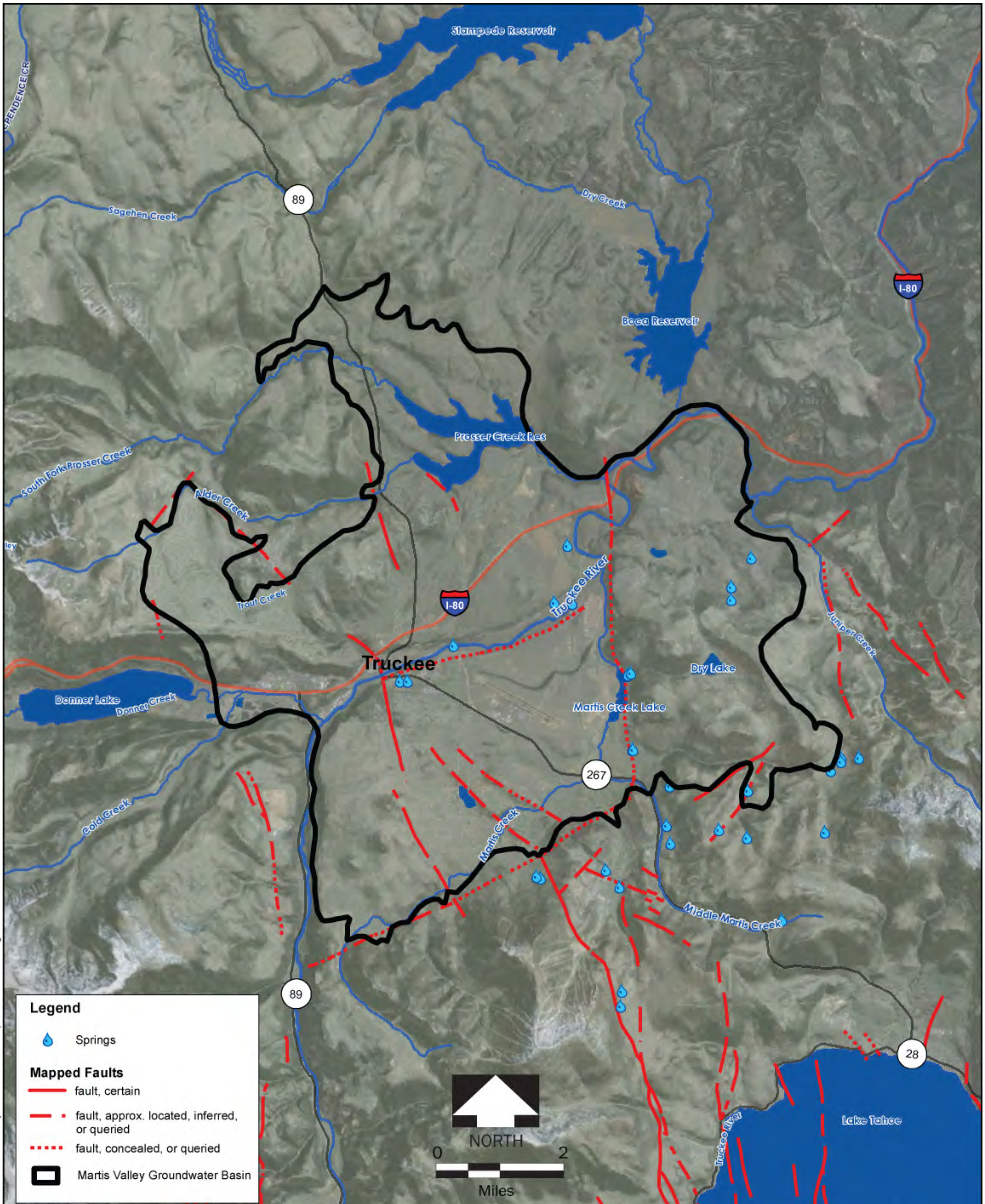
As volcanic activity waned, one of the last flows, the Hirschdale Olivine Latite, flowed across the Truckee River Canyon, damming the basin and causing widespread sediment accumulation and deposition of the Prosser Formation (Qpc), a partly-lacustrine and partly fluvial sedimentary unit (Birkeland, 1963). Brown (2010) has subdivided the Prosser Formation into Upper, Middle, and Lower Members. For geodatabase development purposes, interbedded Lousetown sediments are defined as being capped by volcanics, while the Prosser Formation is not. It is recognized however, that the lower Prosser Formation may have been deposited concurrently with the interbedded Lousetown sediments, and in some cases, may be correlated to these upper sediments where capping volcanics pinch out laterally.

During this same period, Juniper Flat alluvium was being deposited in the Glenshire area with sediment derived from the paleo-Juniper Creek watershed and alluvium derived from the west.

The Prosser Formation and volcanics in other areas are capped by glacial deposits, derived from glacial advances and retreats during a number of glacial episodes (Birkeland, 1961). In the MVGB, most of the deposits consist of glacial outwash deposits of varying age (Qgo). The outwash deposits consist of loose and unconsolidated boulder, cobble, gravel, and sand. In the vicinity of the Truckee River, three distinct outwash deposits (Qogo, Qtao, and Qti) are apparent and form terraces along the course of the river (Birkeland, 1961). A number of glacial moraines were also deposited, and are visible today in the vicinity of Donner Lake, the Tahoe-Donner residential neighborhood, and the Gateway Neighborhood of Truckee.

2.4.3 Structure

The MVGB lies within the Truckee Basin, a structural trough formed at the boundary of the Sierra Nevada and Basin and Range Geomorphic Provinces. Tectonics in this zone are complex and include active right-lateral (strike-slip) shear associated with the Pacific-North American Plate boundary and North Walker Lane Belt, as well as extensional (normal) faulting associated with the Basin and Range Province. The uplift along the faults that created the basin probably began during the late Pliocene and into the early Pleistocene (Birkeland, 1963), while right-lateral faulting is inferred to have occurred into the Holocene (Melody, 2009; Brown, 2010; Hunter and others, 2011). Most recently, the Polaris Fault has been mapped as an active North-South Holocene fault across the center of the MVGB. Identified faults are shown in Figure 2-13.



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DATE	PROJECT	SITE	
9-7-12	140691	Martis Valley Groundwater Basin, California	Figure 2-13
Brown and Caldwell / Balance Hydrologics, Inc.		TITLE: Locations of Springs and Mapped Faults (active and inferred)	

2.5 Groundwater Occurrence and Movement

The geologic units described above are interlayered, with complex spatial relationships, and as such, the occurrence and movement of groundwater within and between these units is variable. For this report, the low-permeability Miocene (Tertiary) volcanic rocks are considered the bottom of the MVGB. This section discusses where groundwater occurs, groundwater and surface water interaction, and water levels over time.

2.5.1 Water-bearing Units and Properties

The Truckee Formation (Tt) is composed of interlayered silts, sands, and clays, and therefore has variable groundwater availability. Well driller's logs document sands and gravels within the Truckee Formation in the center of the basin, near the Truckee Tahoe Airport, at depths of approximately 900 to 1,000 feet, and from 200 to 700 feet in the southern portion of the basin near Shaffer's Mill and Lahontan Golf Clubs. Well yields in the Truckee Formation range from 280 gallons per minute (gpm) in the eastern portion of the basin (Hydro-Search, 1995) to more than 1,000 gpm in faulted areas underlying the Bald Mountain volcanics in the southwestern portions of the MVGB (Herzog, 2001).

Water is found along faults and fractures within the Lousetown volcanics (Qv), though portions of the volcanic flows are massive and unfractured. Figure 2-14a is a photo of a Lousetown volcanic outcrop and illustrates the range of fracture concentrations that can occur in this unit. In most cases, water encountered in this fractured system is pressurized, rising to a static level several hundred feet higher than where initially encountered, suggesting the presence of confining units above these fracture zones.

Wells located in the southern portion of the groundwater basin have been found to be artesian, or flowing, along fractures interpreted as faults (Herzog and Whitford, 2001), with yields ranging from approximately 250 to 1,000 gpm. A number of distinct fault blocks are present in this area, with unique and heterogeneous aquifer properties where faults serve as barriers to groundwater flow (ECO:LOGIC, 2006; ECO:LOGIC, 2007; Bugenig, 2007; Bugenig, 2006; Peck and Herzog, 2008). Groundwater discharge areas in the form of seeps and springs are also found within these areas and along the periphery of the MVGB (Figure 2-13), including thermal springs in the vicinity of the recently-mapped Polaris Fault (Hunter and others, 2011).

The Prosser Formation (Qpc) includes interlayered silts, sands, and clays and has variable water bearing capacity. Figure 2-14b shows an outcrop of the Prosser Formation, where coarser materials such as sand and gravel are present, and moderate groundwater yields may be encountered. Water-bearing portions of the Prosser Formation may also be hydrologically connected to overlying glacial outwash and potentially surface water bodies as well. Well yields in these alluvial formations typically range from 12 to 100 gpm, though larger-diameter production wells have estimated yields as high as 500 gpm according to State well driller's logs.

Hydraulic properties of the glacial moraines contrast sharply with those of the glacial outwash deposits; the moraines consist of poorly-sorted clay to boulder-size materials, while the glacial outwash deposits are primarily well-sorted sands and gravels. As a result, the glacial outwash tends to transmit water relatively easily, while moraines are typically water-limited.

Figure 2-14a. Lousetown Volcanic Outcrop

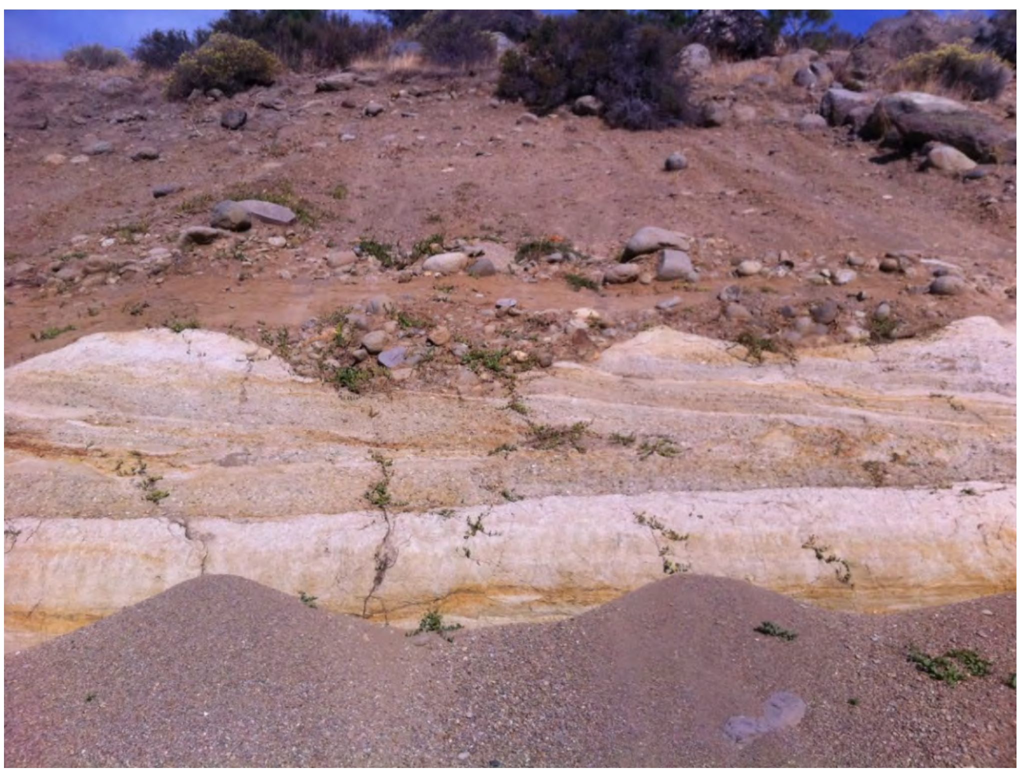


Figure 2-14b. Prosser Formation Outcrop Underlying Glacial Outwash

2.5.2 Surface-groundwater interaction

Generalized groundwater flow directions were inferred by Hydro-Search (1995) and were based on static water levels reported in State well drillers reports and DWR's long-term well monitoring data, and indicated groundwater flow directions toward the Truckee River.

A more detailed surface water and groundwater interaction study (Interflow Hydrology, 2003) was completed for the TDPUD. The Interflow Hydrology study provides estimates of the magnitude of stream losses and gains to and from groundwater across the Martis Valley during summer 2002, in the middle of a multi-year dry period. Observations made during the course of the study showed Martis Creek to be a 'gaining stream' (receiving groundwater discharge) across the Lahontan Golf Club, upstream of Martis Valley; West Martis Creek was found to be a 'losing stream' as it enters Martis Valley, recharging groundwater between the Northstar Golf Course and its confluence with Martis Creek; and Middle Martis Creek showed no loss or gain across the valley floor. Groundwater discharge in the form of springs generally support perennial flows in Lower East Martis and Dry Lake Creeks, as well as from the hillside adjacent to Martis Reservoir.

Interflow Hydrology (2003) computed a basic water balance based on late season low flow measurements in the watershed and found that in October 2002, total streamflow losses across the Martis Valley floor were on the order of 0.65 cfs (approximately 9 percent of the total baseflow into the MVGB from Martis Creek), while losses at Martis Creek Lake were on the order of 1.55 cfs (approximately 29 percent of the total flow at that point). Evaporation and evapotranspiration by plants were not measured as part of the study; however, these data suggest that the Martis Valley floor potentially serves as a groundwater recharge area during the late summer and fall months.

In addition, Interflow Hydrology (2003) identified groundwater recharge occurring where Prosser Creek enters the MVGB, just upstream of Prosser Reservoir. All other tributaries, including Cold, Donner, and Trout Creeks were concluded to be supported by groundwater discharge.

2.5.3 Groundwater levels and Land Subsidence

Groundwater levels have been generally stable in the Martis Valley with some declines occurring in specific regions. Figure 2-15 presents groundwater level monitoring data throughout much of the MVGB as measured by DWR since 1990 in a single set of hydrographs. This graph shows that overall groundwater levels have been stable in the MVGB, including during the drought of the early 1990s, and the wet years of the late 1990s.

Figure 2-16 shows the locations of the 16 DWR monitoring wells and selected respective hydrographs. The hydrographs indicate that groundwater is locally variable in the MVGB, as levels may decline in some wells and rise in other wells over the same period of time. These data suggest that there may be several water-bearing zones in the MVGB that may or not be hydraulically connected. The hydrographs also provides the following well specific information:

- Well 17N16E11F001M (northeast of downtown Truckee) experienced a nearly 50-foot rise in water level in the late 1990s, and then declined steadily over the following decade. This rise coincides with above-average precipitation and streamflow (Figure 2-4).
- Levels in Well 17N17E29B001M (Northstar) and 17N17E19K001M (Truckee Airport) were relatively steady throughout the monitoring period until summer 2007, when seasonal fluctuations began to occur. Water levels have declined seven feet between 2007 and 2012.
- Groundwater levels in well 17N17E05D001M (Truckee River east of Truckee) have increased steadily over the period of record, rising over 10 feet from 1990 to 2012.
- In well 17N1E17F002M (Donner Creek area), groundwater levels fluctuated seasonally but generally remained constant year to year).

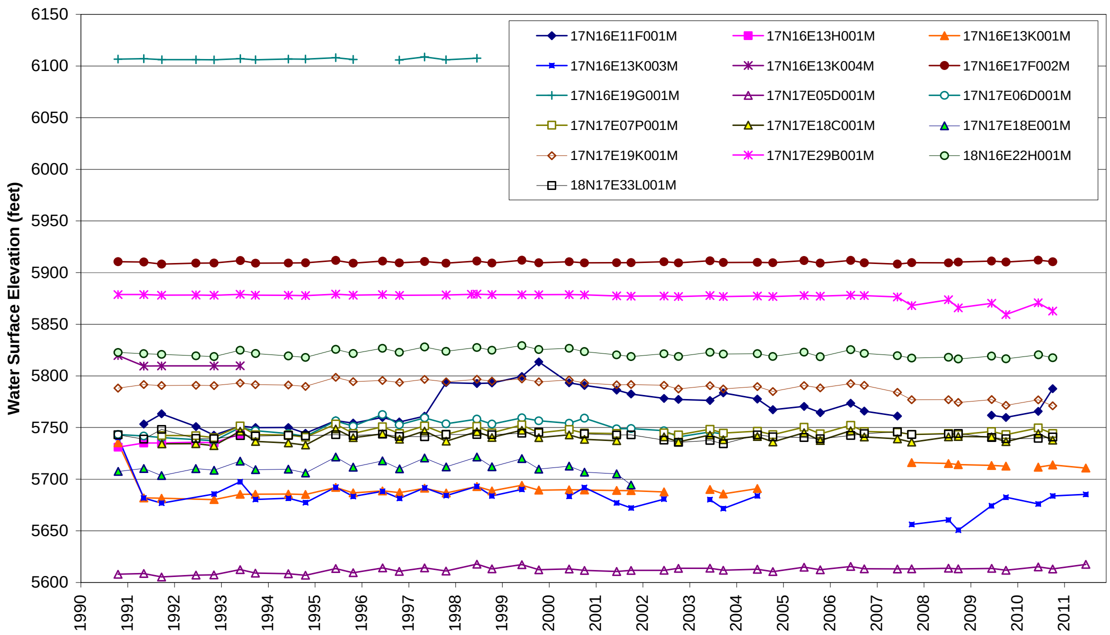


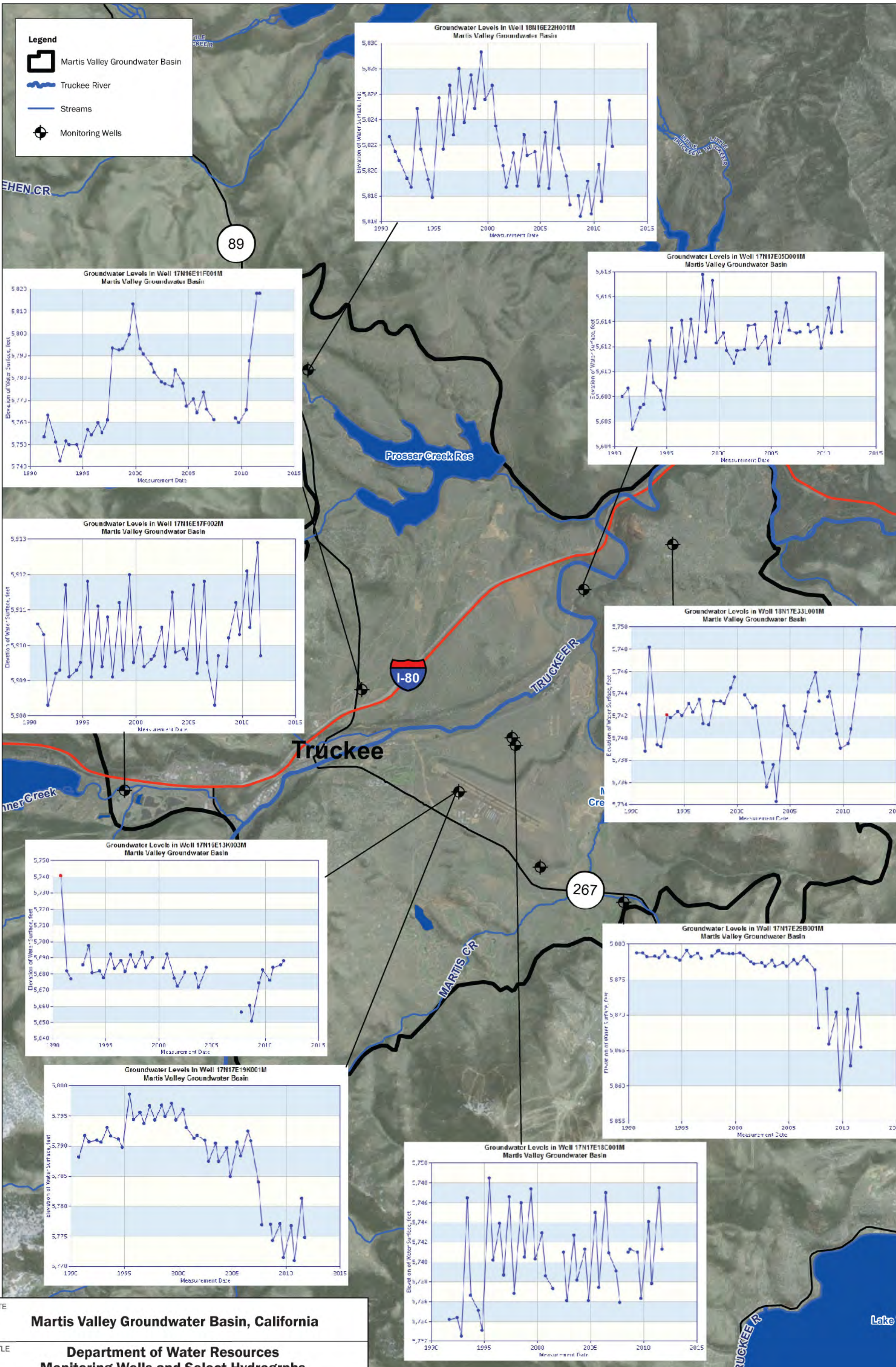
Figure 2-15. Water Levels in DWR Long-term Groundwater Monitoring Wells

2.5.3.1 Land Subsidence

Permanent land subsidence can occur when groundwater is removed by pumpage or drainage due to irreversible compression of aquitard materials. Limited data on land subsidence within the MVGB is available, but no indications of land subsidence have been reported in the documents reviewed as part of this evaluation.

2.6 Groundwater Well Infrastructure

The three partner agencies, hundreds of domestic pumpers, and a number of golf courses rely on the MVGB for drinking water and irrigation supplies. The TDPUD provides water service to portions of the Town of Truckee and adjacent unincorporated areas of Nevada and Placer Counties. The TDPUD currently has 13 active production wells for potable water service, plus 3 wells to serve non-potable water demands. PCWA's Eastern Water System (Zone 4) currently includes two production wells, Lahontan Well #1 and Lahontan Well #2, to serve the Lahontan Golf Club, Shaffer's Mill Golf Club, Hopkins Ranch, and Martis Camp Residences. PCWA is planning to develop a third permanent groundwater production well to serve planned development in and around the existing communities, including Shaffer's Mill Golf Club (Tully and Young, 2011). NCSD supplies water to residents and guests in the Northstar community, producing water from one production well (TH-2) with an estimated yield of 800 gpm. NCSD is currently working to bring a second well (TH-1) online during summer 2012 with a similar anticipated yield. Table 2-2 summarizes the estimated yields and production rates associated with these wells.



SITE

Martis Valley Groundwater Basin, California

TITLE

Department of Water Resources
Monitoring Wells and Select Hydrogrphs

Brown AND Caldwell

DATE 9-7-12

PROJECT 140691

Figure 2-16

Source:?

Table 2-2. Estimated Yield of Public Agency Production Wells[a]	
Well Name	Estimated Maximum Yield (gpm)
NCSD	
TH-2	800
TH-1 (anticipated in 2012)	800 (estimated)
PCWA	
Lahontan Well 1	1,400
Lahontan Well 2	1,400
TDPUD	
A Well	160
Airport	2,140
Prosser Annex	460
Glenshire Drive	1,725
Martis Valley No. 1	1,585
Northside	575
Southside No. 2	200
Southside No. 1 (non-potable)	N/A
Sanders	290
Old Greenwood	870
Hirschdale	35
Prosser Heights	360
Prosser Village	800
Well No. 20	540
Fibreboard (non-potable)	N/A
Donner Creek (non-potable)	N/A

[a] *Well Yield information provided by NCSD, PCWA (Tully and Young, 2011), and TDPUD (Kaufman, 2011)*

A number of private wells are distributed across the basin, and a number of residential neighborhoods or tracts have relatively higher concentrations of wells. Martis Camp operates 2 irrigation wells for their own use and provides Northstar with water from these wells for snowmaking and irrigation purposes as well (Josh Detweiller, NCSD, pers. comm.). At higher elevations in the eastern portion of the basin, the Juniper Hills area includes a number of estates, most of which rely on private wells drilled deep (typically 500 to 800 feet) into uplifted Lousetown volcanics and/or deeper volcanics. In the center of the MVGB, a high density of relatively shallow (200 to 300 feet deep) private wells have been drilled and are in use along Prosser Dam Road. Many of these are drilled into shallow Lousetown volcanics, while others are drilled into glacial outwash and the Prosser Formation. In the northwestern portion of the MVGB a number of homes located on Alder Hill have domestic wells drilled primarily into uplifted Lousetown volcanics and range in depth from 300 to 800 feet.

Figure 2-17 is a cumulative frequency plot derived from DWR data, and shows the number of public and domestic wells drilled at various depths in the MVGB. These data show that the vast majority of domestic wells drilled in the area are relatively shallow, with 50% of domestic wells being installed at depths of 300 feet below ground surface or less, while the public production wells range widely in depth.

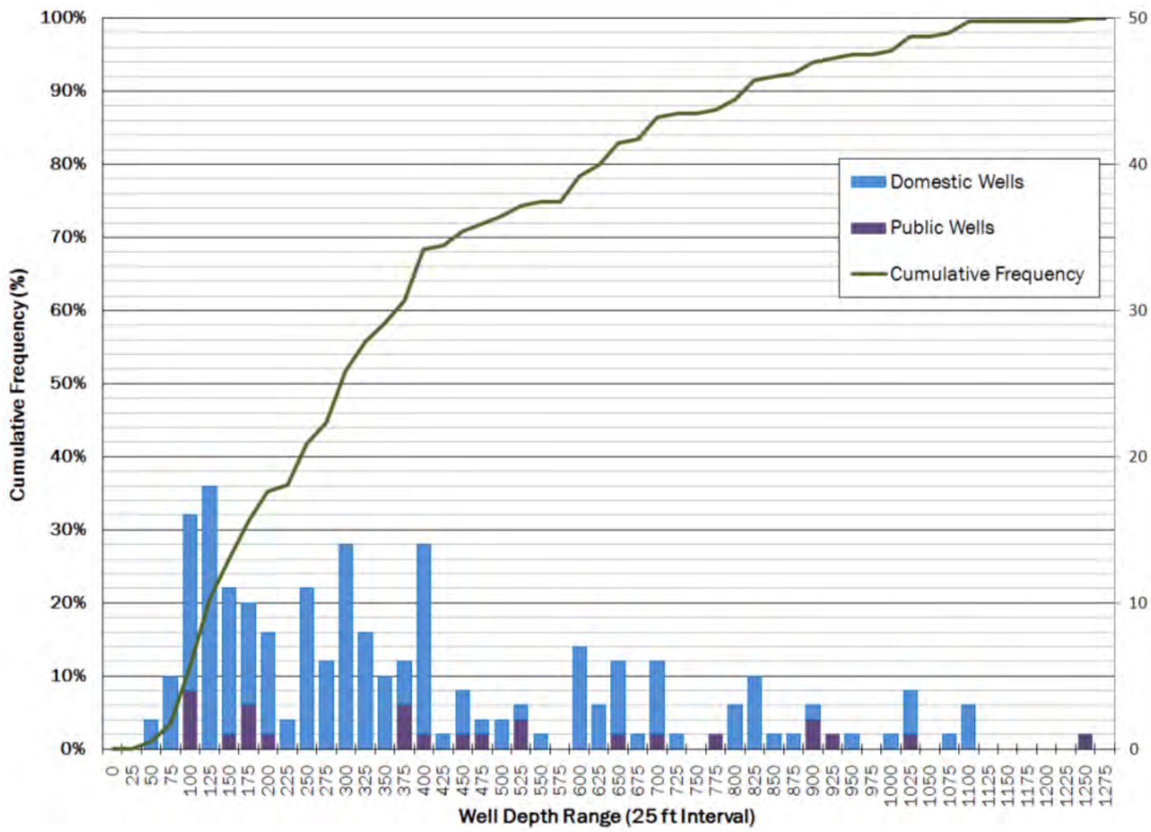


Figure 2-17. Depth Distribution of Wells in the Martis Valley Groundwater Basin

2.7 Groundwater Quality

Groundwater quality in the MVGB is generally of good quality and is currently monitored as part of the agencies' agreements with DPH. Each agency releases an annual water quality report for their service areas in the MVGB; the 2011 annual reports are included in Appendix E. The USGS carried out groundwater monitoring activities in the MVGB in cooperation with the California State Water Resources Control Board (SWRCB) as part of the California Groundwater Ambient Monitoring and Assessment (GAMA) Program (Fram and others, 2007), and sampled 14 wells in the MVGB for a wide range of constituents during summer 2007. The concentrations of most constituents detected in these samples were below drinking-water thresholds, with some exceptions: a) concentrations of arsenic were above the Maximum Contaminant Level (MCL) in 4 of the 14 wells sampled, and b) manganese concentrations were elevated above the MCL in one well. Arsenic levels above the MCL have also been reported by the TDPUD.

The T-TSA operates a water reclamation plant which includes the discharge of tertiary-treated effluent into glacial outwash and Prosser Formation alluvium downstream of the Town of Truckee on the south side of the Truckee River. Hydrogeologic investigations in the vicinity of the plant indicate that effluent flows laterally toward the Truckee River and Martis Creek, discharging to these water bodies after a minimum 50 day travel time (CH2MHill, 1974). DWR (2003) noted that a water quality monitoring program is in place to evaluate potential changes to ground- and surface-water quality.

Sixty-three leaking underground storage tank (LUST) cleanup sites have been identified by the SWRCB's GeoTracker database in the MVGB. Of these 63 sites, cleanup actions for 49 are documented as "completed", while 14 are listed as "open" or "active." All the sites are located in the Town of Truckee, except for one active site in Hirschdale.

2.8 Land Use

Prior to the 1950s, land use in Martis Valley and the Truckee area was primarily ranching and timber related (Shaw and others, 2012). During the 1950s, 60s, and 70s, the rural ranching- and timber-based economy began shifting to more recreational and community development. Today, the primary land uses in the MVGB are residential and ski and/or golf resort related communities with commercial centers in and near downtown Truckee and at the Truckee Airport. Timber and sand and gravel mining operations still continue to operate on a seasonal basis (Shaw and others, 2012).

2.9 Groundwater Recharge

Several previous studies estimated groundwater recharge within the MVGB using water balance and empirical data, resulting in a range from 18,000 to 34,560 acre-feet per year. Recently, DRI has developed annual groundwater recharge estimates using the physically-based PRMS. Table 2-3 summarizes previous and current studies including the study's author, year, and average annual groundwater recharge estimates.

Table 2-3. Summary of Average Annual Groundwater Recharge Estimates for the MVGB

Author	Year	Recharge (ac-ft/yr)
Hydro-Search	1974, 1980, 1995	18,000
Nimbus Engineers	2001	24,700
Kennedy/Jenks Consultants	2001	none
Interflow Hydrology, Inc. and Cordilleran Hydrology, Inc	2003	34,560
DRI, PRMS estimate DRI, modified Maxey-Eakin method	2012	32,745 35,168

DRI outlines its scientific and technical methods, including the climate data used, the PRMS method, and total recharge estimates in a Technical Note, which is included in Appendix F. PRMS simulates land surface hydrologic processes of evapotranspiration, runoff, infiltration, and interflow by balancing energy and mass budgets of the plant canopy, snowpack, and soil zone on the basis of distributed climate information. The PRMS computed recharge consists of the sum of shallow infiltrated water that discharges into the Truckee River and its tributaries as well as deep percolation of ground water to deeper aquifers with water supply wells (Rajagopal and others, 2012). DRI's study "…also applied a modified Maxey-Eakin (1949) method to estimate recharge which relates mean annual precipitation to recharge using recharge coefficients applied to precipitation amounts."

The PRMS is modeled for the years 1983 to 2011 with annual recharge estimates ranging from 12,143 ac-ft/yr (dry year) to 56,792 ac-ft/yr (wet year), with an average annual recharge estimate of 32,745 ac-ft/yr. Because annual precipitation drives recharge, the PRMS simulated recharge varies from year to year. DRI included in its Technical Note annual recharge efficiency, or the ratio of annual recharge to annual precipitation. For the MVGB, the calculated annual recharge efficiency is 18-26%. Figure 2-18 shows the average annual groundwater recharge as simulated by the PRMS model, for a period of record from 1983 to 2011. Figure 2-19 shows the annual recharge for the year 1988, a dry year. Figure 2-20 shows the annual recharge for the year 1995, a wet year.

2.10 Water Use

Groundwater use in the MVGB is primarily for municipal, domestic, and recreational uses. The TDPUD and PCWA have summarized water supply and demand as part of Urban Water Management Plans completed for their respective service areas (Tully and Young, 2011; Kaufman, 2011). Average potable day demand served by the TDPUD in 2010 was reported to be 4.53 million gallons per day (mgd); 5,073 acre-feet per year (ac-ft/yr)). From 2005 to 2009, production from PCWA wells has increased from an average day demand of 0.04 to 0.13 mgd (44 to 141 ac-ft/yr).

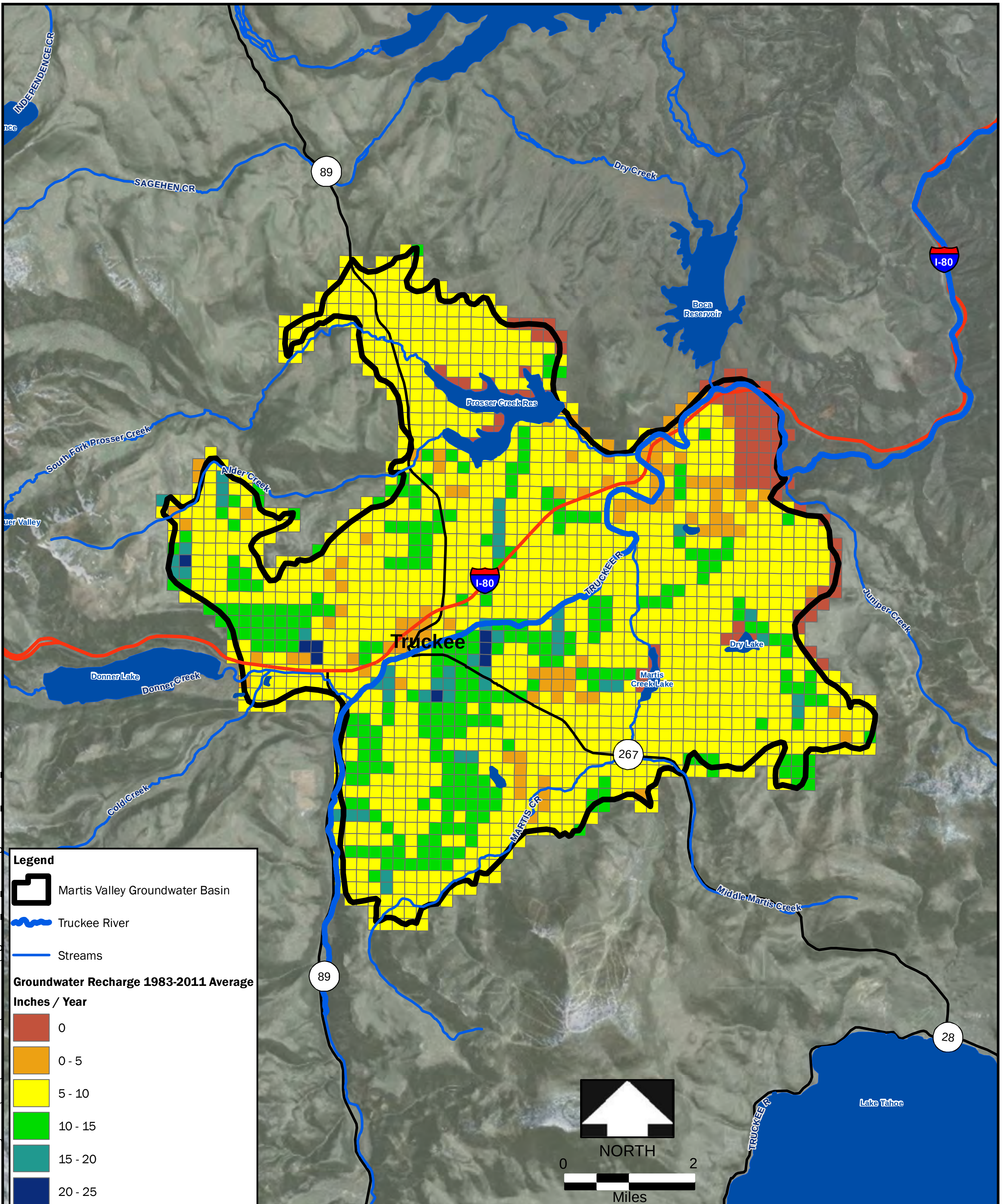
NCSD meets demand primarily from its Big Springs collection system, outside of the MVGB, and uses water pumped from TH-2 (and in the future, TH-1) to augment this supply (J. Detwiler, pers. comm.). Demand on the MVGB imposed by NCSD operations is best represented by pumping records from Well TH-2. Annual water volumes pumped by NCSD averaged 0.18, 0.36, and 0.29 mgd (200, 398, and 320 ac-ft/yr) in water years 2008, 2009, and 2010, respectively.

Nine golf courses depend on the MVGB for irrigation supply; four are supplied by TDPUD (one uses a potable supply and 3 are non-potable), 1 is supplied by NCSD (potable), and 4 are supplied privately and assumed to be all non-potable. Using the partner agencies records of non-potable water pumped and supplied to the majority of the courses, the average non-potable demands range from 0.19 ac-ft/yr to 0.25 ac-ft/yr (210 ac-ft/yr to 279 ac-ft/yr), with an average of 0.24 mgd (272 ac-ft/yr). This average demand rate of 0.24 mgd is applied to the four privately-supplied courses for an estimated production of 993 ac-ft/yr.

Based on the available data and summarized in Table 2-4, current annual production from the MVGB is estimated to be approximately 9,341 ac-ft/yr. Kaufman (2011) estimates buildout water demand for all users in the MVGB to be approximately 21,000 ac-ft/yr.

Table 2-4. Estimated Current Groundwater Production

	mgd	ac-ft/yr
TDPUD		
Potable - Average (2007-2010)	5.78	6,475
Golf Course non-potable – Average (2001-2011)	0.75	837
PCWA		
Potable – Average (2009)	0.10	141
NCSD		
Potable - Average (2008-2010)	0.08	96
Golf Course (potable) – Average (2009-2011)	0.19	210
Snowmaking (Water Year 2011)	0.53	589
Privately Supplied Golf Courses		
Total estimated non-potable production	0.96	993
Estimated Total Demand	8.39	9,341



Source: 2012 Desert Research Institute (DRI)

DATE	PROJECT	SITE
9-17-12	140691	**Martis Valley Groundwater Basin, California**

Brown AND Caldwell

TITLE

Average Annual Groundwater Recharge 1983-2011

Figure 2-18

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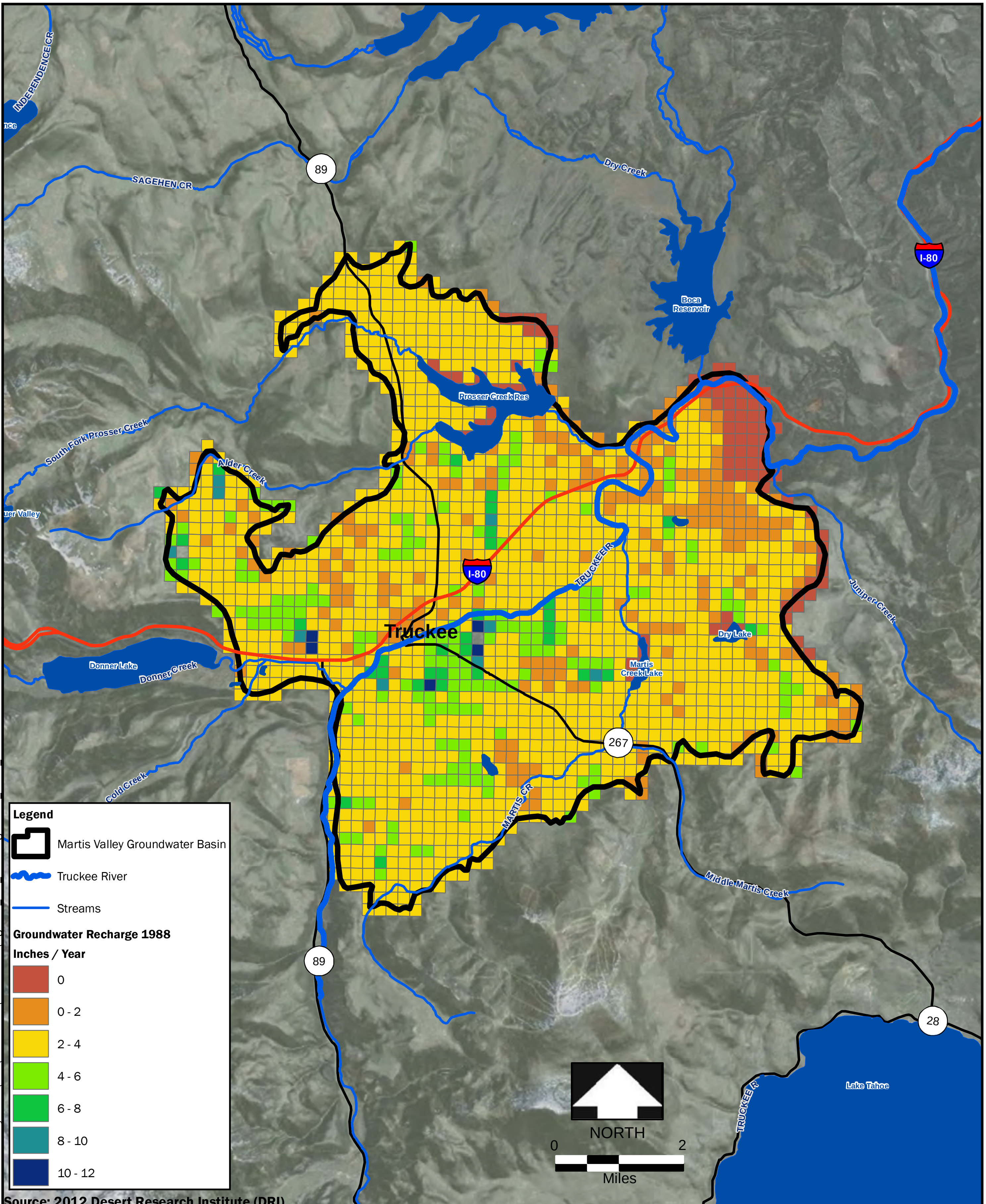


Source: 2012 Desert Research Institute (DRI)

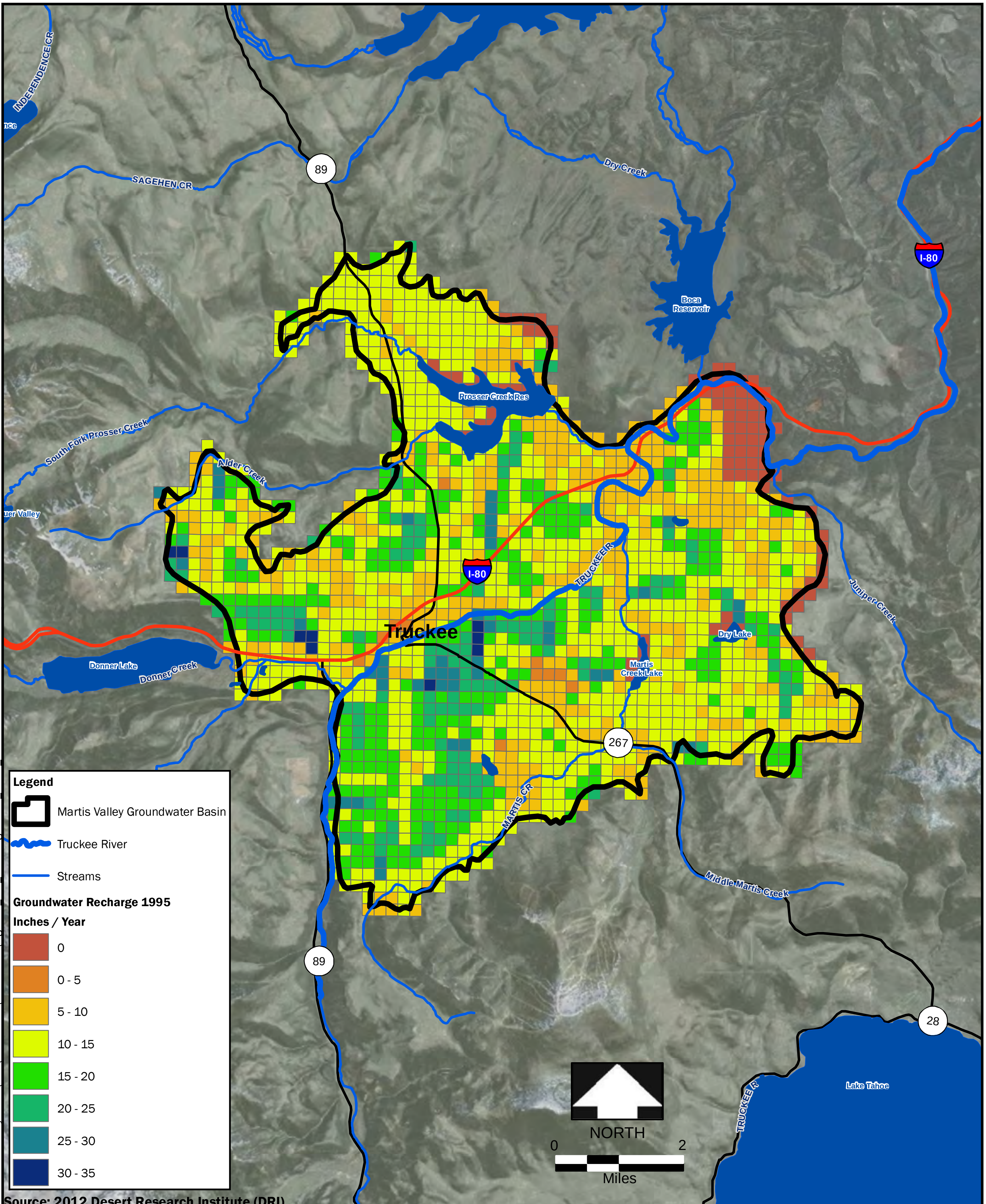
DATE	PROJECT	SITE
9-17-12	140691	**Martis Valley Groundwater Basin, California**

Brown AND Caldwell

TITLE

Annual Groundwater Recharge 1988

Figure 2-19



Source: 2012 Desert Research Institute (DRI)

DATE	PROJECT	SITE
9-7-12	140691	Martis Valley Groundwater Basin, California

Brown AND Caldwell

TITLE

Annual Groundwater Recharge 1995

Figure 2-20

P:\40000\140691 - PCWA Martis Valley GWPV\GIS\MAPDOCS\WORKING\Fig2-20_MV_Recharge1995_8x11_20120820.mxd

Section 3

Plan Implementation

The partner agencies are already performing many of the groundwater management activities associated with an AB 3030 GMP. Through GMP implementation, the partner agencies formalize their groundwater management goal, BMOs, and implementation actions that elaborate on both current actions and planned future actions under the GMP. As discussed in Section 1.6 and shown on Tables 1-2, 1-3, and 1-4, a number of required, voluntary, and suggested components constitute a GMP.

This chapter discusses implementation actions that are grouped under each BMO. The BMOs are fully described in Section 1.5, and are listed below:

1. Manage groundwater to maintain established and planned uses.
2. Manage groundwater use within the provisions of the Truckee River Operating Agreement.
3. Collaborate and cooperate with groundwater users and stakeholders in the Martis Groundwater Basin.
4. Protect groundwater quantity and quality.
5. Pursue and use the best available science and technology to inform the decision making process.
6. Consider the environment and participate in the stewardship of groundwater resources.

3.1 Implementation Actions that Support BMO #1 - Manage Groundwater to Maintain Established and Planned Uses

The MVGB is the primary source of water to multiple users under separate jurisdictions. BMO #1 encourages the partner agencies to pursue management of groundwater that is within their jurisdiction in order to protect existing uses.

Implementation actions identified as falling under BMO #1 facilitate the management of groundwater in the MVGB. These implementation actions are focused on regular communication and consideration of future programs intended to protect the groundwater resource from degradation and depletion.

3.1.1 Develop and implement a summary report every five years

This action is intended to concentrate and document GMP activity, data, and management decisions into periodic reports for use by partner agencies, Stakeholders, and local planning agencies for continual groundwater management decisions and maintenance.

This implementation action provides a report every five years that summarizes groundwater conditions and management activities, and presents an opportunity to update and improve the GMP. The summary report will include:

- A summary of monitoring results with a discussion of historical trends.
- A summary of management actions during the period covered by the report.
- A discussion of whether actions are achieving progress towards meeting BMOs.
- A summary of proposed management actions for the future.
- A summary of any GMP changes that occurred during the period covered by the report.
- A summary of actions taken to coordinate with other water and land agencies and other government agencies.

- Recommendation of updates and changes to the GMP.

3.1.2 Compile an annual summary of groundwater monitoring data

This action will compile, organize and evaluate groundwater level elevation and groundwater quality monitoring data collected during the previous year. The annual summary of monitoring data will include groundwater level monitoring information from the partner agencies water level monitoring efforts, and water quality data collected by the partner agencies from production wells. The annual summary of groundwater monitoring data will be used by the agencies at the annual GMP implementation meeting described in Section 3.1.3 to evaluate the need to implement other portions of the GMP that are contingent on monitoring data. The annual summary of groundwater monitoring data will also be included in the five year summary report.

3.1.3 Partner agencies to meet annually to discuss GMP implementation

This action will require the partnership agencies to meet at least once annually to discuss GMP implementation. Currently, the partner agencies meet in the Truckee area annually and GMP implementation will be added as an agenda item during this annual meeting.

3.1.4 Support TROA provisions associated with well construction, repair, modification, and destruction

The Settlement Act may eventually establish additional requirements for the siting and construction of wells drilled in the Truckee River Basin, which includes the MVGB. Section 6.E of TROA outlines Truckee River basin allocation procedures including well construction, repair, modification and destruction to address groundwater-surface water interactions within the Truckee River Basin including areas of Martis Valley. Section 204(c)(1)(B) of the Settlement Act provides that, "…all new wells drilled after the date of enactment of this title shall be designed to minimize any short-term reductions of surface streamflows to the maximum extent feasible." This implementation action supports the implementation of TROA's well construction guidelines.

3.1.5 Evaluate and consider taking a position on relevant water resources-related policies, programs, and projects under consideration by local, State and Federal agencies

Throughout the state, surface water and groundwater resource management are becoming critical components of meeting growing water supply demands. As part of this implementation action, the partner agencies will actively evaluate and consider policies, programs and projects that may impact water resources quality and/or quantity within the Martis Valley.

3.1.6 Pursue opportunities for improved groundwater basin monitoring and reporting with local, State, and Federal agencies

This implementation action prompts the partner agencies to continuously pursue opportunities and funding that may provide additional groundwater data collection and/or reporting. Groundwater monitoring is a critical component in understanding the physical condition of the groundwater basin and is further described in Section 3.3.1.

3.1.7 Evaluate the need for programs to facilitate saline intrusion control, mitigate the migration of contaminated groundwater, facilitate conjunctive use, and to mitigate overdraft

This implementation action includes evaluation of a variety of potential programs to manage groundwater within the jurisdiction of the partner agencies. As part of this action, the agencies will evaluate the need for saline intrusion controls, mitigation of the migration of contaminated groundwater, conjunctive use programs, and overdraft mitigation.

Currently, the groundwater supply in Martis Valley is not threatened by saline intrusion, contaminant plumes, or in a state of overdraft that would warrant immediate steps for mitigation. Saline intrusion is a primary concern along coastal areas with intruding sea water, which is high in Total Dissolved Solids (TDS) that may threaten fresh groundwater supplies. Saline conditions may also occur in interior basins. In the Martis Valley, groundwater monitoring (discussed under Section 3.4), will assist in identifying saline issues. Should future monitoring indicate that saline intrusion is a potential problem in the MVGB, the partner agencies will evaluate development of a saline intrusion control program.

Groundwater contamination in the MVGB falls under the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). Should monitoring indicate a large scale groundwater contamination issue, the partner agencies will share knowledge of the issue and collaborate with the LRWQCB. If monitoring indicates that contaminated groundwater is migrating, the partner agencies will further collaborate with the LRWQCB to mitigate the migration.

Conjunctive use is the management of surface water and groundwater to optimize the yield of the overall water resource. One method would be to rely primarily on surface water in wet years and groundwater in dry years. Other methods employ artificial recharge, where surface water is intentionally stored into aquifers for later use. NCSD currently manages both its springwater and groundwater supply and TDPUD currently relies solely on groundwater but maintains water rights to several springs. Groundwater is PCWA's only supply source. The partner agencies will evaluate opportunities to increase the use of conjunctive management as they arise within the MVGB.

Groundwater overdraft occurs when pumping exceeds recharge to a groundwater basin. If monitoring indicates through declining groundwater levels that groundwater overdraft is occurring, the partner agencies will consider development of programs to mitigate the groundwater overdraft.

3.1.8 Consider development of contamination cleanup, recharge, storage, conservation and water recycling projects

This implementation action includes evaluation of a variety of potential programs to manage groundwater within the jurisdiction of the partner agencies. As part of this action, the partner agencies will consider development of projects that cleanup contamination, increase groundwater recharge and storage, or increase conservation and water recycling.

The LRWQCB is responsible for developing and enforcing water quality objectives and plans that best protect the State's waters within its hydrologic area. Should monitoring indicate that contaminated groundwater is a threat to groundwater supplies, the partner agencies will consider collaborating with the LRWQCB.

During GMP implementation, opportunities may arise for the partner agencies to engage in activities related to groundwater recharge, storage, conservation and recycling. As those opportunities arise, the agencies will consider participating in projects to improve groundwater recharge, storage, conservation and recycling efforts.

3.1.9 Pursue funding sources for implementation of plan policies, programs, reporting and projects

This implementation action directs the partner agencies to pursue funds from Federal, State and other sources as they become available and are beneficial to pursue. Funding sources may include Local Groundwater Assistance (LGA) grants and Integrated Regional Water Management Planning (IRWMP) grants from DWR, grants from the California Department of Public Health (DPH), various funds available through collaboration with the U.S. Bureau of the Interior, and other agencies.

3.1.10 Participate in the evaluation of relevant local projects to maintain groundwater quantity and quality

Local groups and local, State or Federal agencies may develop opportunities that seek support or assistance for projects that affect groundwater quantity and/or quality in the Martis Valley. This action directs the partner agencies to participate in relevant local projects as appropriate and reasonable.

3.1.11 Summary of BMO #1 Actions

Table 3-1 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #1 including the anticipated schedule of implementation.

Table 3-1. Summary BMO#1 Supporting Implementation Actions

	Description of Action	Implementation Schedule
1-1	Develop and implement a summary report every five years that includes: A summary of monitoring results, with a discussion of historical trends A summary of management actions during the period covered by the report A discussion of whether actions are achieving progress towards meeting BMOs A summary of proposed management actions for the future A summary of any GMP changes that occurred during the period covered by the report A summary of actions taken to coordinate with other water and land agencies and other government agencies Review of the GMP and consider updates to the GMP	Once every five years, first summary report to be completed in 2018
1-2	Compile an annual summary of groundwater monitoring data	Annually
1-3	Partner agencies to meet annually to discuss GMP implementation	Annually
1-4	Support TROA provisions associated with well construction, repair, modification, and destruction	As Needed
1-5	Evaluate and consider taking a position on relevant water resource-related policies, programs, and projects under consideration by local, State and Federal agencies	As Needed
1-6	Pursue opportunities for improved groundwater basin monitoring and reporting with local, State, and Federal agencies	As Needed
1-7	Evaluate the need for programs to facilitate saline intrusion control, mitigate the migration of contaminated groundwater, facilitate conjunctive use, and to mitigate overdraft	As Needed
1-8	Consider development of contamination cleanup, recharge, storage, conservation and water recycling projects	As Needed
1-9	Pursue funding sources for implementation of plan policies, programs, reporting and projects	Ongoing
1-10	Participate in the evaluation of relevant local projects to maintain groundwater quantity and quality	As Needed

3.2 Implementation Actions that Support BMO #2 - Manage Groundwater within the Provisions of TROA

The Settlement Act, Public Law 101-618 (1990), established entitlements to the waters of Lake Tahoe, the Truckee River and its tributaries, and how the storage reservoirs of the Truckee River are operated. Section 205 of the Settlement Act directs the Secretary of the Department of the Interior to negotiate an operating agreement for the operation of Truckee River reservoirs, between DWR, Nevada, Nevada

Energy (formerly Sierra Pacific Power Company), Pyramid Tribe, and the United States Bureau of Reclamation. The operating agreement is known as TROA.

Section 204(c)(1) of the Settlement Act outlines the allocation of 32,000 acre-feet of water (both surface and groundwater) to the State of California from within the Truckee River Basin. The Settlement Act may eventually establish additional requirements for the siting and construction of wells drilled in the Truckee River Basin, which includes the MVGB. Section 6.E of TROA outlines Truckee River Basin allocation procedures including surface water diversions and water accounting procedures. Article 10 of TROA identifies well construction, repair, modification and destruction to address groundwater-surface water interactions within the Truckee River Basin including areas of Martis Valley. Section 204(c)(1)(B) of the Settlement Act provides that, "…all new wells drilled after the date of enactment of this title shall be designed to minimize any short-term reductions of surface streamflows to the maximum extent feasible." Article 10 of TROA requires that new water supply wells be designed to minimize impacts to surface water and outlines siting and design processes. Wells drilled or under construction before May 1, 1996 are presumed to comply with the Settlement Act.

This BMO documents the partner agencies' commitment to continue to comply with provisions of TROA. There are provisions in TROA that apply to groundwater and water wells within the Truckee River Basin (which includes the Martis Valley) to address potential adverse impacts to surface water.

3.2.1 Continue coordination and collaboration with TROA agencies on groundwater management issues and source well development

This implementation action directs the partner agencies to coordinate and collaborate with TROA agencies as necessary to be compliant with the Settlement Act. To meet this implementation action, the agencies will continue regular contact with TROA agencies as appropriate.

3.2.2 Summary of BMO #2 Actions

Table 3-2 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #2 including the anticipated schedule of implementation.

Table 3-2. Summary BMO#2 Supporting Implementation Actions

Description of Action		Implementation Schedule
2-1	Continue coordination and collaboration with TROA agencies on groundwater management issues and source well development	Ongoing

3.3 Implementation Actions that Support BMO #3 - Collaborate and Cooperate with Groundwater Users and Stakeholders in the Martis Valley Groundwater Basin

With one common groundwater supply it makes sense to share information and resources toward similar goals. This objective encourages the partner agencies to reach out to other agencies and groundwater users within the MVGB.

3.3.1 Formalize and institute a Stakeholder Working Group to meet at least annually or as needed on GMP implementation activities and updates

The SWG has been a key component of the GMP development process and will be continued into the implementation phase. This implementation action directs the partner agencies to continue using a

SWG during implementation of the GMP. The SWG will continue to work cooperatively with the partner agencies and will meet at least once a year to discuss GMP implementation.

3.3.2 Collaborate with the LRWQCB to limit the migration of contaminated groundwater and in development of large scale contamination clean up programs

This implementation action directs the partner agencies to communicate, collaborate, and coordinate with the LRWQCB on groundwater contamination issues. There are no currently identified large scale groundwater contamination issues in the Martis Valley at this time. Communication with the LRWQCB allows for collaboration in the event of the identification of groundwater contamination and collaboration with the LRWQCB on the prevention of contaminant migration.

3.3.3 Work cooperatively with local stakeholders and local, State and Federal agencies on groundwater management activities, projects, and studies

Strong relationships with Federal, State, and local agencies and stakeholders are critical in developing and implementing many of the GMP's implementation actions. The partner agencies are already working cooperatively with local stakeholders and agencies on groundwater management, as evidenced by the use of the SWG during GMP development. This implementation action directs the partner agencies to communicate and work cooperatively with local groundwater interests, and includes outreach activities aimed to educate agencies and stakeholders on groundwater management opportunities and activities in the MVGB.

3.3.4 Identify opportunities for public involvement during GMP implementation

Informing the public of GMP implementation activities increases local understanding and support of GMP activities. This implementation action encourages the partner agencies to inform and invite the public to participate in GMP implementation activities. Public information and involvement may take place in the form of a specific webpage designed to communicate GMP implementation actions, public meetings, and at agency board meetings, as well as other activities.

3.3.5 Summary of BMO #3 Actions

Table 3-3 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #3 including the anticipated schedule of implementation.

Table 3-3. Summary BMO#3 Supporting Implementation Actions

Description of Action		Implementation Schedule
3-1	Formalize and institute a Stakeholder Working Group to meet at least annually or as needed on GMP implementation activities and updates.	Annually
3-2	Collaborate with the LRWQCB to limit the migration of contaminated groundwater and in development of large scale contamination clean up programs	As Needed
3-3	Work cooperatively with local stakeholders and local, State and Federal agencies on groundwater management activities, projects and studies	Ongoing
3-4	Identify opportunities for public involvement during plan implementation	Ongoing

3.4 Implementation Actions that Support BMO #4 - Protect Groundwater Quantity and Quality

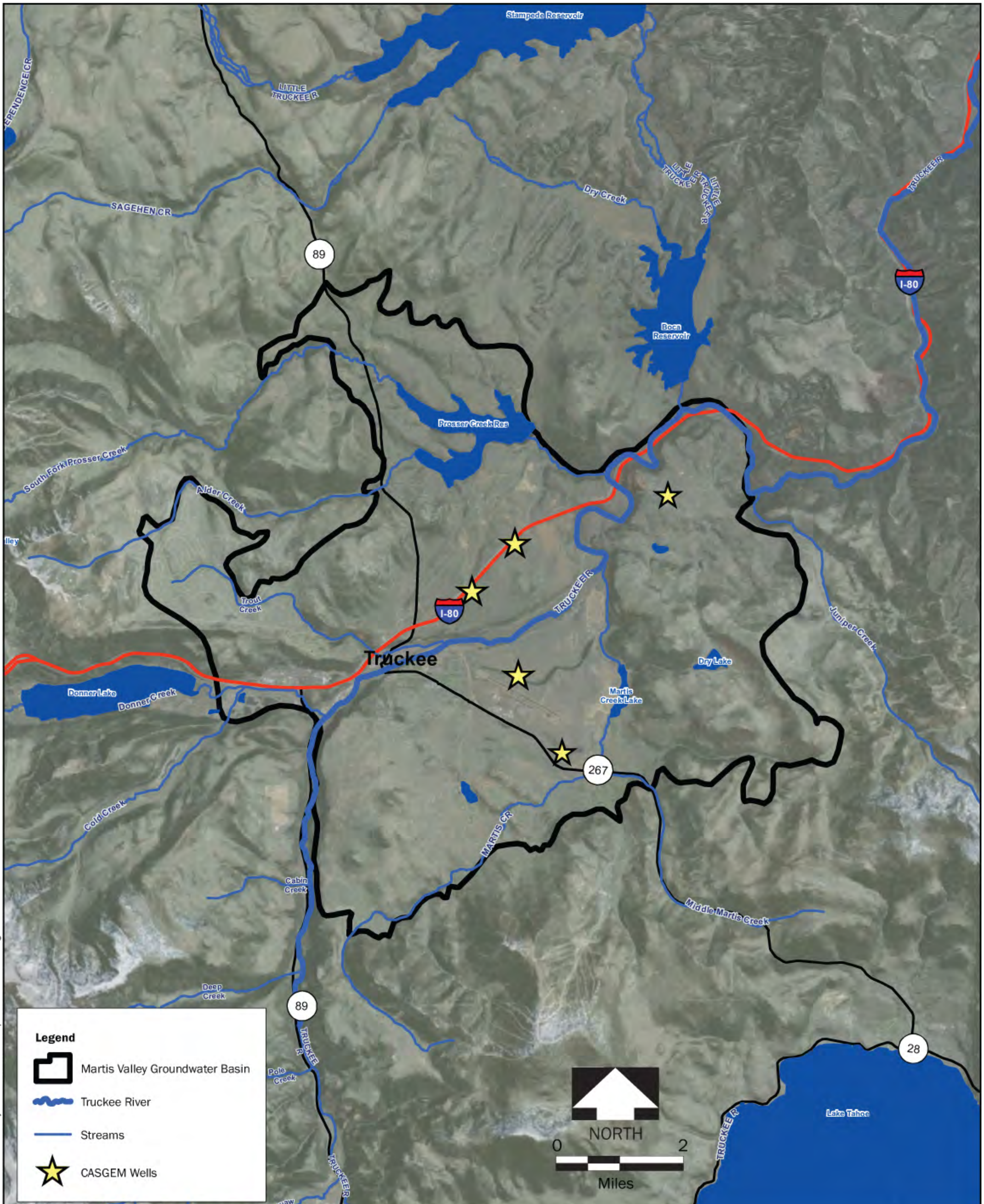
Groundwater performs an integral function in a watershed, one of which is satisfying water supply needs. Improving the understanding of the regional supplies is a critical step in protecting and sustaining the Martis Valley groundwater supply.

The collection, evaluation and analysis of groundwater monitoring data including water quality and water levels on a regular basis is the cornerstone in understanding the MVGB's groundwater resources and provides critical information for management decisions. Groundwater level monitoring can identify areas of overdraft, enabling appropriate management decisions and responses. Groundwater quality monitoring can help identify areas of degrading water quality, potentially identifying specific water quality issues. Ongoing groundwater monitoring provides information needed to document current conditions, assess long-term trends, and to support development and implementation of GMP components.

Groundwater data is collected by both DWR and the partner agencies on a regular basis; and by the USGS on a less regular basis. Accumulating, processing, evaluating, summarizing and reporting the available data for discussion and distribution will be required to make informed decisions regarding continued groundwater supply and demand. Additionally, surface water data is collected by local, State, and Federal agencies and is evaluated by the appropriate agency for their own purpose. These data are critical and can be used in conjunction with the accumulated groundwater data to help improve the understanding of surface water-groundwater relationships.

3.4.1 Establish and maintain a California Statewide Groundwater Elevation Monitoring compliant monitoring program

This implementation action directs the partner agencies to continue their California Statewide Groundwater Elevation Monitoring (CASGEM) compliant monitoring program (included as Appendix D). Figure 3-1 shows the locations of CASGEM monitoring wells in the MVGB. CASGEM monitoring results will be used in the annual groundwater monitoring summary prepared under implementation action 1-2.



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DATE	PROJECT	SITE	
9-7-12	140691	**Martis Valley Groundwater Basin, California**	**Figure 3-1**
Brown AND Caldwell		TITLE **CASGEM and DWR Groundwater Monitoring Wells**	

3.4.2 Continue and Encourage Water Conservation Activities and Public Education

The partner agencies currently implement significant water conservation and public outreach programs per State requirements. All three agencies hold public board meetings and maintain informative websites for public outreach purposes at the following web addresses:

- www.tdpud.org
- www.pcwa.net
- www.northstarcsd.org

This implementation action encourages the partner agencies to continue to implement conservation activities and continue public outreach activities as opportunities become available.

3.4.3 Work with local stakeholders and DWR to identify areas that may need additional groundwater level and groundwater quality monitoring based on identified data gaps or negative performance trends

Currently, groundwater is monitored by the partner agencies under CASGEM, and by DWR, who monitors a number of wells in the MVGB. DWR monitoring wells are shown in Figure 3-1. This implementation action requires the partner agencies to work with local stakeholders and DWR to identify areas in need of additional monitoring. The SWG included two DWR North Central Region office staff and future members of the SWG should continue to include DWR staff. Through the SWG, the partner agencies will be working with local stakeholders and DWR, and will discuss identification of additional monitoring areas at the SWG annual meetings.

3.4.4 Coordinate with other agencies, including DWR and the USGS to identify opportunities for land subsidence monitoring

Inelastic land subsidence is caused by dewatering of aquifers and the compressing of clays. As water is removed from the aquifer, it is transported through interconnected pore spaces between grains of sand and gravel. If an aquifer has intervals of clay or silt within it, the lowered water pressure in the sand and gravel results in the slow drainage of water from the clay and silt beds. The decreased water pressure reduces the support for the clay and silt beds. Because these beds are compressible, they compact (become thinner) and the effects are seen as a lowering of the land surface. The lowering of the land surface elevation from this process is often permanent (inelastic). Recharge of the aquifer will not result in an appreciable recovery of the land-surface elevation.

The partner agencies have not developed a network of extensometers to measure inelastic land subsidence. Groundwater level monitoring indicates that groundwater levels have not been significantly lowered, a condition required for land subsidence due to groundwater extraction to occur. Additionally, the geology (Section 2.4) in the MVGB does not consist of large layers of clay to be compressed, and is unlikely to experience inelastic land subsidence even if groundwater levels begin to decline. Based on a review of groundwater elevation trends over time, it can reasonably be assumed that significant land subsidence has not occurred on a regional scale due to groundwater extraction within the MVGB.

Under this implementation action, the partner agencies will coordinate with DWR and the USGS to identify opportunities for collaboration to detect land subsidence. Because inelastic land subsidence is tied to groundwater levels, the primary means for early detection include:

- Monitor and analyze groundwater levels, watching for significant declines
- Inspect wells for anecdotal evidence of subsidence during groundwater level monitoring

Monitoring groundwater levels with concurrent inspections for anecdotal evidence of subsidence is the least expensive, and least reliable, method to monitor for land subsidence. Declines in groundwater levels can be a precursor to land subsidence. Staff performing water level monitoring can inspect the monitoring well for indicators of subsidence. Anecdotal subsidence indicators include cracks in the well pad, elevation of the well casing in comparison to the ground surface, and cracks in the ground surface.

3.4.5 Evaluate the need for, and advocate for, as necessary, a wellhead protection, groundwater recharge area protection, and other programs as necessary in MVGB

Wellhead protection is a component of the Drinking Water Source Assessment and Protection (DWSAP) program administered by the DPH. The purpose of the DWSAP program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. There are three major components to the DWSAP program, including: Delineation of capture zones around source wells, inventory of potential contaminating activities within protection areas, and analysis of vulnerabilities.

The partner agencies are in compliance with the DWSAP program, will work to comply with the DWSAP program into the future, and will consider supporting programs that will protect groundwater quality in the MVGB.

3.4.6 Map and share groundwater recharge zones

This GMP identifies preliminary areas of groundwater recharge in the MVGB in Section 2.9. Once the groundwater model is calibrated and finalized, groundwater recharge zones will be updated during the scheduled plan update identified in Section 3.1.1. This implementation action encourages the partner agencies to share the recharge zone maps developed in this GMP with local land use agencies to consider in land use decisions.

3.4.7 Provide relevant information to land use agencies regarding groundwater availability

Through GMP implementation activities, such as CASGEM monitoring, groundwater monitoring summary reports and annual meetings of the SWG, the partner agencies will develop water resources information about the MVGB. As development increases in the MVGB, local land use agencies will be faced with decisions regarding zoning and permitting. In Placer County, the Community Development Resource Agency leads development of the County's general plan and land development activities. The Nevada County Community Development Agency is responsible for the Nevada County General Plan and zoning, and the Town of Truckee has developed its own general plan and zoning. This implementation action directs the partner agencies to communicate relevant groundwater information to the appropriate planning agencies to assist them in making informed land use decisions.

3.4.8 Summary of BMO #4 Actions

Table 3-4 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #3 including the anticipated schedule of implementation.

Table 3-4. Summary BMO#4 Supporting Implementation Actions

	Description of Action	Implementation Schedule
4-1	Establish and maintain a CASGEM compliant monitoring program	Ongoing
4-2	Continue and encourage water conservation activities and public education	Ongoing
4-3	Work with local stakeholders and DWR to identify areas that may need additional groundwater level and groundwater quality monitoring based on identified data gaps or negative performance trends	Annually

Table 3-4. Summary BMO#4 Supporting Implementation Actions		
	Description of Action	Implementation Schedule
4-4	Coordinate with other agencies, including DWR and the USGS to identify opportunities for land subsidence monitoring	As Needed
4-5	Evaluate the need for, and advocate for, as necessary, a wellhead protection, groundwater recharge area protection, and other programs as necessary in MVGB	As Needed
4-6	Map and share groundwater recharge zones	Ongoing
4-6	Provide relevant information to land use agencies regarding groundwater availability	As Needed

3.5 BMO #5 - Pursue and use the best available science and technology to inform the decision making process.

Science and technology continue to develop new tools that may improve our understanding of the MVGB. This objective encourages the partner agencies to take actions that work with the best available science to help make informed agency decisions.

The partner agencies are currently working to develop the best groundwater science available by collaborating with the Bureau of Reclamation (Reclamation) and DRI to develop an integrated watershed-groundwater model in conjunction with the Martis Valley GMP. The geologic investigation conducted and documented in Section 2 of this report has been used to shape a bi-modal geologic framework which was used to develop the conceptual model for the hydrogeology of the subsurface components of the integrated watershed model. The integrated model is under development in parallel with the GMP and is not completed at the time of the issuance of the draft GMP.

The integrated watershed model is comprised of a PRMS and MODFLOW coupled together using an UZF package. The PRMS is used to model surface water within the watershed, the MODFLOW is used to model groundwater within the MVGB, and UZF is a kinematic wave vadose zone model used to model the interaction between surface water and groundwater. Each model will be calibrated separately, and then calibrated together over a ten year period using a coupled GSFLOW. Calibrations will be conducted using multiple GCM projections of precipitation and temperature to investigate the influence of future climate on water resources. Calibration targets for GSFLOW will include head values measured from wells, meadow and spring locations, streamflows, measured snow depth, and remotely sensed snow cover.

The integrated model's model domain will cover the entire MVGB, and the watersheds that contribute surface water to the region up to Lake Tahoe. The model grid's cells are 300 meters by 300 meters in size.

The partner agencies will obtain a copy of the groundwater model component for future use.

3.5.1 Work with State and Federal agencies to attempt to secure funding for expansion of the partner agencies' monitoring grid

Increasing the number of monitoring points and frequency of monitoring provides for better long term understanding of groundwater trends in the MVGB. Monitoring locations can be added by drilling new, dedicated monitoring wells, and by reaching agreements with well owners that have wells suitable for monitoring activities. Suitable wells will have a driller's log that describes well construction and sediments encountered, a short screened interval, a sanitary seal to prevent surface water from entering the well, and cannot be municipal supply wells.

The partner agencies are currently working with DWR to expand the monitoring grid by submitting a competitive grant application under DWR's LGA program. The agencies' application includes plans to drill and install three monitoring wells located across the Martis Valley.

This implementation action directs the partner agencies to collaborate with State agencies such as DWR, DPH, and others, as well as Federal agencies such as Reclamation, to acquire funding for improvements to the groundwater monitoring grid in the MVGB.

3.5.2 Maintain relationship with DWR for groundwater monitoring and database management activities

The partner agencies are a designated monitoring entity under DWR's CASGEM program. DWR staff have been an integral part of the SWG during GMP development and their contribution in the SWG is anticipated during GMP implementation.

This implementation action directs the partner agencies to continue to maintain a collaborative relationship with DWR for monitoring and database management activities in the MVGB. A continued relationship with DWR benefits the GMP by continuing the monitoring of long-term monitoring wells (especially those with long periods of records), and ensures that DWR groundwater expertise is involved during plan implementation activities through the SWG.

3.5.3 Identify opportunities for collecting water quality monitoring data

The purpose of water quality monitoring as a GMP implementation action is to assess regional trends in water quality that may be caused by changes in groundwater-related activities. For example, groundwater pumping may induce groundwater flow from deeper aquifers or hard rock areas that are less desirable, such as water with a high mineral content or arsenic. Groundwater quality monitoring from a basin-wide perspective is focused on information that is indicative of overall groundwater basin conditions and not focused on individual anthropogenic contaminants. Localized anthropogenic groundwater quality contaminants fall under the jurisdiction of the LRWCQB.

Groundwater quality is currently monitored as part of the agencies' agreements with DPH. Each agency releases an annual water quality report for their service areas in the MVGB, and maintains databases of water quality information. Partner agency annual water quality reports are included in Appendix E.

Additional opportunities exist to collect groundwater quality information by collaborating with other State and Federal programs, such as the USGS funded California Groundwater Ambient Monitoring and Assessment Special Studies Program (GAMA). The 2007 GAMA study collected water quality data in the MVGB from 52 groundwater wells. The GAMA fact sheet for the MVGB is included in Appendix E.

Another example of how the partner agencies optimize collaboration opportunities occurred in February, 2012. The partner agencies teamed with Lawrence Livermore National Laboratory (LLNL) to conduct a water aging study that will help improve the understanding of how the MVGB functions. The LLNL study is funded by the GAMA Special Studies Program. Results of the LLNL study will supplement and validate the DRI integrated Martis Valley surface-groundwater model.

This implementation action encourages the partner agencies to continue to identify opportunities, both within the agencies' operations and by collaborating with State and Federal agencies to improve groundwater quality data collection in the MVGB. Data collected for GMP implementation will be focused on identifying long-term water quality trends as they are related to groundwater use.

3.5.4 Use and consider updating the hydrologic model to improve understanding of groundwater in the MVGB

The implementation action directs the partner agencies to use the groundwater model component of the integrated watershed model (when completed) to improve local hydrogeologic understanding within the MVGB. This may be achieved by revising the future regional groundwater model to include the following:

- Development of a focused MVGB hydrogeologic conceptual model;
- Refinement of the numerical groundwater model grid size and model extent;
- Revisions to numerical groundwater model layering and parameterization to reflect updates in the conceptual model; and,
- Establishment of appropriate stress periods and time scales for transient model simulations.

Incorporation of these revisions to the DRI-developed groundwater model will improve the tool so that it can be used to characterize groundwater flow patterns originating from key recharge zones; to quantify potential impacts on groundwater resources resulting from localized extractions; and to evaluate current and future impacts on base flows within the Truckee River as a result of groundwater pumping within the MVGB.

3.5.5 Seek new tools, technology, and information that may improve the understanding of the water resources in the MVGB and watershed

The partner agencies strive to have the best possible understanding of water resources in the MVGB, and prepare reports on water resources such as urban water management plans, water supply analyses, and water master plans in accordance to State requirements.

This implementation action directs the partner agencies to actively seek out tools, technology, and compiled information in order to improve the understanding of water resources in the MVGB. The agencies will share and compare their water resources planning documents to identify similarities and differences. Additionally the agencies will continue to be proactive in looking for methods, approaches, and analysis that improves understanding of water in the MVGB.

3.5.6 Summary of BMO #5 Actions

Table 3-5 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #5 including the anticipated schedule of implementation.

Table 3-5. Summary BMO#5 Supporting Implementation Actions

	Description of Action	Implementation Schedule
5-1	Work with State and Federal agencies to attempt to secure funding for expansion of the Partner Agencies monitoring grid	Ongoing
5-2	Maintain relationship with DWR for groundwater monitoring and database management activities	Ongoing
5-3	Identify opportunities for collecting water quality monitoring data	As Available
5-4	Use and consider updating the hydrologic model to improve understanding of groundwater in the MVGB	Ongoing
5-5	Seek new tools, technology, and information that may improve the understanding of the water resources in the MVGB and watershed	Ongoing
5-6	Use the best available data to inform and link agency interdependent planning documents (i.e. urban water management plans, water supply analyses, and water master plans)	Ongoing

3.6 Implementation Actions that Support BMO #6 - Consider the environment and participate in the stewardship of groundwater resources

The partner agencies are dedicated stewards of the Martis Valley groundwater resources. The partner agencies' mission statements reflect the importance of managing their respective agencies in an environmentally sound manner, such as minimizing negative impacts of operations on the environment. This BMO directs the partner agencies to continue their leadership in the stewardship of the groundwater, watershed and natural infrastructure.

3.6.1 Consider local, State, or Federal riparian, surface water, or surface water-groundwater interaction investigations, studies or programs in the MVGB

This implementation action directs the partner agencies to consider existing and future studies and investigations of riparian habitat, surface water, and surface- groundwater interaction investigations. Wetlands and riparian areas play an important role in protecting water quality and reducing adverse water quality impacts (EPA, 2005). This implementation action, while not solely focused on pollution prevention, may address issues with such through traditional point sources and non-point sources. Many pollutants are delivered to surface waters and to groundwater from diffuse sources, such as urban runoff, agricultural runoff, and atmospheric deposition of contaminants. Pollution of surface water can impact groundwater quality and conversely pollution of groundwater can impact surface water. The agencies will evaluate the need to consider studies, guidance documents, and programs that investigate the linkages between ground and surface waters.

3.6.2 Continue support and collaboration with local groups that identify, coordinate, or implement projects that support the overall sustainability of the MVGB

This implementation action directs the partner agencies to support and collaborate with local groups that improve sustainability in the MVGB.

The partner agencies will continue support and collaboration with groups and agency members of the SWG, and through public involvement and outreach, identify additional groups to include in GMP implementation.

3.6.3 Summary of BMO #6 Actions

Table 3-6 presents a summary of implementation actions to be undertaken by the partner agencies that support BMO #3 including the anticipated schedule of implementation.

Table 3-6. Summary BMO#6 Supporting Implementation Actions

Description of Action		Implementation Schedule
6-1	Consider local, State, or Federal riparian, surface water, or surface water-groundwater interaction investigations, studies or programs in the MVGB.	As Needed
6-2	Continue support and collaboration with local groups that identify, coordinate, or implement projects that support the overall sustainability of the MVGB.	Ongoing

Section 4

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Appendix A: Resolutions of Intent to Adopt a Groundwater Management Plan

RESOLUTION NO. 11 - 13 OF THE BOARD OF DIRECTORS OF THE PLACER COUNTY WATER AGENCY DECLARING ITS INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN AND ADOPT A STATEMENT OF PUBLIC PARTICIPATION

WHEREAS, one of the responsibilities of Placer County Water Agency (Agency) is to provide for sustainable use of groundwater resources within Placer County; and

WHEREAS, The Agency uses groundwater to serve customers in its Martis Valley water system located near Truckee, California; and

WHEREAS, the Agency adopted its current Martis Valley Groundwater Management Plan on October 6, 1998; and

WHEREAS, the current groundwater management plan allows for periodic updates and advocates working collaboratively with others in Martis Valley; and

WHEREAS, the Agency has established a partnership with Truckee Donner Public Utilities District and Northstar Community Services District to prepare an updated groundwater management plan and develop a groundwater model to reflect current water resources planning in Martis Valley and enhance understanding of the underlying groundwater basin; and

WHEREAS, the Agency intends to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Placer County Water Agency that:

1. The Board intends to prepare, adopt, and implement an updated Martis Valley Groundwater Management Plan. Among other content, the updated groundwater management plan will include basin management objectives, plan components, and management actions.

2. The Agency further intends to provide for and encourage public/stakeholder involvement in the preparation of this updated groundwater management plan.

The foregoing resolution was duly passed at meeting of the Board of Directors of the Placer County Water Agency held on April 7, 2011, by the following on roll call:

AYES DIRECTORS: Gray Allen, Alex Ferreira, Mike Lee, Ben Mavy, Chairman Lowell Jarvis

NOES DIRECTORS: None

ABSENT DIRECTORS: None

Signed and approved by me after its passage this 7th day of April, 2011.

Chair, Board of Directors
Placer County Water Agency

ATTEST:

Clerk, Board of Directors
Placer County Water Agency

z:/ns.martis valley.resolution.vf

N·C·S·D
Northstar Community Services District
908 Northstar Drive, Northstar, CA 96161
P: 530.562.0747 · F: 530.562.1505 · www.northstarcsd.com

BOARD OF DIRECTORS

NORTHSTAR COMMUNITY SERVICES DISTRICT

RESOLUTION NO. 11 - 05

RESOLUTION OF INTENTION TO COOPERATE IN THE PREPARATION OF THE UPDATED MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN WITH THE PLACER COUNTY WATER AGENCY AND THE TRUCKEE DONNER PUBLIC UTILITY DISTRICT

AS A BASIS AND PREMISE for this Resolution, the Board of Directors of NORTHSTAR COMMUNITY SERVICES DISTRICT ("District") finds and states as follows:

The District is a "local agency" as that term is defined in the provisions of the California Water Code relating to adoption of a Groundwater Management Plan ("Plan").

The District uses groundwater resources available in the Martis Valley.

The Placer County Water Agency ("Agency") and Truckee Donner Public Utilities District ("TDPUD") also use water from the same or adjoining groundwater aquifers.

The Agency adopted its current Martis Valley Groundwater Management Plan ("Plan") on October 6, 1998, and the Plan allows for periodic updates and advocates working collaboratively with others with an interest in groundwater resources in the Martis Valley.

The Agency, the District and TDPUD have determined it is in their best interests to, and have established a partnership (1) to develop a groundwater model to reflect current water resources planning and operations in the Martis Valley, (2) to enhance understanding of the underlying groundwater basin, and (3) to prepare an updated Plan and propose it for adoption by all three entities as a joint Plan.

On March 16, 2011 this Board directed that notice be given of its desire to adopt this Resolution of Intention, and such notice has been given as provided by law.

NOW, THEREFORE, the BOARD OF DIRECTORS of the NORTHSTAR COMMUNITY SERVICES DISTRICT does hereby RESOLVE, DETERMINE, and ORDER as follows:

1. The District intends to cooperate with the Agency and TDPUD in the development a groundwater model to reflect current water resources planning and operations in the Martis Valley and an updated Martis Valley Groundwater Management Plan, and to propose the Plan for adoption as a joint Plan within the time provided by law.

2. Among other content, the updated Plan will consider inclusion of basin management objectives, plan components, and management actions.

Together with the Agency and TDPUD, the District further intends to provide for and encourage public involvement in the preparation of the updated Plan.

PASSED AND ADOPTED at a regular meeting of the Board of Directors on April 20, 2011 by the following vote:

AYES:	Evans, Green, Ives, Moll, Seelig
NOES:	None
ABSTAIN:	None
ABSENT:	None

Duane E. Evans, President of the Board

ATTEST:

James Bowling, Assistant Secretary of the Board

Resolution No. 2011 - 01

TRUCKEE DONNER PUBLIC UTILITY DISTRICT DECLARING ITS INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN AND ADOPT A STATEMENT OF PUBLIC PARTICIPATION

WHEREAS, groundwater is a valuable natural resource in California and should be managed to ensure both its safe production and its quality; and,

WHEREAS, one of the responsibilities of Truckee Donner Public Utility District (District) is to provide for sustainable use of groundwater resources; and

WHEREAS, the District uses groundwater to serve customers from the Martis Valley water system located near Truckee, California; and

WHEREAS, the District adopted its current Martis Valley Groundwater Management Plan on January 3, 1995; and

WHEREAS, the current groundwater management plan allows for periodic updates and advocates working collaboratively with others in Martis Valley; and

WHEREAS, the District has established a partnership with Northstar Community Services District and Placer County Water Agency to prepare an updated groundwater management plan and develop a groundwater model to reflect current water resources planning in Martis Valley and enhance understanding of the underlying groundwater basin; and

WHEREAS, the District intends to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders;

WHEREAS, prior to adoption of this resolution, the District has held a public hearing, after publication of notice pursuant to Section 6066 of the Government Code, on whether or not to adopt a resolution for intention to update a groundwater management plan;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Truckee Donner Public Utility District that:

1. The Board intends to prepare, adopt, and implement an updated Martis Valley Groundwater Management Plan. Among other content, the updated groundwater management plan will include basin management objectives, plan components, and management actions.

2. The District further intends to provide for and encourage public/stakeholder involvement in the preparation of this updated groundwater management plan.

PASSED AND ADOPTED by the Board of Directors of the Truckee Donner Public Utility District in a meeting duly called and held within said District on the 6th day of April, 2011.

AYES: Directors Aguera, Bender, Hemig, Hillstrom and Laliotis

NOES: None

ABSTAIN: None

ABSENT: None

TRUCKEE DONNER PUBLIC UTILITY DISTRICT

Jeff Bender, President

ATTEST:

Michael D. Holley, P.E. Clerk of the Board

Agenda Item # 11

TRUCKEE DONNER
Public Utility District

ACTION

To: Board of Directors
From: Steven Poncelet
Date: March 16, 2011
Subject: Consideration of Setting a Public Hearing Date to Begin the Martis Valley Groundwater Management Plan Process

1. WHY THIS MATTER IS BEFORE THE BOARD

The Board is responsible for the long-term stewardship of our water supply. Studying the Martis Valley aquifer and having an up-to-date Groundwater Management Plan are important tools for effective stewardship of our water supply.

2. HISTORY

The District has always been concerned with maintaining long-term water supply and water quality for our community. The Board last adopted a Groundwater Management Plan in 1995. The opportunity exists to both update this document and to greatly improve our understanding of how the aquifer functions. This includes better information on the sustainable yield of the aquifer, how changes in the built environment may be impacting water quality, and how climate change may be impacting our long term water supply and quality.

The Board approved the FY09 budget which included $150,000 for a study of the Martis Valley aquifer and an update of our Groundwater Management Plan. The District was able to partner with Placer County Water Agency (PCWA) and Northstar Community Services District (Northstar CSD) to expand the funding for this effort to a total of $250,000. The Board adopted a Memorandum of Agreement for development of the Martis Valley Groundwater Management Plan and groundwater model with PCWA and Northstar CSD at the July 21, 2010 Board meeting. The agency partners secured an additional approximately $500,000 in grant funding from the Bureau of Reclamation for Desert Research Institute (DRI) modeling services and integration of a climate change model. The total project funding is now approximately $750,000.

In late 2010, PCWA, the lead agency, issued a Request for Proposal to hire a consultant to manage the development of the Martis Valley aquifer model and to develop a Groundwater Management Plan and associated public outreach. At their February 7, 2011 Board meeting, a contract was awarded to Brown and Caldwell, with local Truckee sub-contractor Balanced Hydrologics.

3. NEW INFORMATION

Brown and Caldwell has begun work on the Groundwater Management Plan and associated public outreach. The State of California has specific requirements for the development of Groundwater Management Plans. Included in the State requirements is that the District must hold a public hearing, and adopt a Board Resolution to announce the intention to update the Groundwater Management Plan. The District must also hold a second public hearing, and a Board Resolution to adopt the final Groundwater Management Plan. Staff is recommending that we hold the initial public hearing and that the Board consider adopting a Resolution for the intention to update the Groundwater Management Plan at the April 6, 2011 Board meeting.

Brown and Caldwell is developing a final project workplan and schedule. The development of the Martis Valley aquifer model and Groundwater Management Plan and associated public outreach is expected to take approximately two years. Key next steps include:

- Agency partner kick-off meeting with Brown and Caldwell and DRI on March 21, 2011
- Public notice and hearing on the District's intention to update our Groundwater Management Plan
- Creation of a Stakeholder Working Group which would include a technical advisory committee
- Development of a project website available to the public
- Kick-off of the Martis Valley aquifer modeling effort by DRI

4. FISCAL IMPACT

Sufficient funds exist within the approved FY11 budget for the project.

5. RECOMMENDATION

Authorize staff to:

- Schedule a public hearing for the April 6, 2011 Board meeting
- Advertise a public notice for the public hearing

Steven Poncelet
Public Information & Conservation Manager

Michael D. Holley
General Manager

SIERRA SUN

Serving the Truckee Community since 1869

Nicole

Proof and RECEIVED

Statement of Publication

P.O. Box 1888 Carson City, NV 89702
Phone (775) 881-1201
Fax (775) 887-2408

Account Number: 1066693

Legal Account
Placer County Water Agency
P.O. Box 6570
Auburn, CA 95604
Attn: Nicole Snyder

Rachel Renaud says:
That (s)he is a legal clerk of the **SIERRA SUN**, a newspaper published Wednesday, Friday, Saturday at Truckee, in the State of California.

Martis Valley Groundwater Plan

Ad # 6289415

of which a copy is hereto attached, was published in said newspaper for the full required period of **2 times** commencing on **March 16, 2011,** and ending on **March 23, 2011,** all days inclusive.

Signed: Rachel Renaud

STATEMENT:

DATE	AMOUNT	CREDIT	BALANCE
3/23/11	$135.26	$ 0.00	$135.26

NOTICE OF PLACER COUNTY WATER AGENCY BOARD OF DIRECTORS MEETING AGENDA ITEM FOR RESOLUTION OF INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that the Placer County Water Agency (PCWA) will hold a public hearing in accordance with California Water Code Section 10753.2 to review and consider a Resolution of Intent to update its Martis Valley Groundwater Management Plan. The public hearing will be held April 7, 2011 at 2:00 p.m. at the regularly scheduled meeting of the PCWA Board of Directors which is held in the American River Room at its Business Center, 144 Ferguson Road, Auburn, California. The public is invited to comment on PCWA's intent as described.

The reasons for updating the Martis Valley Groundwater Management Plan are to reflect current water resources planning in the region, to reflect the latest information and understandings of the underlying groundwater basin, and to update the plan in partnership with adjacent water purveyors in an effort to work collaboratively and align policy. The plan will be updated in partnership with Truckee Donner Public Utilities District and Northstar Community Services District. In addition to updating the groundwater management plan, a computer model of the groundwater basin will be developed, which will assimilate available data and enhance understanding of the basin.

PCWA and its partners intend to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders. For more information please contact Tony Firenzi at (530) 823-4886 or tfirenzi@pcwa.net.

Pub: March 16, 23, 2011 Ad#6289415

SIERRA SUN

Serving the Truckee Community since 1869

PCWA FINANCE

Proof and Statement of Publication

RECEIVED 4/28/11

P.O. Box 1888 Carson City, NV 89702
Phone (775) 881-1201
Fax (775) 887-2408

2011 APR 25 PM 1 16

Account Number: 1066693

Legal Account
Placer County Water Agency
P.O. Box 6570
Auburn, CA 95604
Attn: Nicole Snyder

Rachel Renaud says:
That (s)he is a legal clerk of the **SIERRA SUN**, a newspaper published Wednesday, Friday, Saturday at Truckee, in the State of California.

Martis Valley Groundwater Management Plan

Ad # 6400246

of which a copy is hereto attached, was published in said newspaper for the full required period of **2 times** commencing on **April 13, 2011,** and ending on **April 20, 2011,** all days inclusive.

Signed: Rachel Renaud

STATEMENT:

DATE	AMOUNT	CREDIT	BALANCE
4/20/11	$226.63	$ 0.00	$226.63

RESOLUTION NO. 11 -13 OF THE BOARD OF DIRECTORS OF THE PLACER COUNTY WATER AGENCY DECLARING ITS INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN AND ADOPT A STATEMENT OF PUBLIC PARTICIPATION

WHEREAS, one of the responsibilities of Placer County Water Agency (Agency) is to provide for sustainable use of groundwater resources within Placer County; and

WHEREAS, The Agency uses groundwater to serve customers in its Martis Valley water system located near Truckee, California; and

WHEREAS, the Agency adopted its current Martis Valley Groundwater Management Plan on October 6, 1998; and

WHEREAS, the current groundwater management plan allows for periodic updates and advocates working collaboratively with others in Martis Valley; and

WHEREAS, the Agency has established a partnership with Truckee Donner Public Utilities District and Northstar Community Services District to prepare an updated groundwater management plan and develop a groundwater model to reflect current water resources planning in Martis Valley and enhance understanding of the underlying groundwater basin; and

WHEREAS, the Agency intends to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Placer County Water Agency that:

1. The Board intends to prepare, adopt, and implement an updated Martis Valley Groundwater Management Plan. Among other content, the updated groundwater management plan will include basin management objectives, plan components, and management actions.
2. The Agency further intends to provide for and encourage public/stakeholder involvement in the preparation of this updated groundwater management plan.

The foregoing resolution was duly passed at meeting of the Board of Directors of the Placer County Water Agency held on April 7, 2011, by the following on roll call:

AYES DIRECTORS: Gray Allen, Alex Ferreira, Mike Lee, Ben Mavy, Chairman Lowell Jarvis

NOES DIRECTORS: None

ABSENT DIRECTORS: None

Signed and approved by me after it passage this 7th day of April, 2011

/s/ Lowell M. Jarvis
Chair, Board of Directors
Placer County Water Agency

ATTEST:
/s/ Cheri Sprunck
Clerk, Board of Directors
Placer County Water Agency

Pub: April 13, 20, 2011 Ad#6400246

16391896

PUBLIC NOTICE

16391896

PUBLIC NOTICE

NOTICE OF PLACER COUNTY WATER AGENCY BOARD OF DIRECTORS MEETING AGENDA ITEM FOR RESOLUTION OF INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

NOTICE IS HEREBY GIVEN that the Placer County Water Agency (PCWA) will hold a public hearing in accordance with California Water Code Section 10753.2 to review and consider a Resolution of Intent to update its Martis Valley Groundwater Management Plan. The public hearing will be held April 7, 2011 at 2:00 p.m. at the regularly scheduled meeting of the PCWA Board of Directors which is held in the American River Room at its Business Center, 144 Ferguson Road, Auburn, California. The public is invited to comment on PCWA's intent as described.

The reasons for updating the Martis Valley Groundwater Management Plan are to reflect current water resources planning in the region, to reflect the latest information and understandings of the underlying groundwater basin, and to update the plan in partnership with adjacent water purveyors in an effort to work collaboratively and align policy. The plan will be updated in partnership with Truckee Donner Public Utilities District and Northstar Community Services District. In addition to updating the groundwater management plan, a computer model of the groundwater basin will be developed, which will assimilate available data and enhance understanding of the basin.

PCWA and its partners intend to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders. For more information please contact Tony Firenzi at (530) 823-4886 or tfirenzi@pcwa.net.

PUBLISHED IN AUBURN JOURNAL: MARCH 16, 23, 2011

The above space is reserved for Court/County Filed Date Stamp

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of Placer

I am a citizen of the United States and employed by a publication in the County aforesaid. I am over the age of eighteen years, and not a party to the mentioned matter. I am the principal clerk of **The Auburn Journal**, a newspaper of general circulation, in the **City of Auburn**, which is printed and published in the **County of Placer**. This newspaper has been judged a newspaper of general circulation by the Superior Court of the State of California, in and for the **County of Placer**, on the date of May 26, 1952 (Case Number 17407). The notice, of which the attached is a printed copy (set in type not smaller than nonpareil) has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

MARCH 16, 23

I certify, under penalty of perjury, that the foregoing is true and correct.

Terry Clark

Dated in Auburn, California

MARCH 23, 2011

PROOF OF PUBLICATION
THE AUBURN JOURNAL
1030 High Street
Auburn, CA 95604-5910

16395813

PUBLIC NOTICE

16395813

PUBLIC NOTICE

RESOLUTION NO. 11 - 13 OF THE BOARD OF DIRECTORS OF THE PLACER COUNTY WATER AGENCY DECLARING ITS INTENT TO UPDATE ITS MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN AND ADOPT A STATEMENT OF PUBLIC PARTICIPATION

WHEREAS, one of the responsibilities of Placer County Water Agency (Agency) is to provide for sustainable use of groundwater resources within Placer County; and

WHEREAS, The Agency uses groundwater to serve customers in its Martis Valley water system located near Truckee, California; and

WHEREAS, the Agency adopted its current Martis Valley Groundwater Management Plan on October 6, 1998; and

WHEREAS, the current groundwater management plan allows for periodic updates and advocates working collaboratively with others in Martis Valley; and

WHEREAS, the Agency has established a partnership with Truckee Donner Public Utilities District and Northstar Community Services District to prepare an updated groundwater management plan and develop a groundwater model to reflect current water resources planning in Martis Valley and enhance understanding of the underlying groundwater basin; and

WHEREAS, the Agency intends to prepare, adopt, and implement this updated groundwater management plan in cooperation with the general public and stakeholders;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Placer County Water Agency that:

1. The Board intends to prepare, adopt, and implement an updated Martis Valley Groundwater Management Plan. Among other content, the updated groundwater management plan will include basin management objectives, plan components, and management actions.

2. The Agency further intends to provide for and encourage public/stakeholder involvement in the preparation of this updated groundwater management plan.

The foregoing resolution was duly passed at meeting of the Board of Directors of the,
Placer County Water Agency held on April 7, 2011, by the following on roll call:

AYES DIRECTORS: Gray Allen, Alex Ferreira, Mike Lee, Ben Mavy, Chairman Lowell Jarvis

NOES DIRECTORS: None

ABSENT DIRECTORS: None

Signed and approved by me after its passage this 7th day of April, 2011.

PUBLISHED IN AUBURN JOURNAL: APRIL 13, 20, 2011

A/P Has Original

The above space is reserved for Court/County Filed Date Stamp

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of Placer

I am a citizen of the United States and employed by a publication in the County aforesaid. I am over the age of eighteen years, and not a party to the mentioned matter. I am the principal clerk of **The Lincoln News Messenger**, a newspaper of general circulation, in the **City of Lincoln**, which is printed and published in the **County of Placer.** This newspaper has been judged a newspaper of general circulation by the Superior Court of the State of California, in and for the **County of Placer**, on the date of April 3, 1952, Superior Court Order Number 89429. The notice, of which the attached is a printed copy (set in type not smaller than nonpareil) has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

APRIL 13, 20

I certify, under penalty of perjury, that the foregoing is true and correct.

Terry Clark

Dated in Lincoln, California

APRIL 20, 2011

PROOF OF PUBLICATION
THE LINCOLN NEWS MESSENGER
553 F Street
Lincoln, CA 95648

N·C·S·D
Northstar Community Services District
908 Northstar Drive, Northstar, CA 96161
P: 530.562.0747 • F: 530.562.1505 • www.northstarcsd.com

NORTHSTAR COMMUNITY SERVICES DISTRICT
NOTICE OF THE REGULAR MEETING
OF THE BOARD OF DIRECTORS

DATE: **MARCH 16, 2011**
TIME: **9 A.M.**
PLACE: **NORTHSTAR FIRE STATION, 910 NORTHSTAR DRIVE**

I. CALL TO ORDER, PLEDGE OF ALLEGIANCE, ROLL CALL

II. PUBLIC COMMENTS

Any member of the public may address the Board after roll call on any topic related to the District that is not on the agenda. Public comment will be taken on agenda action items immediately prior to Board action.

III. RECURRING BUSINESS

1. Approval and Discussion of the minutes of the February 15, 2011 Finance Committee Meeting and the February 16, 2011 Regular Meeting.
2. Meetings attended by NCSD Board Members – Discussion.

IV. NEW BUSINESS

3. East West Partners – Update.
4. Northstar Property Owners Association – Update.
5. CAMCO – Update.
6. Northstar-at-Tahoe/Vail – Update.
7. Martis Valley Groundwater Management Plan – Action to set Public Hearing on Resolution of Intention to cooperate in the preparation of the Martis Valley Groundwater Management Plan – Discussion – Action.
8. Resolution 11-03 "Resolution Approving the Department of Forestry and Fire Protection Agreement for Services from July 1, 2010 to June 30, 2013" – Discussion – Action.
9. Approval of Shift Proposal for Strategic Communications and Community Engagement Strategies – Martis Valley Regional Trail – Discussion – Action.
10. Approval of Memorandum of Agreement Between the North Lake Tahoe Resort Association and the Northstar Community Services District for use of Transient Occupancy Tax (TOT) Infrastructure Funds – Discussion – Action.
11. Approval of Exempt Employee Flexible Work Schedule Policy – Discussion – Action.

V. ATTORNEYS REPORT

VI. CLOSED SESSION

12. Conference with Legal Counsel – Existing Litigation [California Government Code Section 54956.9(a)]; Two cases: 1) Name of Case: *Community Facilities District #1 of the Northstar Community Services District vs. Highlands Hotel Residences Company, LLC, Bank of America, et al*, Placer County, California Superior Court #SCV0027907. 2) Name of Case: *Bank of America & Thomas Morone, as Receiver for Highlands Hotel Company vs. NCSD & Community Facilities District No. 1 of NCSD*, Placer County, California Superior Court #SCV0028495.

13. Public Employee Performance Evaluation (Government Code Section 54957) – Titles: Engineering and Mapping Department: Information Systems Supervisor, Director of Public Works, Associate Engineer, GIS Analyst – Administration Department: Controller, Administrative Manager, Administrative Assistant, Human Resource Director
14. Conference with Labor Negotiators (Government Code §54957.6) – Agency designated representatives: Jim Bowling, Mark Shadowens. Employee organization: Employee Representation – Fire Department employees.

VII. DIRECTOR REPORTS

Individual directors may give brief reports on miscellaneous items for the information of the other members of the board and NCSD staff. No action will be taken.

VIII. OPERATION REPORTS

15. General Managers Report – Staudenmayer – Discussion.
16. Fire Department Report – Shadowens – Discussion.
17. Director of Public Works Report – Geary – Discussion.
18. Utilities Department Report – Ryan – Discussion.
19. Administration Department Report – Tanner/Lewis/Bowling – Discussion.

IX. WARRANT REGISTER & MELLO-ROOS REQUISITIONS

20. Approval of the Warrant Register.
21. Ratification of Mello-Roos Requisitions in the amount of $15,353.42.

X. ADJOURNMENT

Items may not be taken in the order listed above.

In compliance with the Americans with Disabilities Act, if you are a disabled person and you need a disability-related modification or accommodation to participate in this meeting, then please contact Myra Tanner at (530) 562-0747 or (530) 562-1505 (fax). Requests must be made as early as possible and at least one-full business day before the start of the meeting.

Appendix B: Resolutions Adopting the Groundwater Management Plan

SIERRA SUN

P.O. Box 1888 Carson City, NV 89702
(775) 881-1201 FAX: (775) 887-2408

Customer Account: # 1073085

Legal Account
Placer County Water Agency
P.O. Box 6570
AUBURN, CA 95604
Attn: Vibeke Figueroa

Victoria Lopez says:
That (s)he is a legal clerk of the **SIERRA SUN**, a newspaper published Wednesday and Friday at Truckee, in the State of California.

Copy Line
Joint Martis Valley

PO#:

Ad #: 8823943D
of which a copy is hereto attached, was published in said newspaper for the full required period of **2** time(s) commencing on **1/23/2013**, and ending on **1/30/2013**, all days inclusive.

Signed:______________________

Date: 01/31/2013 State of Nevada, Carson City

Price: $ 235.980

Subscribed and sworn to before me this ____ day of ______

____
Notary Public

Proof and Statement of Publication

Ad #: 8823943D

PUBLIC HEARINGS

NOTICE OF TRUCKEE DONNER PUBLIC UTILITIES DISTRICT BOARD OF DIRECTORS
NOTICE OF NORTHSTAR COMMUNITY SERVICES DISTRICT BOARD OF DIRECTORS
NOTICE OF PLACER COUNTY WATER AGENCY BOARD OF DIRECTORS
MEETING AGENDA ITEMS TO ADOPT THE MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

Truckee Donner Public Utility District (TDPUD), Northstar Community Services District (NCSD) and Placer County Water Agency (PCWA) will hold their individual public hearings in accordance with California Water Code Section 10753.2 to review and consider adoption of the Martis Valley Groundwater Management Plan. The respective public hearings are scheduled accordingly:

- The TDPUD public hearing will be held February 20, 2013 at 6:00 PM at the regularly scheduled meeting of the TDPUD Board of Directors located at 11570 Donner Pass Road, Truckee, California.
- The NCSD public hearing will be held February 20, 2013 at 9:00 AM at the regularly scheduled meeting of the NCSD Board of Directors located at the Northstar Fire Station located at 910 Northstar Drive, Northstar, California.
- The PCWA public hearing will be held February 21, 2013 at 2:00 PM, at the regularly scheduled meeting of the PCWA Board of Directors, which is held in the American River Room at its Business Center, 144 Ferguson Road, Auburn, California.

The public is invited to comment on the partner Agencies' intent as described.

The reasons for updating the Martis Valley Groundwater Management Plan are to reflect current water resources planning in the region, to reflect the latest information and understandings of the underlying groundwater basin, and to update the plan in partnership with TDPUD, NCSD and PCWA in an effort to promote regional water management, work collaboratively, and align policy. The plan document includes management objectives and actions that support long term quality and availability of groundwater in the Martis Valley Groundwater Basin. In addition to updating the groundwater management plan, a Bureau of Reclamation-sponsored computer model of the Martis Valley groundwater basin and watershed is currently being developed by the Desert Research Institute, which provided preliminary groundwater recharge estimates of the Martis Valley groundwater basin and will ultimately enhance understanding of basin groundwater resources.

Copies of the draft Martis Valley Groundwater Management Plan are available for public review and comment at the respective agency offices or at www.MartisValleyGMP.org. Printed copies may be obtained for the cost of reproduction. The three partners intend to adopt and implement this updated groundwater management plan in cooperation with the general public and stakeholders. For more information please contact Barbara Cahill at (530) 582-3909 or barbaracahill@tdpud.org ; Mike Staudenmayer (NCSD) at (530) 562-0747 or mikes@northstarcsd.com ; or Tony Firenzi (PCWA) at (530) 823-4886 or tfirenzi@pcwa.net. Any comments or protests by landowners in the plan area must be submitted prior to the close of public comment at any of the three hearings listed above.

Pub: January 23, 30, 2013 **Ad#8823943**

16489006

PUBLIC HEARINGS

16489006

PUBLIC HEARINGS

NOTICE OF TRUCKEE DONNER PUBLIC UTILITIES DISTRICT BOARD OF DIRECTORS NOTICE OF NORTHSTAR COMMUNITY SERVICES DISTRICT BOARD OF DIRECTORS NOTICE OF PLACER COUNTY WATER AGENCY BOARD OF DIRECTORS MEETING AGENDA ITEMS TO ADOPT THE MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

Truckee Donner Public Utility District (TDPUD), Northstar Community Services District (NCSD) and Placer County Water Agency (PCWA) will hold their individual public hearings in accordance with California Water Code Section 10753.2 to review and consider adoption of the Martis Valley Groundwater Management Plan. The respective public hearings are scheduled accordingly:

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- The PCWA public hearing will be held February 21, 2013 at 2:00 PM, at the regularly scheduled meeting of the PCWA Board of Directors, which is held in the American River Room at its Business Center, 144 Ferguson Road, Auburn, California.

The public is invited to comment on the partner Agencies' intent as described.

The reasons for updating the Martis Valley Groundwater Management Plan are to reflect current water resources planning in the region, to reflect the latest information and understandings of the underlying groundwater basin, and to update the plan in partnership with TDPUD, NCSD and PCWA in an effort to promote regional water management, work collaboratively, and align policy. The plan document includes management objectives and actions that support long term quality and availability of groundwater in the Martis Valley Groundwater Basin. In addition to updating the groundwater management plan, a Bureau of Reclamation-sponsored computer model of the Martis Valley groundwater basin and watershed is currently being developed by the Desert Research Institute, which provided preliminary groundwater recharge estimates of the Martis Valley groundwater basin and will ultimately enhance understanding of basin groundwater resources.

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PUBLISHED IN AUBURN JOURNAL: JANUARY 23, 30, 2013

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PROOF OF PUBLICATION (2015.5 C.C.P.)

STATE OF CALIFORNIA
County of Placer

I am a citizen of the United States and employed by a publication in the County aforesaid. I am over the age of eighteen years, and not a party to the mentioned matter. I am the principal clerk of **The Auburn Journal**, a newspaper of general circulation, in the **City of Auburn**, which is printed and published in the **County of Placer**. This newspaper has been judged a newspaper of general circulation by the Superior Court of the State of California, in and for the **County of Placer**, on the date of May 26, 1952 (Case Number 17407). The notice, of which the attached is a printed copy (set in type not smaller than nonpareil) has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

JANUARY 23, 30

I certify, under penalty of perjury, that the foregoing is true and correct.

Terry Clark

Dated in Auburn, California

JANUARAY 30, 2013

PROOF OF PUBLICATION
THE AUBURN JOURNAL
1030 High Street
Auburn, CA 95604-5910

N·C·S·D
Northstar Community Services District
908 Northstar Drive, Northstar, CA 96161
P: 530.562.0747 • F: 530.562.1505 • www.northstarcsd.org

BOARD OF DIRECTORS
NORTHSTAR COMMUNITY SERVICES DISTRICT

RESOLUTION 13-01

RESOLUTION OF THE BOARD OF DIRECTORS OF THE NORTHSTAR COMMUNITY SERVICES DISTRICT ADOPTING THE MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

WHEREAS, On April 20, 2011 the Board of Directors passed Resolution 11-05 "Resolution of Intention to Cooperate in the Preparation of the Updated Martis Valley Groundwater Management Plan with the Placer County Water Agency and the Truckee Donner Public Utility District and adopt a statement of public involvement; and

WHEREAS, the District prepared an updated plan in partnership with the Truckee Donner Public Utilities District and the Placer County Water Agency (PCWA) in an effort to work collaboratively and align policy; and

WHEREAS, the updated Martis Valley Groundwater Management Plan was prepared in accordance with the California Groundwater Management Act, Assembly Bill 3030, and Senate Bill 1938; and

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Northstar Community Services District hereby adopts the updated Martis Valley Groundwater Management Plan.

PASSED AND ADOPTED by the Northstar Community Services District this 20th day of February, 2013, by the following vote on call:

AYES:	**Green, Ives, Seelig, Smith**
NOES:	**None**
ABSENT:	**None**
ABSTAIN:	**Evans**

Nancy P. Ives
President of the Board

ATTEST:

James Bowling
Secretary of the Board

RESOLUTION NO. 13-03 OF THE BOARD OF DIRECTORS OF THE PLACER COUNTY WATER AGENCY ADOPTING THE UPDATED MARTIS VALLEY GROUNDWATER MANAGEMENT PLAN

WHEREAS, On April 7, 2011 the Board of Directors passed Resolution 11-13 declaring its intent to update its Martis Valley Groundwater Management Plan and adopt a statement of public involvement; and

WHEREAS, the Agency prepared an updated plan in partnership with the Truckee Donner Public Utilities District and the Northstar Community Services District in an effort to work collaboratively and align policy; and

WHEREAS, the updated Martis Valley Groundwater Management Plan was prepared in accordance with the California Groundwater Management Act, Assembly Bill 3030, and Senate Bill 1938; and

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Placer County Water Agency hereby adopts the updated Martis Valley Groundwater Management Plan.

The foregoing resolution was duly passed at meeting of the Board of Directors of the Placer County Water Agency held on February 21, 2013, by the following on roll call:

AYES DIRECTORS: Joshua Alpine, Robert Dugan, Alex Ferreira, Mike Lee, Chair Gray Allen

NOES DIRECTORS: None

ABSENT DIRECTORS: None

Signed and approved by me after its passage this 21st day of February, 2013.

Chair, Board of Directors
Placer County Water Agency

ATTEST:

Clerk, Board of Directors
Placer County Water Agency

Resolution No. 2013 – 04

Adopt the Martis Valley Groundwater Management Plan

WHEREAS, groundwater is a valuable natural resource in California and should be managed to ensure both its safe production and its quality; and,

WHEREAS, one of the responsibilities of Truckee Donner Public Utility District (District) is to provide for sustainable use of groundwater resources; and

WHEREAS, the District uses groundwater to serve customers from the Martis Valley water system located near Truckee, California; and

WHEREAS, the District adopted its current Martis Valley Groundwater Management Plan on January 3, 1995; and

WHEREAS, on April 8, 2011, the Board of Directors passed Resolution 2011-01 declaring its intent to update its Martis Valley Groundwater Management Plan and adopt a statement of public involvement; and

WHEREAS, the District prepared an updated plan in partnership with the Placer County Water Agency and the Northstar Community Services District in an effort to work collaboratively and align policy; and

WHEREAS, the updated Martis Valley Groundwater Management Plan was prepared in accordance with the California Groundwater Management Act, Assembly Bill 3030, and Senate Bill 1938.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Truckee Donner Public Utility District hereby adopts the updated Martis Valley Groundwater Management Plan.

The foregoing resolution was duly passed at a meeting of the Board of Directors of Truckee Donner Public Utility District held on February 20, 2013, by the following roll call:

AYES: Directors Bender, Ellis, Hemig and Laliotis
NOES: None
ABSTAIN: None
ABSENT: Director Aguera

TRUCKEE DONNER PUBLIC UTILITY DISTRICT

Jeff Bender, President

ATTEST:

Michael D. Holley, District Clerk

Appendix C: Public Outreach Plan

Brown AND Caldwell
10540 White Rock Road, Suite 180
Rancho Cordova, CA 95670
Tel: 916-444-0123
Fax: 916-635-8805

Technical Memorandum

Project Title: Martis Valley Groundwater Management Plan

Project No: 140691

Public Outreach Plan Technical Memorandum (Deliverable Task 1.2)

Date: May 25, 2011

To: Tony Firenzi, Brian Martin, Michael Holley, Steven Poncelet, and Mike Staudenmayer

From: Tina Bauer, Project Manager

Prepared by: ______________________

John Ayres, Task One Manager

Reviewed by: ______________________

Tina M. Bauer, Project Manager

Introduction

The partnership of Placer County Water Agency (PCWA), Truckee Donner Public Utilities District (TDPUD), and Northstar Community Services District (NCSD), herein referred to as the partnership agencies, are working together to update a Groundwater Management Plan (GMP) for the Martis Valley in accordance with the California Water Code, Article 107050. The overall goal of the GMP is to develop a framework that maintains groundwater quantity and quality, thereby providing a sustainable, high-quality supply for beneficial use in the Martis Valley. Brown and Caldwell (BC) has been contracted by the partnership to prepare the GMP and perform public outreach activities.

The reasons for updating the Martis Valley GMP are to:

- Reflect current water resources planning in the region,
- Update the understanding of the underlying groundwater basin, and
- Prepare the plan in partnership with basin water purveyors in an effort to work collaboratively and align policy.

In addition to updating the GMP a computer model of the groundwater basin will be developed by the Desert Research Institute (through a grant from the Bureau of Reclamation) which will assimilate available data and enhance the understanding of the basin. This groundwater model will be used as a tool to improve basin understanding during GMP development.

Public outreach as described herein is a key component of the process in preparing the GMP.

Public Outreach Objectives

This plan's outreach activities are designed to meet the following outreach objectives:

- Inform the public regarding the development of the GMP.
- Provide meaningful opportunities for stakeholders and the general public to contribute to the development of the GMP.
- Incorporate stakeholder input regarding the GMP.
- Document stakeholder recommendations in a clear, complete manner.
- Develop public understanding and support of the GMP.

To pursue these objectives effectively, various outreach methods will be necessary to reach the groups targeted for inclusion in the planning process.

Groundwater Management Plan Preparation

During the course of preparing the GMP, various entities will be involved in developing, approving, and adopting the GMP. Their roles and responsibilities are as follows:

Partnership Agencies – Each individual agency will follow the GMP adoption process. As such, each agency will conduct two public hearings. The first hearing will be to adopt a resolution of intent to prepare a GMP and the second hearing will be to determine whether or not to adopt the GMP. These hearings will be conducted in compliance with the California Water Code, Article 10753.2 through Article 10753.6. Hearings were held by each agency in April 2011 to indicate to the public the intent of the agencies to develop a GMP. The public was notified in advance in accordance with the California Water Code.

Groundwater Management Plan Team – The GMP team consists of the partnership agencies, BC, and BC's subcontractor, Balance Hydrologics, Inc of Truckee, Ca. Brown and Caldwell will perform the majority of the technical work and analyses, conduct and document the public outreach effort, conduct public meetings and SWG meetings, develop and maintain a website so that information on the project is available to interested parties, and prepare newsletters and notifications of meetings and events. The partnership agencies will provide available resource data, GIS information, and review BC's work. The partnership agencies will provide the names and addresses of special interest groups and interested public members, and assist in distributing newsletters and notifications of meetings and events through the media. The Partnership Agencies will also provide available data and information related to land and water use policies and ordinances affecting water management in Martis Valley.

Stakeholder Working Group – The Stakeholder Working Group (SWG) will be comprised of representatives of federal, state, and local governments, environmental and special interest groups, local land use interests, and the general public selected by the partnership agencies. The SWG will provide local knowledge, data and information, opinions, and review and comment on material prepared by the GMP team. Five meetings with the SWG are anticipated to occur at strategic times for addressing particular items, as appropriate.

General Public – The public will be invited to participate in two public hearings for each partnership agency and two public workshops. The first workshop will explain the process of GMP development and present groundwater model concepts (July 2011). The second workshop will be conducted near project completion and will provide an overview of GMP content. The first agency public hearings have been completed. The second agency public hearings will be conducted at project completion (anticipated November 2012). All agency public hearings will be in compliance with the California Water Code, Article 107050.

Communications and Notifications

Communication and notification is an important aspect of effective outreach. Various means of communication and notification will be utilized to implement this Public Outreach Plan including the following:

Notifications - Notifications are the primary method of outreach used to inform the public of upcoming meetings and hearings. Notifications will be published in the Sierra Sun and the Auburn Journal and will be prepared and submitted to the review group approximately one week prior to the planned publication date.

Website - During project implementation, a public website will be developed and hosted. The website will also contain basic information about the project, including project goals, sponsoring agencies, and who to contact for more information. The website will be updated monthly to supply regular information updates to the public about project progress, data gathered, and decisions made. The website will have pages dedicated to GMP development, groundwater model development, and a page that provides notices, newsletters, and quarterly reports.

Mailing/Contact List - A list of the names and addresses of participants and interested parties will be created by BC and used for communicating information regarding meetings and materials related to the GMP.

Newsletters - Public outreach will include three newsletters. Newsletters will consist of a double-sided full page color flyer that provides basic information about the project including the project goal, sponsoring agencies, and who to contact for more information. Each newsletter will address specific components of the project. The newsletters will be distributed at each partnership agency office and be uploaded onto the website.

Public Workshops, Public Hearings, and SWG Meetings

An important part of the public outreach will be the communications provided by the GMP team and comments provided by those participating in a particular forum. In general, the framework for the various forums conducted by Brown and Caldwell will be as described below. The timing for conducting the respective forums is shown on attached Table 1. Communications and notifications will be made in advance of each forum using the means noted.

Public Workshops – Two public workshops will be conducted. The 1st public workshop will be held to explain the process of GMP and model development to the public. This goal of this workshop is to inform the public of the purpose of the GMP and expected outcomes of GMP and model development. The second public workshop will provide an overview of GMP content and present groundwater modeling results. The goal of this workshop is to build public support of the GMP and model. Public workshops will be held using an open format, with presenters at multiple stations in different parts of the meeting room. Each presenter will be focused on a specific component of project development, and will have visual materials with them to facilitate explanation of the subject matter. Meeting participants will move from station to station according to their interests and time constraints.

Public Hearings – Two public hearings are required to adopt a GMP in compliance with the California Water Code, Article 17050. The first public hearing is conducted to adopt a resolution of intent to prepare a GMP and the second public hearing will be conducted to determine whether or not to adopt the GMP. Hearings were held by each partnership agency in April, 2011 to indicate to the public the intent of the agencies to develop a GMP.

Stakeholder Working Group Meetings – During the course of the project, meetings will be held with the partnership agencies and the SWG. All meetings will have an agenda and PowerPoint presentation with copies of pertinent information, as appropriate. Notes of the meetings will be prepared to document the salient items discussed. The anticipated content of the SWG meetings are as follows:

- The 1st SWG meeting will be held to introduce SWG members to the project and solicit their involvement. Presentation materials will include an overview of GMP content, discussion of the GMP's relationship with the groundwater model, and discussion of SWG member's local knowledge and the SWG's role during GMP development.
- The 2nd SWG meeting will present the conceptual model and physical conditions of the groundwater basin to SWG members. The physical conditions of the Martis Valley groundwater basin will be presented, including cross sections, monitoring well hydrographs, and other information as appropriate. The goal of this meeting is form consensus on what groundwater resources are present in the basin to be managed by the GMP.
- The 3rd SWG meeting will present preliminary GMP goals and management objectives for comment and suggestions to SWG members. The goal of this meeting is to build consensus about the identified goal and management objectives of the GMP.
- The 4th SWG meeting will present preliminary implementation actions and implementation schedule to the SWG for comment and suggestions. The goal of this meeting is to fully identify implementation actions for the GMP.
- The goal of the 5th SWG meeting is to discuss steps taken after adoption of the GWMP.

Summary of Opportunities for Public Participation

The partnership agencies are providing numerous opportunities for the public to participate in and to stay informed throughout the GMP planning process. A summary of the opportunities noted above with the anticipated timing of the event, as shown on the Outreach Activity Schedule, include the following:

- Partnership agency meetings and public hearings.
- Public Workshops.

In addition, a website will be available to the public to facilitate being informed of meeting dates, draft documents, notices, newsletters, and contact information.

	Outreach Activity	2011										2012													
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1	Hearing to Adopt Intent to Develop GMP		□																						
2	Agency Meetings		▣				▣		▣				▣			▣		▣			▣				
3	Public Outreach pPlan			☆																					
4	Website and Monthly Updates			✪	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
5	Stakeholder Working Group Meeting		■																						
6	Public Workshop					□																			
7	Stakeholder Working Group Meeting						■																		
8	Newsletter							▤																	
9	Stakeholder Working Group Meeting												■												
10	Stakeholder Working Group Meeting														■										
11	Newsletter															▤									
12	Newsletter																		▤						
13	Public Workshop																		□						
14	Stakeholder Working Group Meeting																			■					
15	Hearing to Adopt GMP																					□			

KEY

Client Agencies Meeting	▣
Stakeholder Group Meeting	■
Public Meeting or Hearing	□
Public Outreach Plan	☆
Website Live	✪
Website update	★
Newsletter	▤

Table 1 Outreach Schedule

Appendix D: CASGEM Monitoring Plan

Martis Valley Groundwater Monitoring Program

California Statewide Groundwater Elevation Monitoring (CASGEM)

Placer County Water Agency

Truckee Donner Public Utilities District

Northstar Community Services District

December 2011

Revised July 12, 2012

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

This Martis Valley (MV) Groundwater Monitoring Program (Monitoring Program) report serves to describe the activities related to the monitoring of groundwater elevations in the MV area, as shown on **Figure 1-1**.

The elevation data gathered as part of this program will be included as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) Program recently adopted by the California Department of Water Resources (DWR) as part of their mandated monitoring requirements under Senate Bill (SB) 6[1] of the State Water Code. This report strongly encourages the reader to review and understand the full text of the CASGEM Well Monitoring Guidelines, attached as **Appendix A**.

This Monitoring Program pulls together the efforts completed to date in the identification of existing and future well monitoring sites that satisfy the local and state requirements for a monitored groundwater basin. In addition, the Monitoring Program prepares the MV groundwater users to initiate a semi-annual monitoring event, which started with its first measurements in fall of 2011. Placer County Water Agency (PCWA), Truckee Donner Public Utilities District (TDPUD), and Northstar Community Services District (NCSD) are the three partners in MV area, in which their respective services areas are presented in Figure 1-1.

All field forms and measurement methods are included herein for the sole purpose of providing monitoring staff with easy access to printing and using these forms as part of their monitoring activities. The MV Monitoring Program report is a living document subject to change over time as more information is collected on the wells, and as technologies change to provide the best measurement of groundwater levels and water quality, and as more wells become available.

[1] SB 6 requires collaboration between local monitoring parties, or entities, and DWR to collect groundwater elevations statewide and that this information is made available to the public. SB 6 provides that:

- Local parties may assume responsibility for monitoring and reporting groundwater elevations.
- DWR work cooperatively with local Monitoring Entities to achieve monitoring programs that demonstrate seasonal and long-term trends in groundwater elevations.
- DWR accept and review prospective Monitoring Entity submittals, then determine the designated Monitoring Entity, notify the Monitoring Entity, and make that information available to the public.
- DWR perform groundwater elevation monitoring in basins where no local party has agreed to perform the monitoring functions.
- If local parties (for example, counties) do not volunteer to perform the groundwater monitoring functions, and DWR assumes those functions, then those parties become ineligible for water grants or loans from the State.

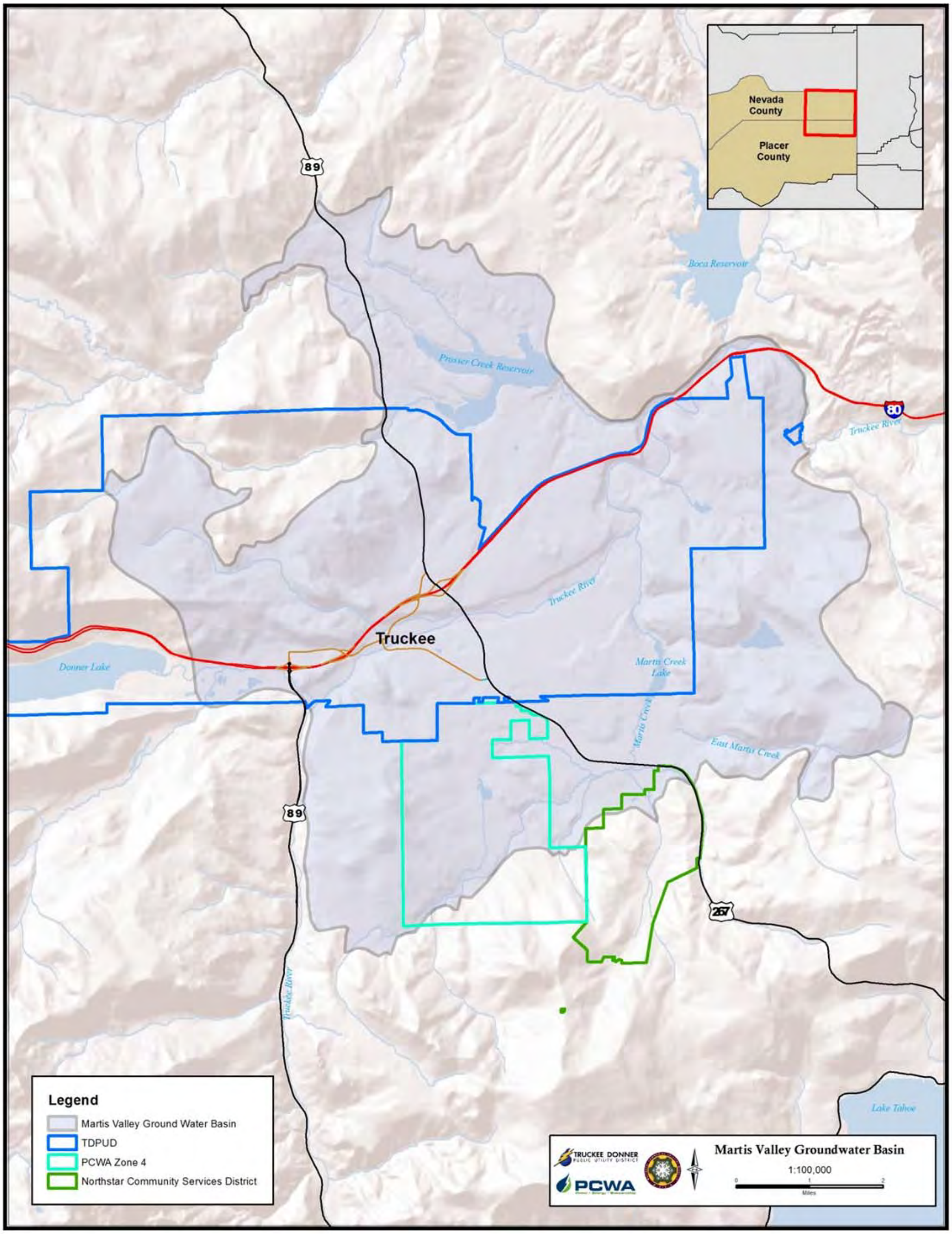


FIGURE 1-1. MAP OF GROUNDWATER BASIN TO BE MONITORED

1.1 ORGANIZATION OF REPORT

The Monitoring Program will be described in the sections summarized below:

- **Section 1. Introduction –** An initial summary of the report's contents and goals while highlighting the reasons for the Monitoring Program.

- **Section 2. Background –** A brief understanding of the groundwater aquifer is provided to ensure a minimum level of understanding by field staff of the conditions taking place below the ground.

- **Section 3. Monitoring Network –** Criteria for selection of monitoring wells is described and the current list of wells to be monitored is provided.

- **Section 4. Monitoring Equipment and Preparation –** Each monitoring event requires an inventory of the equipment that will be taken out into the field and to have staff trained to conduct the measurement and interface with the well owners.

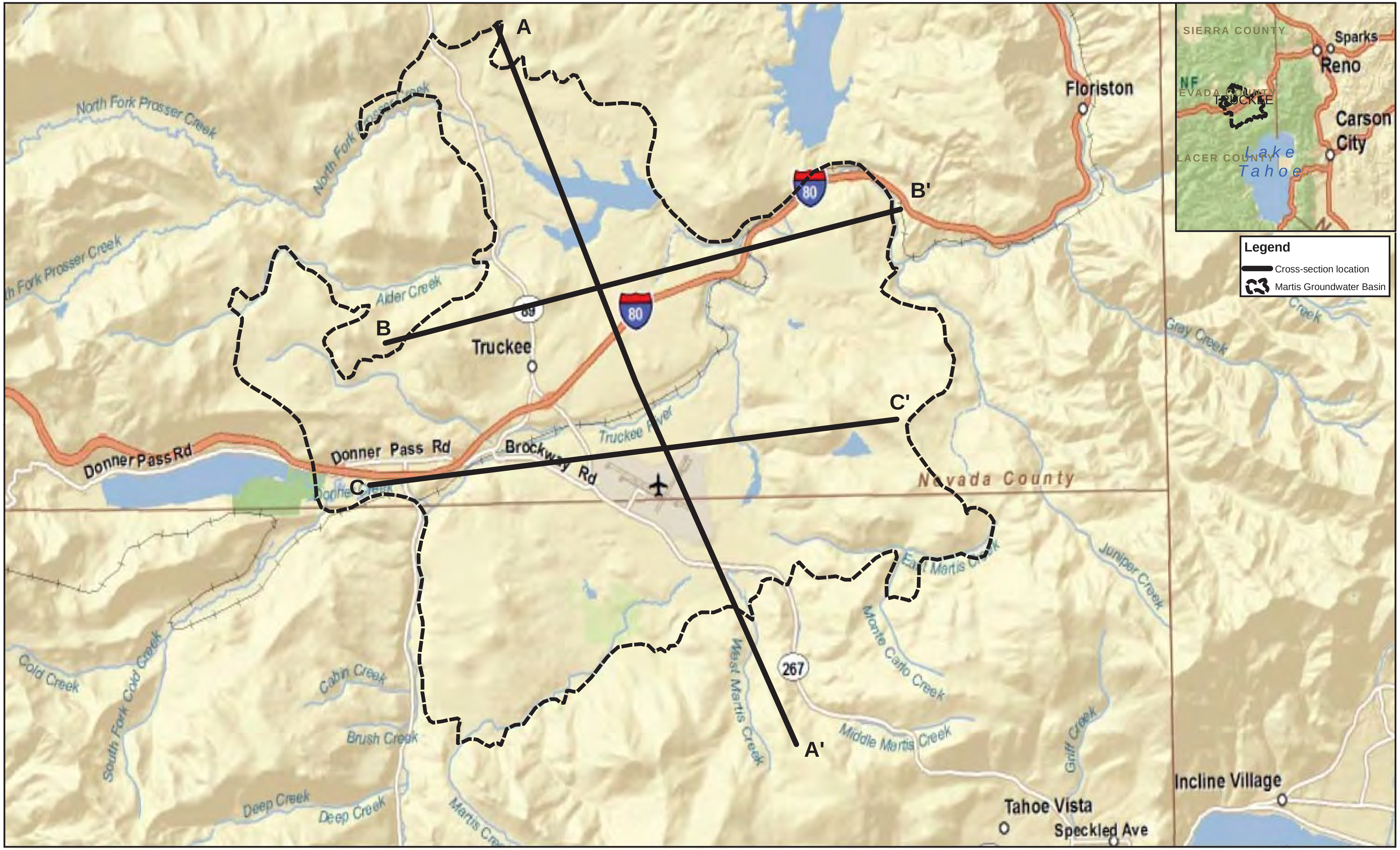
- **Section 5. Depth-to-Groundwater Procedures and Frequency of Monitoring and Reporting –** The resolution of measurement data is described with a brief discussion of the pros and cons of high and low sampling frequency.

- **Section 6. Recording of Monitoring Data, Data Management and the CASGEM Requirements –** Once data is brought back from the field (and laboratory); all data will need to be uploaded to the State. DWR will allow batch uploading and downloading using the CASGEM database and graphical user interface.

2.0 BACKGROUND

This section briefly describes the MV groundwater basin. The MV basin is located beneath the Truckee River, near Truckee, CA, in which the Truckee River crosses the basin from south to east in a shallow, incised channel. Principal tributaries to the Truckee River are Donner Creek, Martis Creek, and Prosser Creek. Major surface water storage reservoirs include Donner Lake, Martis Creek Lake, and Prosser Creek Reservoir. State driller logs required as part of the well construction process provide the lithology (i.e., soil types and thickness) to characterize the water-bearing formations.

Figure 1 delineates the MV groundwater basin along with overlying geography and the alignment of three basin cross sections. These cross sections are presented in **Plates 1, 2, and 3**. The geological formations in the MV basin include basement rocks, sedimentary deposits, and volcanic deposits. The two types of basement rock in this region are Cretaceous-Jurassic plutonic/metamorphic rocks and Miocene volcanic units. Plutonic/metamorphic rocks appear east of the basin and Miocene volcanic units which ranges from andesite to basalt appear adjacent to the basin. These basement rocks contain a very small portion of the groundwater. Sedimentary deposits which include stream/lake deposits and alluvial material provide storage for groundwater. Volcanic deposits include basaltic andesite lava, tuff breccia and volcaniclastic deposits, and also provide storage for groundwater. Municipal and private wells in the basin primarily extract from the Prosser Creek Alluvium and Truckee Formation, with some Shallow wells also extracting from Outwash Deposits.



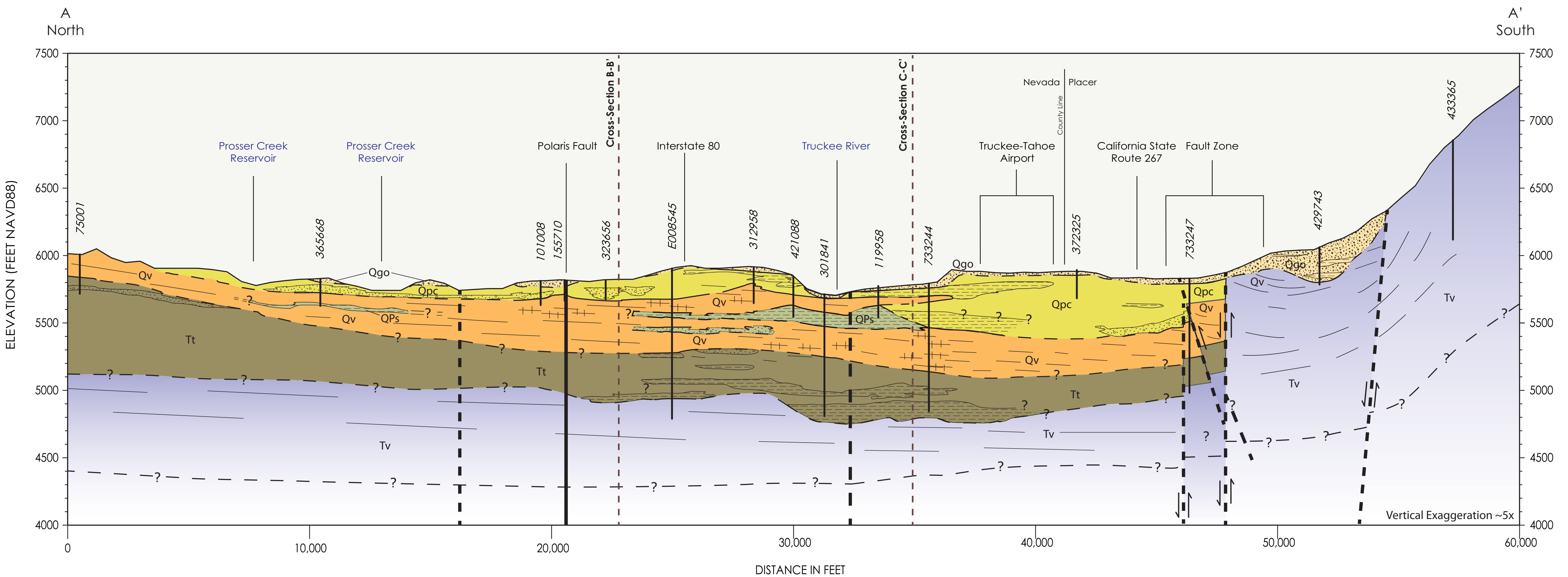
Balance Hydrologics, Inc.

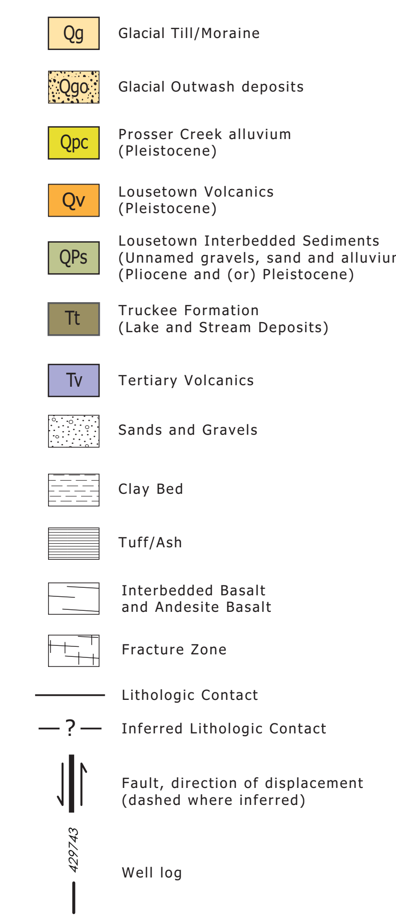
210142 X-sec locations.mxd

Figure 1. **Geologic cross-section locations, Martis Groundwater Management Plan, Placer and Nevada Counties, California**

Plate 1: Cross-section A-A'
Martis Groundwater Basin,

Placer and Nevada Counties, California





NOTES:

1. Approximate vertical exaggeration = 5x.
2. Elevation profile developed from 30-meter digital elevation model, downloaded from National Elevation Dataset (http://seamless.usgs.gov/index.php).
3. Well log locations are approximate within 600 feet.
4. Fault locations are approximate, based on Saucedo, "Geologic Map of Lake Tahoe Basin," 2005 and Hunter and others, 2011.
5. Surficial geology inferred from Saucedo, 2005.
6. Significant sand, gravel, and clay beds shown where noted in well logs.
7. Fracture zones shown where noted in well logs.

References:

Birkeland, P.W., 1963 Pleistocene History of the Truckee area, north of Lake Tahoe, California, Geological Society of America Bulletin, v. 64, p. 1453-1464.

Hunter, L.E., Howle, J.F., Rose, R.S., and Bawden, G.W., 2011, LiDAR – assisted identification of an active fault near Truckee, California, Bulletin of the Seismological Society of America, v. 101, n. 3, p. 1162-1181.

Latham, T.S., 1985, Stratigraphy, structure, and geochemistry of Plio-Pleistocene volcanic rocks of the western Basin and Range Province, near Truckee, California, unpublished doctoral dissertation, University of California, Davis, 341 p.

Melody, A., 2009, Active faulting and Quaternary paleohydrology of the Truckee Fault Zone north of Truckee, California, MS Thesis, Humboldt State University, Humboldt, CA 71 p.

Saucedo, G.J., 2005, Geologic Map of Lake Tahoe Basin, California and Nevada, California Geological Survey Regional Geologic Map Series, Map No. 4, 1:100,000 scale.

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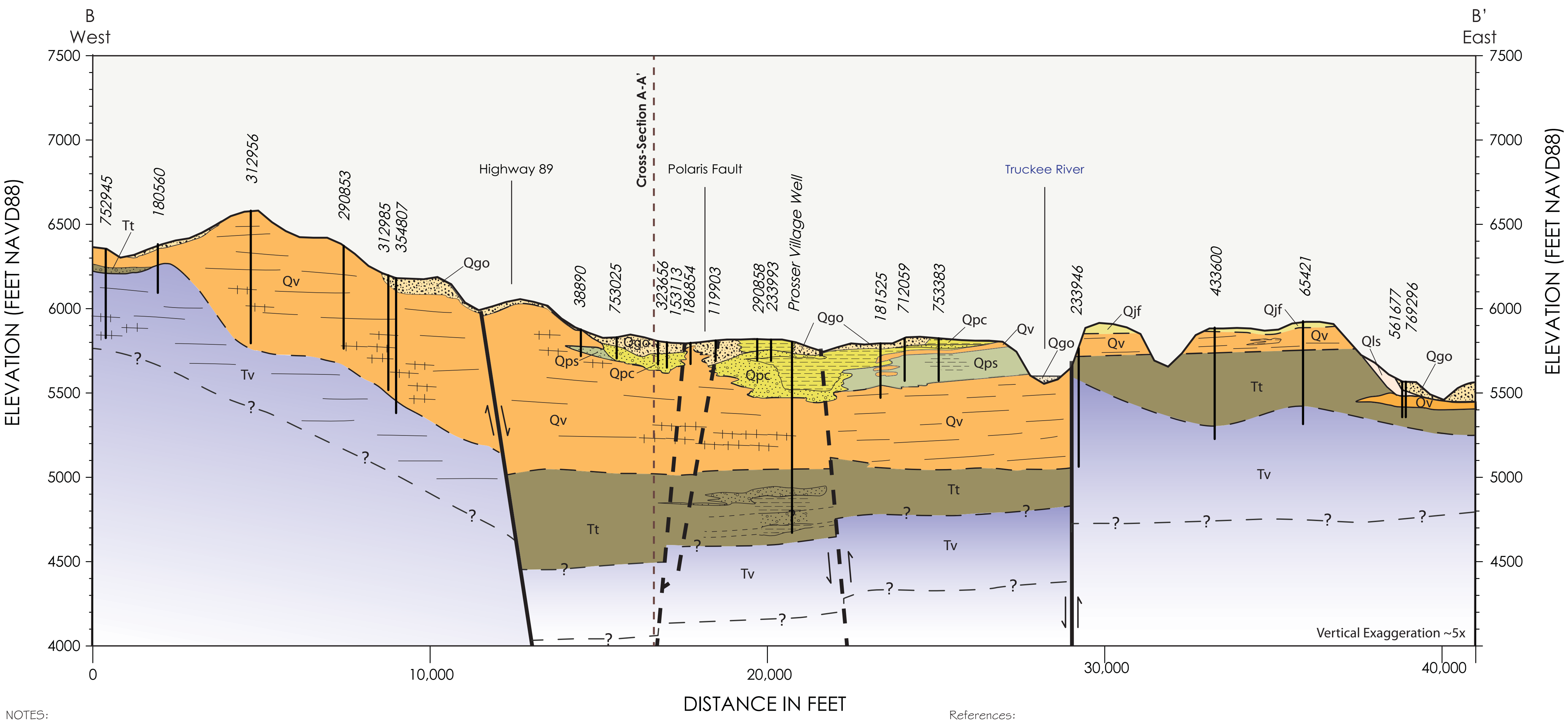
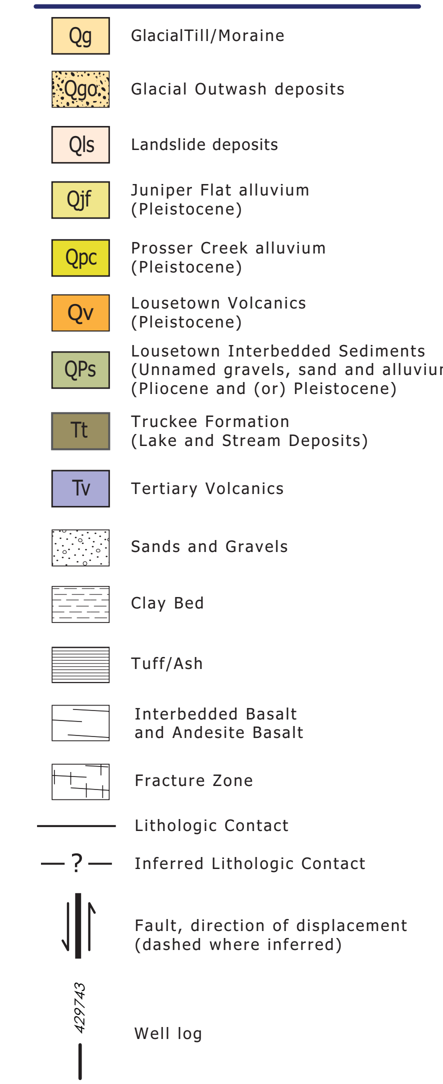
Plate 2: Cross-section B-B'
Martis Groundwater Basin,
Placer and Nevada Counties, California





NOTES:
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2. Elevation profile developed from 30-meter digital elevation model, downloaded from National Elevation Dataset (http://seamless.usgs.gov/index.php).
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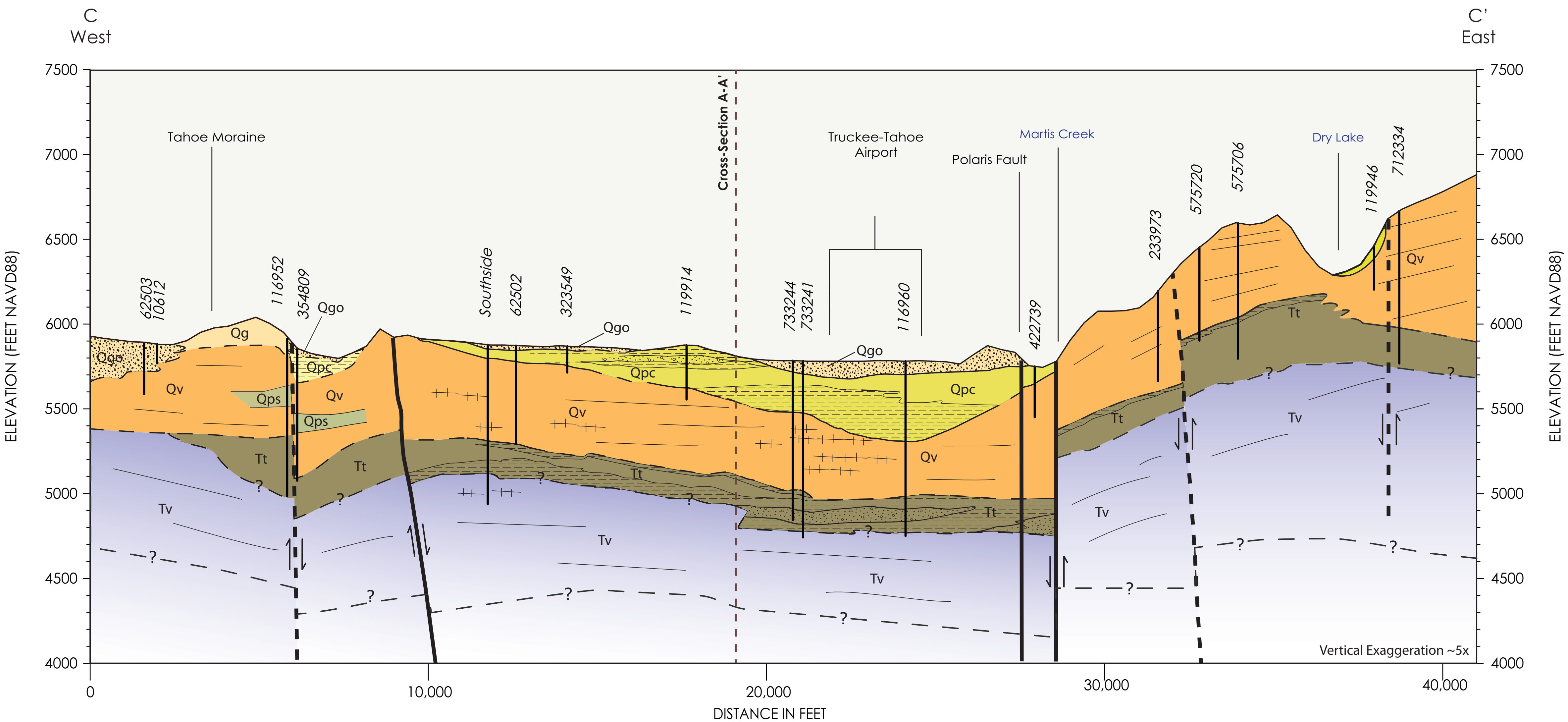
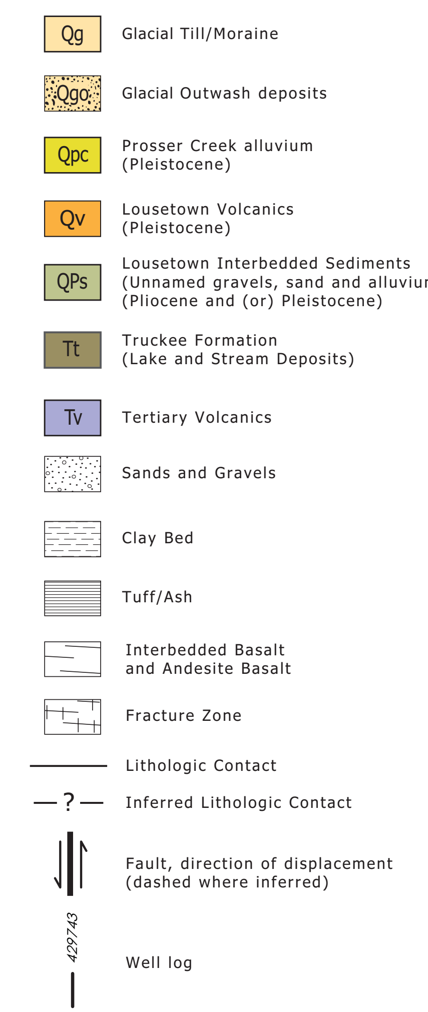
Balance Hydrologics, Inc.

Plate 3: Cross-section C-C' Martis Groundwater Basin,

Placer and Nevada Counties, California





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Balance Hydrologics, Inc.

3.0 MONITORING NETWORK

The following sections describe the rationale for selection of monitoring wells to be included in the monitoring network. Because surface water and groundwater may interact, the monitoring network may need to be expanded at some future date to include data available from surface water monitoring of major rivers and local streams. The partners involved in this Monitoring Program are also underway in preparing an updated Groundwater Management Plan (GMP) and groundwater model. It is anticipated that knowledge gained from that effort will help inform the partners and the State on where additional monitoring points, in the ground and at the surface, should be located. If existing wells are not available at such locations, the partners will seek opportunities to construct new ones in data gap areas.

3.1 RATIONALE OF MONITORING NETWORK

In order to manage groundwater resources for long-term sustainability, key issues in the basin that need to be documented include:

- Identification of sources of recharge and the protection of recharge areas
- Changes in groundwater elevations that affect groundwater storage
- Groundwater quality and changes over time

The following sections describe the rationale for selecting the MV monitoring network well sites. MV groundwater monitoring wells will be selected to provide regional coverage that can be economically accomplished yet provide high quality, reliable data that adequately characterizes basin conditions over time. The location and spacing of the MV monitoring wells are expected to vary, dependent upon a group of selected characteristics (i.e., geographic location, accessibility, age, well construction, well log availability, etc.). The approach described herein is intended to assist in the selection of monitoring locations that are sufficiently distinct from each other and address the issues bulleted above.

3.2 GROUNDWATER WELL NETWORK DEVELOPMENT PROCESS

A database of wells in Martis Valley was developed as part of the GMP and modeling effort. The State well logs provided more than 700 wells; however, these were filtered to omit wells that had limited information available, shallow depths, and other factors that rendered them not useful for hydrogeologic evaluation. The database includes 197 wells that are presented in **Figure 3-1**, in which wells owned and operated by the three partners are distinguished from the others. These wells include municipal and private, monitoring and production, and are generally concentrated in the lowland areas of the basin surrounding the Truckee River and other surface waters. In addition to these wells, wells currently monitored by the State Department of Water Resources (DWR) are presented.

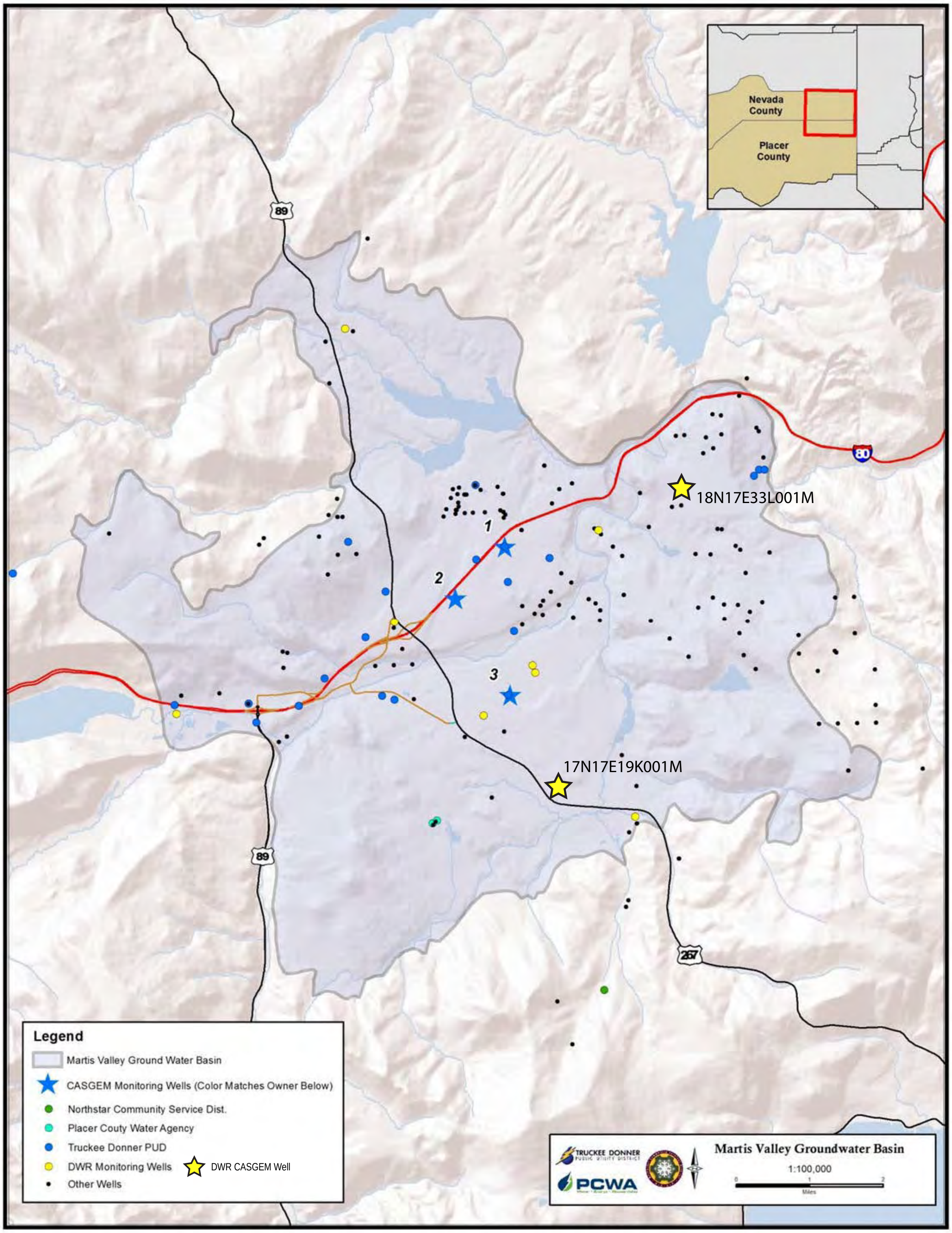

FIGURE 3-1. EXISTING WELLS IN MARTIS VALLEY

Development of a full well monitoring network will be a long-term process that is based on the scientific knowledge gained from the GMP and modeling effort that is currently underway. The network is currently limited to monitoring wells owned by TDPUD. This network includes a total of three wells that are presented in **Table 3-1** along with pertinent well information. It is expected that ideal monitoring locations as related to the issues bulleted above will be scientifically resolved in the next few years. If existing wells, such as those shown in Figure 3-1, meet the monitoring well requirements described below and can be made available, they will be used. If existing wells cannot be used, the partners will seek funding and property rights to construct designated monitoring wells in these locations. It is anticipated that desired new monitoring sites will be prioritized based on value, availability of existing wells, feasibility of installing new wells, and cost. This prioritization will ensure optimal value relative to these constraints in establishing new monitoring locations until the full network is established.

3.3 MONITORING WELL REQUIREMENTS

The following are criteria for selecting monitoring wells in the MV groundwater basin. Wells selected for monitoring should have:

- A State Well Driller Log that describes the well construction details and a description of the sediments encountered
- A detailed description of the well's location
- A brief description of the well's use (i.e. irrigation, residential)
- A relatively short screen interval in only one aquifer
- A sanitary seal to prevent surface water from entering the well
- Wells cannot be municipal (public) production wells for water supply

The most desirable wells to be included in the monitoring network are wells with short screen intervals completed within a specified aquifer. However, some wells with longer screen intervals may need to be initially included in the network when no others are available. Wells with long screen intervals may also be designated for monitoring because their long historic records provide valuable trending information. Data obtained from the longer screen wells usually represents an average of groundwater elevations across the unconfined and semi-confined aquifers.

TABLE 3-1. SELECTED INFORMATION FOR CURRENT MONITORING WELLS IN MARTIS VALLEY GROUNDWATER BASIN			
Figure 3-1 Reference Index	**1**	**2**	**3**
State Well Number	17N16E01	17N16E01	17N16E13
Reference Point Elevation (ft - NAVD88)	5,843	5,904	5,796
Reference Point Description	Top of Casing (All Three)		
Ground Surface Elevation (ft - NAVD88)	5,839	5,900	5,792
Method of Determining Elevation	Digital Terrain Model (All Three)		
Accuracy of Elevation (ft)	+/- 3 (All Three)		
Well Use	Monitoring (All Three)		
Well Status	Active (All Three)		
Geographic Coordinates (NAD83, CA Z2)			
Latitude:	39.354541	39.344834	39.325769
Longitude:	-120.14377	-120.156033	-120.143471
Method of Determining Coordinates	GPS (All Three)		
Accuracy of Coordinates (ft)	+/- 3 (All Three)		
Well Completion Type	Single (All Three)		
Casing Diameter (in.)	8	6	8
Total Depth (ft)	1,197	1,220	1,040
Screen Intervals (2 ea.) (ft)			
First Screen:	360 to 620	120 to 160	315 to 633
Second Screen:	760 to 1,160	200 to 240	707 to 978
Well Completion Report Number	733242	E008043	733241
Year Drilled	2000	2003	2000
Common Name	Prosser Village	Fibreboard	Martis Valley
Well Location Description	12546 Fairway Drive 75 Yards Southwest of Building	12650 Caleb Circle On Path to Pond	12201 Joerger Road 50 Yards East of Building

TABLE 3-1 CONTINUED. SELECTED INFORMATION FOR DWR CASGEM MONITORING WELLS IN MARTIS VALLEY GROUNDWATER BASIN		
Figure 3-1 Reference Index	17N17E19K001M	18N17E33L001M
State Well Number	17N17E19K001M	18N17E33L001M
Reference Point Elevation (ft-NAVD88)	5862.8	5922.5
Reference Point Description	Top of PVC Casing	Top of PVC Casing
Ground Surface Elevation (ft-NAVD88)	5860	5920
Method of Determining Elevation	Surveying	
Accuracy of Elevation (ft)	Within 0.1 ft.	
Well Use	Observation	Observation
Well Status	Active	Active
Geographic Coordinates (NAD83)		
Latitude:	39.3072	39.3653
Longitude	-120.1315	-120.099
Method of Determining Elevation	Unkown	
Accuracy of Elevation (ft)	Unkown	
Well Completion Type	Single Well	Single Well
Casing Diameter (in.)	2	2
Total Depth (ft)	201	200
Screen Intervals (ft)	187-197	180-190
Well Completion Report Number	N/A	365669
Year Drilled	1990	1990
Well Location Description	50 ft. South of Martis Creek Rd. 1000 ft. east of the intersection of Martis Creek Rd. and Hwy 267.	Truckee Fire Protection District P.O. Box 686 Truckee, CA

3.4 REQUIRED STEPS IN SELECTING A NEW MV MONITORING WELL

Upon selection of any new well, that is not currently a MV monitoring well, to be potentially included in the monitoring network, a site visit will be necessary to assess the field conditions. The conditions necessary for a well to be used in the network include:

- A well owner (and tenant) who will allow access for monitoring.
- All-weather access, key to locked gates or fences, and no guard dogs.
- Ability to survey the ground elevation and reference point elevation of the well. See Page 9 of the DWR Groundwater Elevation Monitoring Guidelines for details establishing the reference point.
- A clear access point through the pump or well casing for water-level sounders. Figure 3-2 shows a typical well sounding location detail.
- An assessment to determine if lubrication oil from a turbine pump has accumulated in the well or if there are obstructions in the well that would prevent obtaining repeat and reliable measurements.
- If currently in use, to have access in shutting a well down for a minimum 2-hour period (24-hous preferred) for reaching quasi-equilibrium.
- For wells that are owned by others, private or public, the protocols discussed below shall be followed for explaining the project purpose and establishing rights for access.
- If a new monitoring well is to be installed, appropriate hydrogeologic investigation shall be made, a design that considers the specific needs of monitoring shall be prepared, and the well shall be drilled under the observation and direction of a hydrogeologist.

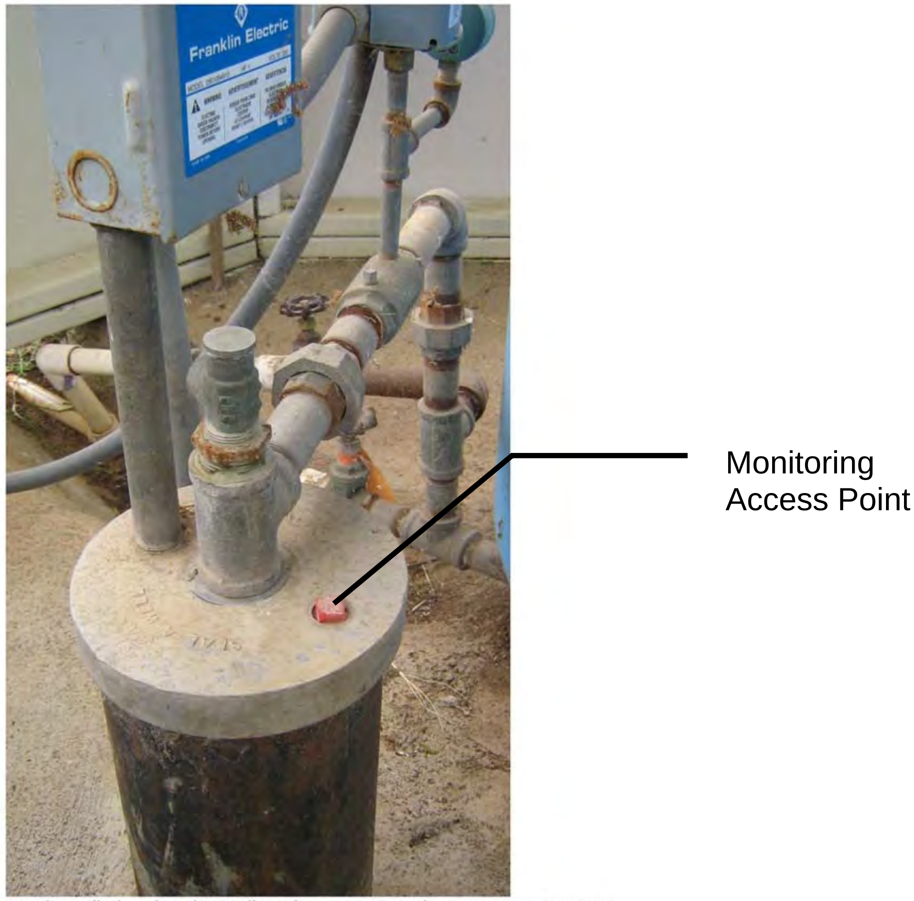

Photo: A domestic well showing the well casing, cover, and conveyance system. The well is located inside a shed with a concrete floor.

FIGURE 3-2. ACCESS POINT ON A WELL

Before knocking on the door of potential well owners, every effort should be made to justify the need for the owner's well in the network. Staff shall coordinate with Right-of-Way personnel to arrange a field visit if the owner allows it. The reason for monitoring and the benefits to long-term sustainability shall be described. Additionally, practical details about site access and how measurements are made shall be discussed. If the owner is interested in allowing their well into the network, the well shall be inspected for adequacy based on the bulleted criteria above. If the well is adequate, formal rights of entry shall be prepared by Right-of-Way personnel before proceeding. Any special contact information to perform the monitoring should also be noted along with information related to sites where a tenant is renting from the property owner. These steps will ensure consistent monitoring even though monitoring staff, tenants and well site access may change over time.

4.0 MONITORING EQUIPMENT AND PREPARATION

This section provides the MV monitoring entities with a "how to" manual for accessing monitoring wells and, taking depth-to-groundwater measurements and water quality samples. The range of equipment and protocols covered in this section will assist monitoring staff with the challenges that exist in the field. Each time a well is accessed as part of a monitoring event, staff needs to conduct themselves in a professional manner by being prepared with the right equipment and looking prepared with the correctly labeled vehicle and clothing, and pertinent staff identification. Staff should also strive to maintain a good relationship with the well owners and demonstrate genuine courtesy.

This section also provides relevant portions of the CASGEM Groundwater Elevation Monitoring Guidelines (Guidelines) handbook attached as Appendix A. The CASGEM handbook is intended for the following purpose:

> …*Guidelines were developed to assist DWR by establishing criteria for the selection and measurement of monitoring wells in the event that DWR is required to perform the groundwater monitoring functions in lieu of a local monitoring agency pursuant to Water Code Section 10933.5(a).*

The Guidelines also imply that a local agency that wishes to take over an existing monitoring well or create a new monitoring well should follow a documented consistent approach for each well over the life of the well. Given the unique location, construction technique, and down-hole equipment installation, measurement of each well should endeavor to follow the Guidelines knowing that field conditions may require slight deviations. This endeavor leads to the need of having a specialized documented procedure for each monitoring well that ensures a consistent measurement technique over time (some wells dating back to the 1930s). Changes in the well setting, use, and equipment may change over time, requiring changes in monitoring techniques. Wells constructed for and devoted to monitoring the groundwater can also change depending on activities around the well that may artificially change the static condition of groundwater levels (e.g., construction and use of a nearby high-production municipal well) or the elevation of the well head (e.g., well is located in proposed paved area where the well head will be cut below grade with a sealed and locked access chamber flush to pavement).

4.1 PERSONNEL TRAINING

All well monitoring programs are subject to turnover in agency staff. The best and most effective way of transitioning and training new staff is to have new staff work alongside the experienced staff during a transition period. Absent this on-the-job-training, thorough record keeping, periodic updating of the monitoring plan, and review of this document will expose new staff to the wells and the protocols followed from previous measurements.

4.2 WELL MONITORING LOG BOOK (WMLB)

The WMLB is the definitive field document that contains the following:

- Well owner and contact information
- Special entrance instructions (e.g., call at gate, honk horn, or dog off leash)
- A schematic identifying the location of the well (high-resolution aerial imagery can also be used if the monitoring well can be clearly identified)
- Pictures of the well including reference point and access port (See **Figure 4-1**)
- Checklist of special instructions based on well owner requirements or special conditions (i.e. – closed gates, protected wetlands, electrical power shut off, etc.)
- Equipment needed for measurement (i.e., some wells require walking a fair distance into the field, wrench to remove access plug)
- Ground and reference point elevations and source of measurement
- List of historical measurements and codes identifying questionable measurements or field conditions making measurements impossible

Multiple wells can be in the same WMLB for convenience out in the field. This will likely be the case if multiple agencies will be making measurements within their respective jurisdiction. An example of the minimum data form and information kept for each well is taken from the CASGEM Guidelines, as shown on Figure 4-1.

4.2.1 Required Equipment

The monitoring agency will need to compile a set of tools and have them stored in a designated location at the monitoring agency's premises. The equipment should be in a locked toolbox that can easily be carried by one person, if needed. The CASGEM Guidelines include a list of field equipment needed for the initial well measurements, as shown on **Figure 4-2**. Once all wells have established reference points and measurement conditions, a shorter list of supplies can be assembled for field measurements as follows:

- Digital camera
- Crescent wrench (large and small)
- Channel lock pliers (large and small)
- Small hammer and rubber mallet

State of California | DEPARTMENT OF WATER RESOURCES | California Natural Resources Agency

WELL DATA

State No. ____________________

District ____________________

OWNER		STATE NO.	
ADDRESS		OTHER NO.	
TENANT			
ADDRESS			
TYPE OF WELL ☐ SPECIAL STUDIES	☐ MONTHLY	☐ SEMI ANNUAL	☐ WATER QUALITY
LOCATION: COUNTY	BASIN	NO.	
U.S.G.S. QUAD.		QUAD NO.	
1/4 1/4 SECTION	TWP.	RGE.	BASE & MERIDIAN: MD ☐ SB ☐ H ☐
COORDINATES X:	Y:	SOURCE:	
DESCRIPTION			
REFERENCE POINT DESCRIPTION			
WHICH IS FT. ABOVE ☐ BELOW ☐	LAND SURFACE.	GROUND ELEVATION	FT.
REFERENCE POINT ELEVATION FT.	DETERMINED FROM		
WELL: USE	CONDITION	DEPTH	FT.
CASING, SIZE IN.,	PERFORATIONS		
MEASUREMENTS BY: ☐ DWR ☐ USGS ☐ USBR	☐ COUNTY ☐ IRR. DIST.	☐ WATER DIST.	☐ CONS. DIST.
CHIEF AQUIFER: NAME	DEPTH TO TOP AQ.	DEPTH TO BOT. AQ.	
TYPE OF MATERIAL	PERM. RATING	THICKNESS	
GRAVEL PACKED? ☐ YES ☐ NO	DEPTH TO TOP GR.	DEPTH TO BOT GR.	
SUPP. AQUIFER	DEPTH TO TOP AQ.	DEPTH TO BOT. AQ.	
DRILLER	DATE DRILLED:	LOG NUMBER:	
EQUIPMENT: PUMP, TYPE	MAKE		
SERIAL NO. SIZE OF DISCHARGE PIPE IN.	WATER ANALYSIS: MIN. (1)	SAN. (2)	H.M. (3)
POWER, KIND MAKE	WATER LEVELS AVAILABLE: YES (1)	NO	
H.P. MOTOR SERIAL NO	PERIOD OF RECORD: BEGIN	END	
ELEC. METER NO. TRANSFORMER NO.	COLLECTING AGENCY:		
YIELD G.P.M. PUMPING LEVEL FT.	PROD. REC. (1)	PUMP TEST (2)	YIELD (3)
SKETCH (N)	REMARKS		
	RECORDED BY:		
	DATE:		

DWR 429 (Rev. 1/09)

Source: Table 3. General Well Data Form, CASGEM Guidelines, DWR, December 2010

FIGURE 4-1. GENERAL WELL DATA FORM (DWR FORM 429)

FIGURE 4-2. CASGEM FIELD EQUIPMENT LIST

Equipment and supplies needed for (a) all measurements, (b) establishing permanent RP, (c) steel tape method, (d) electric sounding tape method, (e) sonic water-level meter, and (f) automated measurements with pressure transducer.
(a) All measurements
GPS instrument, digital camera, watch, calculator, and maps
General well data form (DWR Form 429; see Table 3)
Pens, ballpoint with non-erasable blue or black ink, for writing on field forms and equipment log books
Well file with previous measurements
Measuring tape, graduated in feet, tenths, and hundredths of feet
Two wrenches with adjustable jaws and other tools for removing well cap
Key(s) for opening locks and clean rags
(b) Establishing a permanent reference point
Steel tape, graduated in feet, tenths, and hundredths of feet
Calibration and maintenance log book for steel tape
Paint (bright color), permanent marker, chisel, punch, and(or) casing-notching tool

(c) Steel tape method
DWR field form 1213 (see Table 5)
Steel tape, graduated in feet, tenths, and hundredths of feet
Calibration and maintenance log book for steel tape
Weight (stainless steel, iron, or other noncontaminating material – do not use lead)
Strong ring and wire, for attaching weight to end of tape. Wire should be strong enough to hold weight securely, but not as strong as the tape, so that if the weight becomes lodged in the well the tape can still be pulled free.
Carpenters' chalk (blue) or sidewalk chalk
Disinfectant wipes, and deionized or tap water for cleaning tape.
(d) Electric sounding tape method
DWR field form 1213 (see Table 5)
Steel tape, graduated in feet, tenths, and hundredths of feet
An electric tape, double-wired and graduated in feet, tenths, and hundredths of feet, accurate to 0.01 ft. Electric sounding tapes commonly are mounted on a hand-cranked and powered supply reel that contains space for the batteries and some device ("indicator") for signaling when the circuit is closed.
Electric-tape calibration and maintenance log book; manufacturer's instructions.
Disinfectant wipes, and deionized or tap water for cleaning tape.
Replacement batteries, charged.
(e) Sonic water-level meter method
DWR field form 1213 (see Table 5)
Temperature probe with readout and cable
Sonic water-level meter with factory cover plate
Custom sized cover plates for larger well diameters
Replacement batteries
(f) Automated measurements with pressure transducer
Transducer field form (see Figures 1 and 2 in Drost, 2005: http://pubs.usgs.gov/of/2005/1126/pdf/ofr20051126.pdf)
Transducer, data logger, cables, suspension system, and power supply.
Data readout device (i.e., laptop computer loaded with correct software) and data storage modules.
Spare desiccant, and replacement batteries.
Well cover or recorder shelter with key.
Steel tape (with blue carpenters' chalk or sidewalk chalk) or electric sounding tape, both graduated in hundredths of feet.
Tools, including high-impedance (digital) multimeter, connectors, crimping tool, and contact-burnishing tool or artist's eraser.

Source: Table 4- Equipment and Supply List, CASGEM Guidelines, DWR, December 2010

- Keys for gates and monitoring well covers
- Stop watch
- Wasp or hornet nest spray
- Twelve-foot tape measure
- Pencil and graph paper
- First aid kit

Minimum Tools needed for actual in the field depth-to-groundwater measurements include:

- 200-foot well sounding steel tape measure
- Blue chalk for metal tape
- 200-foot electronic well sounding probe (See **Figure 4-3**)
- Soap, high-purity water, and spray bottle for cleaning tape and probe
- Sterilizer solution for tape and probe to prevent introducing contaminants to a the well

FIGURE 4-3. WELL SOUNDING PROBE AND TAPE

4.3 CHALLENGES TO BE PREPARED FOR

The steps necessary to complete a measurement of depth to groundwater are different for each monitoring well. See Pages 14 through 28 of the DWR Groundwater Elevation Monitoring guidelines for details on measuring water levels. Monitoring staff will need to understand these steps before accessing the well's property location. The WMLB will include a written and graphical stepwise illustration to fully inform monitoring staff. Consideration of how diversified the steps could be are illustrated in the following real-life examples:

- **Well is located on hilly terrain with no defined access trail or markers –** This type of well benefits from training new staff for at least two monitoring events. Absent the on-the-job experience the WMLB should be detailed enough in its descriptions and images to find the well. Steeper terrain may also require several trips to the vehicle for equipment to ensure free hands are available in case of a fall.

- **Well has no access port or casing bolt –** Many of the older wells and private domestic wells were not designed for dropping a tape measure or probe into the well. In these cases, the monitoring staff should clearly identify the access point by using orange utility marking spray paint while being careful to not get paint overspray into the well itself. Absent the paint identifier, the tape chalk can be used as well, but it may disappear over time due to rain and wind. Wells with only a small slit at the base of the concrete casing interface will require a tape measurement.

- **Well can only be accessed when owner is home –** This occurs in many cases where the well owner has to unlock a gate or simply wants to be home when the monitoring event occurs. In this case, an appointment is made by phone providing owner with a 1 hour or less window when monitoring staff will show up. In cases where this is needed to open a locked gate, the owner may allow access and then request that the gate be closed and locked when finished. Review the checklist in the WMLB before leaving the monitoring well.

- **Well is running when monitoring staff arrive –** If the well is a municipal production well or large agricultural well, it is best to work with the well owner to allow a 24-hour period of off-time before taking a measurement. If the well owner is not responsive to this request, ask to turn off the well upon arrival and monitor recovery. If the well is a private domestic well, ask if the water use can be turned off (typically a hydropneumatic tank will allow small quantities of water use without the well turning on) and monitor recovery as explained in next chapter.

- **Well casing is set flush to the ground –** This occurs when a well uses a submersible pump or no pump and no onsite hydropneumatic tank– in most cases this is a private well that may be abandoned or the tank is located away from well. In addition, wells with no visible casing can become covered with vegetation or debris and be difficult to find. In both cases, monitoring staff should stake the well and paint the wood stake orange.

- **Reference point is missing or the wellhead has been replaced –** This occurs if the reference point is not a permanent mark such as a cut or welded steel marker. This will also occur when a well is deepened or redrilled and the upper casing has been replaced. Monitoring staff will need to select a permanent mark (e.g., top of casing, monitoring hole) where the depth to groundwater can be measured. Monitoring staff should also measure the distance between the new reference point and the ground elevation at the base of the well. This measurement should be noted in the logbook.[2]

[2] The elevation of the new reference point will be calculated by the assigned data entry personnel using the ground elevation from the original survey and the reference point distance measured by field staff. The data entry personnel will need to be careful if the groundwater elevation is an automated calculation (i.e., past measurements will need to keep the old reference point) in a spreadsheet or DMS.

5.0 DEPTH-TO-GROUNDWATER PROCEDURES AND FREQUENCY OF MONITORING AND REPORTING

The following section describes the frequency for monitoring and reporting and describes the depth-to-groundwater measurement during each of the designated monitoring periods. **Figure 5-1** provides a form for documenting these described field measurements. An alternate form can be used if desired as long as the salient information is included. See also Pages 5 through 7 of the DWR Groundwater Elevation Monitoring Guidelines for additional details.

5.1 SEMIANNUAL GROUNDWATER-LEVEL MONITORING

Groundwater levels from all designated monitoring wells listed in Table 3-1 will be measured in the spring and fall (semiannually). Spring is generally considered to be the first week in May. Fall is generally considered to be the first week of November. If possible, all groundwater-level measurements should be taken within a 2-week period and, if possible, coordinate groundwater-level monitoring with DWR and its semiannual measurements.

5.2 DEPTH-TO-GROUNDWATER MONITORING PROCEDURES

DWR's Groundwater Elevation Monitoring Guidelines (see Appendix A) provide a complete set of procedures for measuring the depth to groundwater. The following procedures are included to supplement the CASGEM's broader guidelines. Over time, as monitoring staff become familiar with the well sites, a customized list can be documented. Staff will find that steps and monitoring equipment identified in the Guidelines do not apply to the wells being measured in the MV region or additional steps are required. The one exception to the MV monitoring wells is those that are measured through a continuous data logger. It is expected that the agency owning these wells will be downloading data collected by these devices separately from the MV Monitoring Program. This section focuses on measuring the depth to groundwater at designated MV monitoring well sites using a sounding probe or metal tape. Water-level measurements will be collected semiannually to assess the groundwater flow direction and to detect trends that can lead to improved management of the groundwater resources.

Each well has been assigned a unique Well Log identification (ID) number. The numbers and pertinent information for each well are listed in Table 3-1. Figure 6-1 (DWR Form 429, Page 11) extracted from the DWR's CASGEM Monitoring Guideline Handbook, along with the time and date of the measurement is recorded with groundwater-level measurements during the semiannual monitoring event.

GROUNDWATER LEVEL DATA FORM
MANUAL MEASUREMENTS

WELL ID NUMBER	WELL NAME	STATE WELL NUMBER	COUNTY	B-118 BASIN OR SUBBASIN	MEASURING AGENCY	LAND SURFACE DATUM (LSD) ELEV.	RP TO LAND SURFACE DATUM (LSD), IN FT	REFERENCE POINT (RP) ELEV.

NO MEASUREMENT (NM)
0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaky or wet
9. Temporarily inaccessible

QUESTIONABLE MEASUREMENT (QM)
0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaky or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

MEASUREMENT METHOD (MM)
0. Steel tape
1. Electric sounding tape
2. Other

DATE	TIME	N M	Q M	MM	TAPE at RP	TAPE at WS	RP to WS	LSD to WS	OBS	COMMENTS

[For explanation of terms, see figure 1.]

DWR Form 1213 (modified 6/28/2010) (data for Water Data Library)

FIGURE 5-1. GROUNDWATER-LEVEL DATA FORM FOR MANUAL MEASUREMENTS

The depth-to-static-groundwater level will be obtained at each well using an electric water-level sounder with a cable graduated in increments of 0.01 foot. Before measurement, monitoring staff will need to review the WMLB for the location of the reference point and measurement access port. A crescent wrench may be needed to access the well casing for measurement. Monitoring staff will need to also review past measurements in the WMLB to allow for careful lowering of the probe or tape.[3] To obtain a depth-to-water measurement, the electric sounder cable or tape will be lowered into the well to within 20 feet short of past measurements taken in the same season of the year, spring or fall.

Monitoring staff will continue to slowly lower the probe through the access port until the sounder indicates submergence by either a beeping sound or a light, depending on the type of signal installed for that particular model. At this point, the sampling personnel will note the depth to water (to the nearest 0.01 foot) from the reference point. The depth will be confirmed by lifting the sounder above the water surface by about 2 to 3 feet and then remeasuring the depth to water. If the depth remains constant, the depth to water will be recorded on Figure 6-1 (DWR Form 1213, Page 18). If measurements are showing change with each measurement, the monitoring staff will indicate the issue on the form and, with it, attach a graphic curve of the variable nature of the measurement, and its possible cause (e.g., bouncing, recovering water level).

5.3 QUALITY CONTROL

After completing their field work, the monitoring staff will enter the data into an electronic database management system. The monitoring staff will review the groundwater-level and water quality data for accuracy within 5 days of obtaining the measurements. Should a measurement appear suspicious, a groundwater level confirmation reading will be obtained.

[3] Tape measurements will require chalking of the tape and repeated measurements as per the CASGEM Guidelines (Page 15).

6.0 RECORDING OF MONITORING DATA, DATA MANAGEMENT AND THE CASGEM REQUIREMENTS

Once data is brought back from the field it will need to be digitized and loaded onto the CASGEM website. The partners will be collecting data from their respective wells and distributing it to the plan administrator, which is currently Placer County Water Agency. The Agency will function as the clearinghouse of all data that is relevant to the MV groundwater basin. In addition, the Agency will be the primary point of contact for the CASGEM Program and will upload all relevant data in a timely manner. The steps laid out currently for CASGEM participation are described as follows (see Appendix C, On-line Submittal System Manual):

> *Phase 1 of the CASGEM System was released in December, 2010, and allows prospective Monitoring Entities to do the following:*
>
> - *Create, edit, and submit notifications to become a Monitoring Entity*
> - *Create and manage user accounts*
> - *Create and manage agency information*
> - *Submit GIS shapefiles of mapped monitoring areas*
>
> *Phase 2 of the CASGEM System, released in May, 2011, makes the following additional functions available to prospective Monitoring Entities:*
>
> - *Submittal of groundwater monitoring plans*
> - *Submittal of well construction and location information on monitoring wells proposed to be monitored*
> - *Allow corrections to initial Monitoring Entity notifications or submittal of additional information requested by DWR*
> - *Ability to view and query maps of groundwater basins, proposed monitoring areas, monitored wells, and other geographic information associated with the CASGEM Program Phase 3 of the CASGEM System, scheduled for release in late fall, 2011, will allow designated Monitoring Entities to do the following:*

- *Submit groundwater elevation measurement data*
- *View and update their CASGEM data, as needed*

With Phase 3 of the CASGEM System, public access to the Statewide CASGEM data will be available. Users will be able to download data and view spatial and temporal groundwater elevation trends in the GIS viewer application.

(URL: http://www.water.ca.gov/groundwater/casgem/submittal_system.cfm, On-line Submittal System, DWR)

The Agency has already completed Phase 1 of the CASGEM Program. The next step requires entry of data for each of the monitoring wells included as part of this Monitoring Program. **Figure 6-1** is taken from the CASGEM On-line System manual. The manual states that "Data may be entered on a well-by-well basis on a system data entry screen, or users can do a batch upload of information from multiple wells (using a spreadsheet template available for download within the system)." The latter will likely be the best method for entering the data given that most of the well information is already captured in an Excel Workbook.

Data entry for groundwater elevations is not fully described but will likely be similar to the well inventory where a spreadsheet template can be uploaded for all groundwater-elevation data. The conversion of groundwater-elevation data from a database (including GIS) platform is typically straight forward with a copy-and-paste step or a small routine that outputs the data in the desired format.

The inventory of Martis Valley well data will be based on DWR's CASGEM Monitoring Plan Summary attached as **Appendix B**. The set of data fields used for each well will require a decision on its need based on Appendix B requirements.

FIGURE 6-1. CASGEM'S WELL INVENTORY INPUT FORM

Appendix A

CASGEM Guidelines

Department of Water Resources

Groundwater Elevation Monitoring

Guidelines

December 2010

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Introduction to the CASGEM Program

On November 4, 2009 the state legislature amended the Water Code with SB 6, which mandates a statewide, locally-managed groundwater elevation monitoring program to track seasonal and long-term trends in groundwater elevations in California's groundwater basins. To achieve that goal the amendment requires collaboration between local Monitoring Entities and the Department of Water Resources (DWR) to collect groundwater elevation data. In accordance with the amendment, DWR developed the California Statewide Groundwater Elevation Monitoring (CASGEM) program.

If no local entities volunteer to monitor groundwater elevations in a basin or part of a basin, DWR may be required to develop a monitoring program for that part. If DWR takes over monitoring of a basin, certain entities in the basin may not be eligible for water grants or loans administered by the state.

DWR will report findings of the CASGEM program to the Governor and the Legislature by January 1, 2012 and thereafter in years ending in 5 or 0.

Purpose of Guidelines for DWR Monitoring

The following Guidelines were developed to assist DWR by establishing criteria for the selection and measurement of monitoring wells in the event that DWR is required to perform the groundwater monitoring functions in lieu of a local monitoring agency pursuant to Water Code Section 10933.5(a).

The primary objective of the CASGEM monitoring program is to define the seasonal and long-term trends in groundwater elevations in California's groundwater basins. The scale for this evaluation should be the static, regional groundwater table or potentiometric surface. A secondary objective is to provide sufficient data to draw representative contour maps of the elevations. These maps could be used to estimate changes in groundwater storage and to evaluate potential areas of overdraft and subsidence.

Although it is not an objective of the CASGEM program, it would be valuable to include monitoring wells near localized features that impact more dynamic groundwater elevations. These features would include wells near aquifer storage and recovery projects, near high volume pumping wells, and near rivers.

NETWORK DESIGN CONCEPTS

SELECTION OF MONITORING WELLS FOR MONITORING PLANS

The number of groundwater wells that need to be monitored in a basin to adequately represent static water levels (and corresponding elevations) depends on several factors, some of which include: the known hydrogeology of the basin, the slope of the groundwater table or potentiometric surface, the existence of high volume production wells and the frequency of their use, and the availability of easily-accessible monitoring wells. Dedicated groundwater monitoring wells with known construction information are preferred over production wells to determine static water levels, and monitoring wells near rivers or aquifer storage and recovery projects should be avoided due to the potential for rapidly fluctuating water levels and engineered groundwater systems. The selection of wells should be aquifer-specific and wells which are screened across more than one aquifer should not be candidates for selection.

Heath (1976) suggested a density of groundwater monitoring wells ranging from 2 wells per 1,000 square miles (mi^2) for a large area in which only major features are to be mapped, to 100 wells per 1,000 mi^2 for a complex area to be mapped in considerable detail. The objective of the Heath (1976) design was to evaluate the status of groundwater storage and the areal extent of aquifers.

Sophocleous (1983) proposed a redesign of a water-level monitoring program for the state of Kansas based on efficiency, economics, statistical analysis, comparison of water-level hydrographs, and consistency across the state. The Sophocleous study recommended a "square well network" with a density of 1 observation well per 16 mi^2.

The Texas Water Development Board proposed varying well network densities for counties according to the amount of groundwater pumpage. These densities range from 0.7 wells per 100 mi^2 for counties with 1,000-2,500 acre-feet per year (AF/yr) of pumpage to 4 wells per 100 mi^2 for counties with over 100,000 AF/yr of pumpage (Hopkins, 1994). These densities were converted to pumpage per 100 mi^2 area by dividing by the size of an average county in Texas of about 1,000 mi^2 (Table 2)

Most designs of water-level monitoring programs rely on a probabilistic approach. Alley (1993) discussed four probabilistic designs: (1) simple random sampling throughout an aquifer; (2) stratified random sampling within different strata of an aquifer; (3) systematic grid sampling (e.g., at the midpoint of each section within an aquifer); and (4) random sampling within blocks (e.g., randomly selected wells within each section of an aquifer). The Sophocleous (1983) program used the third approach, systematic grid sampling. The guidelines on well density from the programs mentioned above are summarized in Table 2.

Based on the few referenced studies with specific recommendations, the consensus appears to fall between 2 and 10 groundwater monitoring wells per 100 mi^2. The exceptions to this density range include the lower end of the Heath (1976) range and the low-use counties in Texas.

There will always be a tradeoff between the improved spatial (and temporal) representation of water levels in an aquifer and the expense of monitoring. A higher-resolution contour map would be warranted in an area with a greater reliance upon groundwater in order to anticipate potential problems, such as supply and groundwater contamination concerns, while a lower-resolution contour map might be sufficient in an area with few people or a low reliance upon groundwater. Ideally, areas with relatively steep groundwater gradients or areas of high recharge or discharge would have a greater density of monitoring wells.

The illustrations in Figure 1 show a local groundwater elevation contour map developed with different numbers of wells. The examples cover the same area and use the same dataset, with wells randomly deleted by grid area from the full dataset to create a less dense network of wells. The resulting range of plotting density is 2 to 20 groundwater monitoring wells per 100 mi^2. The contours in Figure 1 show how the accuracy and resolution of the contour map increases with the density of wells used for plotting. To avoid presenting misleading contour maps, only wells with the best possible elevation accuracies should be used. These accuracies are a combination of the accuracies in the water-level measurement and the reference point (RP) measurement. Unless the RP elevation has been surveyed, it will be the limiting factor on elevation accuracy.

Program and(or) Reference	Density of monitoring wells (wells per 100 mi^2)
Heath (1976)	0.2 – 10
Sophocleous (1983)	6.3
Hopkins (1994) (a) Basins with >10,000 AF/yr groundwater pumping per 100 mi^2 area	4.0
(b) Basins with 1,000-10,000 AF/yr groundwater pumping per 100 mi^2 area	2.0
(c) Basins with 250-1,000 AF/yr groundwater pumping per 100 mi^2 area	1.0
(d) Basins with 100--250 AF/yr groundwater pumping per 100 mi^2 area	0.7

Table 1. Recommended density of monitoring wells for groundwater-level monitoring programs.

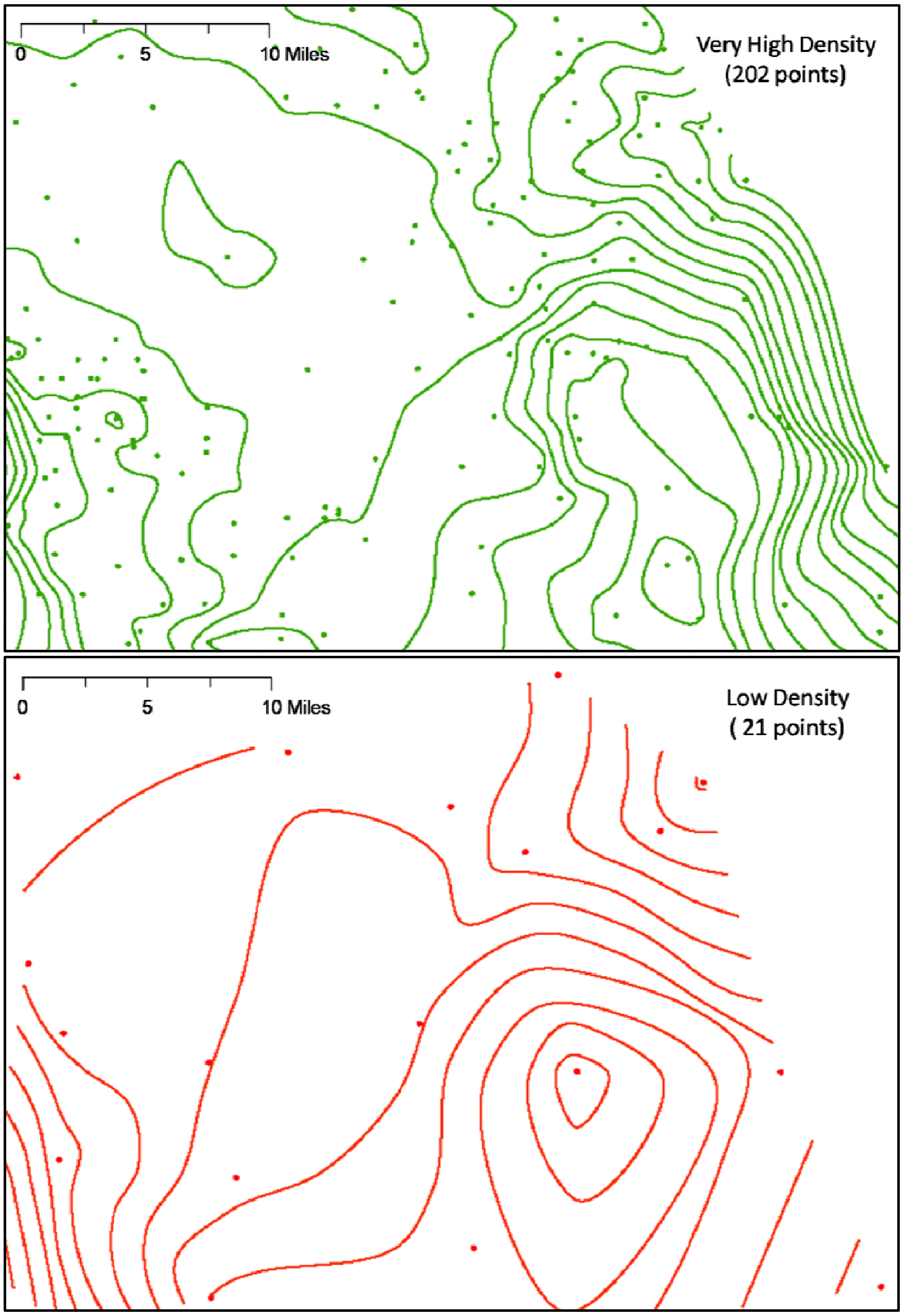

Figure 1. Contour maps – Contours of a very high-density well network (about 20 wells per 100 mi^2) compared to a low-density well network (about 2 wells per 100 mi^2).

FREQUENCY OF WATER-LEVEL MEASUREMENTS

To determine and define seasonal and long-term trends in groundwater levels a consistent measurement frequency must be established. At minimum, semi-annual monitoring of the designated wells in each basin or subbasin should be conducted to coincide with the high and low water-level times of year for each basin. However, quarterly- or monthly-monitoring of wells provides a better understanding of groundwater fluctuations. The DWR office responsible for monitoring a particular basin should use independent judgment to determine when the high and low water-level times occur in a groundwater basin, and to provide a justification for measurement rationale. The semi-annual frequency is a compromise between more frequent measurements (continuous, daily, monthly, or quarterly) and less frequent measurements (annual). A good discussion of water level measurement frequency and other issues related to the design of water-level monitoring programs can be found in the USGS Circular 1217 (Taylor and Alley, 2001).

An example of the effect of different measurement frequencies on the water-level hydrographs in a Northern California well is shown in Figure 2. The data shows that higher-frequency monitoring (e.g., daily or monthly) best captures the seasonal fluctuations in the groundwater levels, quarterly monitoring identifies some of the elevation change, but semi-annual measurements often miss the true seasonal highs and lows.

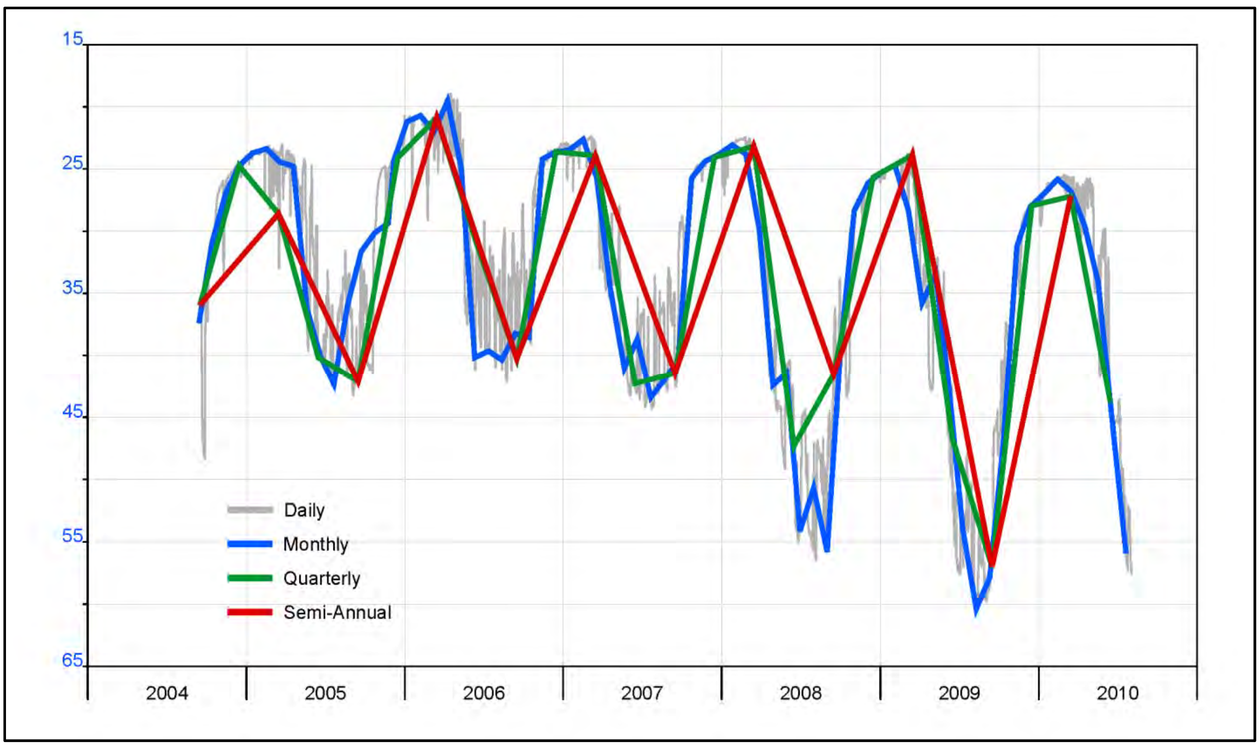

Figure 2. Groundwater Hydrographs – Groundwater elevation changes in a monitoring well over time comparing various measurement frequencies.

The Subcommittee on Ground Water of the Advisory Committee on Water Information generally recommends more frequent measurements than are being required by the CASGEM program; quarterly to annually for aquifers with very few groundwater withdrawals, monthly to quarterly for aquifers with moderate groundwater withdrawals, and daily to monthly for aquifers with many groundwater withdrawals (Table 2). The general effect of environmental factors on the recommended measurement frequency is illustrated in Figure 3.

Measurement Type	**Aquifer Type**	**Nearby Long-Term Aquifer Withdrawals**		
		Very Few Withdrawals	***Moderate Withdrawals***	***Many Withdrawals***
Baseline Measurements	**All aquifer types**	Once per month	Once per day	Once per hour
Surveillance Measurements	**All aquifer types:** "low" hydraulic conductivity (<200 ft/d), "low" recharge (<5 in/yr)	Once per year	Once per quarter	Once per month
	All aquifer types: "high" hydraulic conductivity (>200 ft/d), "high" recharge (>5 in/yr)	Once per quarter	Once per month	Once per day
Data made available to NGWMN	All aquifer types, throughout range of hydraulic conductivity	As stored in local database, but at least annually	As stored in local database, but at least annually	As stored in local database, but at least annually

Table 2. Information on recommended minimum water-level measurement frequency from the Subcommittee on Ground Water of the Advisory Committee on Water Information (2009) (abbreviations: ft/d, feet per day; in/yr, inches per year; NGWMN, National Ground Water Monitoring Network). NOTE: These are not recommendations of the CASGEM program.

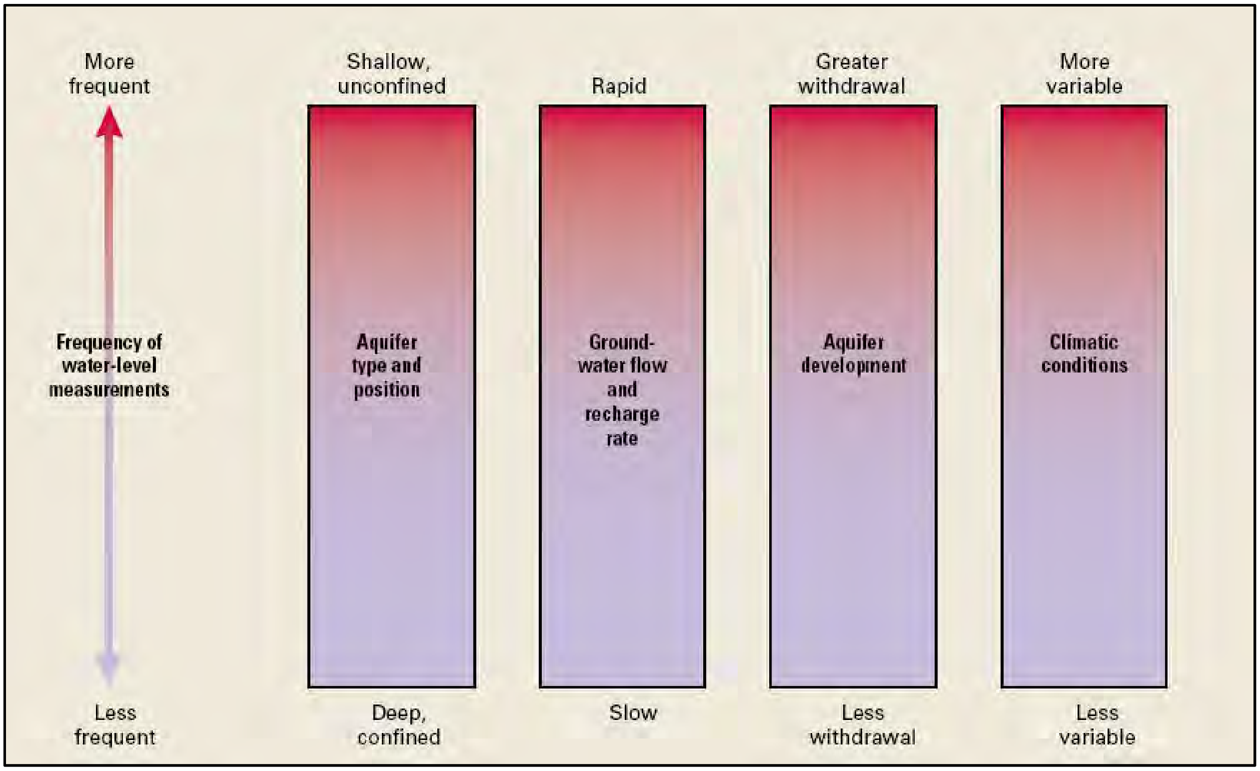

Figure 3. Common environmental factors that influence the choice of frequency of water-level measurements (from Taylor and Alley, 2001).

FIELD GUIDELINES FOR CASGEM WATER-LEVEL MEASUREMENTS

INTRODUCTION

This document presents guidelines for measuring groundwater levels in wells for the CASGEM program to ensure consistency between DWR offices. Following these guidelines will help ensure that groundwater level measurements are accurate and consistent in both unconfined and confined aquifers. Although a well network comprised entirely of dedicated monitoring wells (hereafter referred to as monitoring wells) is preferred, by necessity active production wells used for irrigation or domestic purposes and abandoned production wells that were used for domestic, irrigation, and public supply purposes will also need to be included. **The portions of these guidelines that apply to only production wells will be shown in bold throughout.** DWR does not currently plan to include public supply wells in the CASGEM well networks due to security concerns of the California Department of Public Health.

The main reference used for these guidelines is the United States Geological Survey (USGS) National Field Manual (NFM) (U.S. Geological Survey, 2006). The final report of the Subcommittee on Groundwater (SOGW) of the Advisory Committee on Water Information was also used as a main reference, although in general it relied on the USGS guidelines (Subcommittee on Ground Water of the Advisory Committee on Water Information, 2009). The water-level measurement portion of the USGS guidelines were written for monitoring wells and not for production wells (Taylor and Alley, 2001; U.S. Geological Survey, 2006). Thus, although the USGS guidelines have been adopted with only minor modifications for the monitoring well guidelines of the CASGEM program, additional modifications have been incorporated in the guidelines for production wells. **The most significant changes made to the USGS guidelines for production wells are: (1) reducing the required precision for consecutive depth to water measurements, (2) checking for obstructions in the well, and (3) not attaching weights to the steel tape so as not to hang up on obstructions.**

The guidelines presented in this document are for the use of steel tape, electric sounding tape, sonic water-level meters, or pressure transducers. Although the semi-annual measurements required by the CASGEM program can be satisfied with the use of a steel or electric sounding tape or sonic meter, a pressure transducer with a data logger provides a much better picture of what is happening with water levels over time. The use of the air-line or flowing-well methods should not be needed in most basins. However, if they are, guidelines for these methods are available in sections A4-B-4 (pages B17-B20) and A4-B-5 (pages B21-B24), respectively of the NFM (U.S. Geological Survey, 2006).

ESTABLISHING THE REFERENCE POINT

Water-level measurements from a given well must be referenced to the same datum (the reference point, or RP) to ensure data comparability (see Figure 4). For monitoring wells, the RP should be marked on the top of the well casing. For production wells, the RP will most likely be the top of the access tube or hole to the well casing. The RP must be as permanent as possible and be clearly visible and easily located. It can be marked with a permanent marker, paint, imprinting a mark with a chisel or punch, or by cutting a slot in the top of the casing. In any case, the location of the RP should be clearly described on DWR Form 429 (see Table 3). A photograph of the RP, with clear labeling, should be included in the well folder. In some cases, it may be valuable to establish multiple RPs for a well, depending on the consistent accessibility of the primary RP. In this case, each RP should be clearly described on DWR Form 429 and labeled in the field. The RP should be established with the following coordinate system: horizontal location (decimal latitude and longitude referenced to the North American Datum of 1983; NAD83) and vertical elevation (referenced to the North American Vertical Datum of 1988; NAVD88, in feet).

The land-surface datum (LSD) is established by the person making the initial water-level measurement at the well. The LSD is chosen to represent the average elevation of the ground around the well. Because LSD around a well may change over time, the distance between the RP and LSD should be checked every 3 to 5 years. If appropriate, a concrete well pad or well vault may be chosen as the LSD, since they will be more permanent than the surrounding ground surface.

The elevation of the RP can be determined in several ways: (1) surveying to a benchmark, (2) using a USGS 7.5' quadrangle map, (3) using a digital elevation model (DEM), or (4) using a global positioning system (GPS). While surveying is the most accurate (± 0.1 ft), it is also the most expensive. Depending on the distance to the nearest benchmark, the cost can be prohibitive. The latitude and longitude of the well can be established accurately using a handheld GPS. From this information, the LSD can be located on a USGS quadrangle and the elevation estimated. However, the accuracy is only about ± one half of the contour interval. Thus, for a contour interval of 5 feet, the accuracy of the elevation estimate would be about ± 2.5 feet. The contour interval of high quality DEMs is currently about 30 feet. Therefore, the accuracy of using

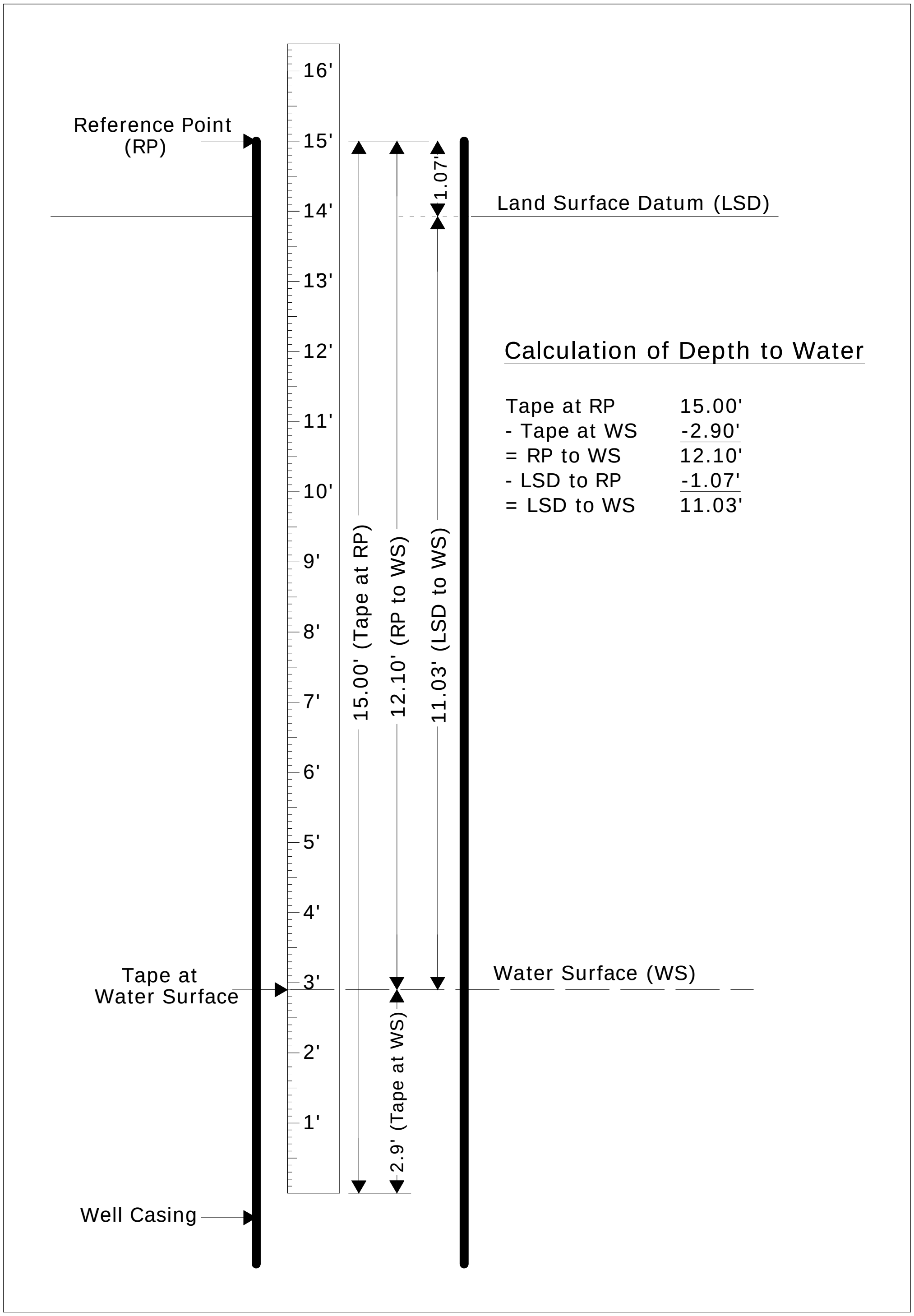

Figure 4. Groundwater-level measurements using a graduated steel tape (modified from U.S. Geological Survey, 2006).

State of California | DEPARTMENT OF WATER RESOURCES | California Natural Resources Agency

WELL DATA

State No. ____________________

District ____________________

OWNER			STATE NO.	
ADDRESS			OTHER NO.	
TENANT				
ADDRESS				
TYPE OF WELL	☐ SPECIAL STUDIES	☐ MONTHLY	☐ SEMI ANNUAL	☐ WATER QUALITY
LOCATION: COUNTY		BASIN		NO.
U.S.G.S. QUAD.			QUAD NO.	
1/4	1/4 SECTION	TWP.	RGE.	MD ☐ SB ☐ H ☐ BASE & MERIDIAN
COORDINATES X:	Y:		SOURCE:	
DESCRIPTION				
REFERENCE POINT DESCRIPTION				
WHICH IS FT.	ABOVE ☐ BELOW ☐	LAND SURFACE.	GROUND ELEVATION	FT.
REFERENCE POINT ELEVATION	FT.	DETERMINED FROM		
WELL: USE	CONDITION		DEPTH	FT.
CASING, SIZE	IN.,	PERFORATIONS		
MEASUREMENTS BY:	☐ DWR ☐ USGS	☐ USBR ☐ COUNTY	☐ IRR. DIST. ☐ WATER DIST.	☐ CONS. DIST.
CHIEF AQUIFER: NAME		DEPTH TO TOP AQ.	DEPTH TO BOT. AQ.	
TYPE OF MATERIAL		PERM. RATING	THICKNESS	
GRAVEL PACKED?	☐ YES ☐ NO	DEPTH TO TOP GR.	DEPTH TO BOT GR.	
SUPP. AQUIFER		DEPTH TO TOP AQ.	DEPTH TO BOT. AQ.	
DRILLER		DATE DRILLED:	LOG NUMBER:	
EQUIPMENT: PUMP, TYPE		MAKE		
SERIAL NO.	SIZE OF DISCHARGE PIPE IN.	WATER ANALYSIS: MIN. (1)	SAN. (2)	H.M. (3)
POWER, KIND	MAKE	WATER LEVELS AVAILABLE: YES (1)	NO	
H.P.	MOTOR SERIAL NO	PERIOD OF RECORD: BEGIN	END	
ELEC. METER NO.	TRANSFORMER NO.	COLLECTING AGENCY:		
YIELD	G.P.M. PUMPING LEVEL FT.	PROD. REC. (1)	PUMP TEST (2)	YIELD (3)
SKETCH (N)		REMARKS		
		RECORDED BY:		
		DATE:		

DWR 429 (Rev. 1/09)

Table 3. General well data form (DWR Form 429).

DEMs to determine the elevation of the LSD is about ± 15 feet. While a handheld GPS unit is not very accurate for determining elevation, more expensive units with the Wide Area Augmentation System can be more accurate. However, GPS readings are subject to environmental conditions, such as weather conditions, overhead vegetative cover, topography, interfering structures, and location. Thus, the most common method of determining the elevation will probably be the use of USGS quadrangles. The method used needs to be identified on DWR Form 429 (Table 3). The important matter is that all measurements at a well use the same RP, as the elevation of that point can be more accurately established at a later date. The equipment and supplies needed for establishing the RP are shown in Table 4.

If possible, establish a clearly displayed reference mark (RM) in a location near the well; for example, a lag bolt set into a nearby telephone pole or set in concrete in the ground. The RM is an arbitrary datum established by permanent marks and is used to check the RP or to re-establish an RP should the original RP be destroyed or need to be changed. Clearly locate the RP and RM on a site sketch that goes into the well folder (see Table 3). Include the distance and bearing between the RP and the RM and the height of the lag bolt above the ground surface. Photograph the site, including the RP and RM locations; draw an arrow to the RP and RM on the photograph(s) using an indelible marker, and place the photos in the well file.

Table 4. Equipment and Supply List

Equipment and supplies needed for (a) all measurements, (b) establishing permanent RP, (c) steel tape method, (d) electric sounding tape method, (e) sonic water-level meter, and (f) automated measurements with pressure transducer.
(a) All measurements
GPS instrument, digital camera, watch, calculator, and maps
General well data form (DWR Form 429; see Table 3)
Pens, ballpoint with non-erasable blue or black ink, for writing on field forms and equipment log books
Well file with previous measurements
Measuring tape, graduated in feet, tenths, and hundredths of feet
Two wrenches with adjustable jaws and other tools for removing well cap
Key(s) for opening locks and clean rags
(b) Establishing a permanent reference point
Steel tape, graduated in feet, tenths, and hundredths of feet
Calibration and maintenance log book for steel tape
Paint (bright color), permanent marker, chisel, punch, and(or) casing-notching tool

Table 4. Equipment and Supply List (continued)

(c) Steel tape method
DWR field form 1213 (see Table 5)
Steel tape, graduated in feet, tenths, and hundredths of feet
Calibration and maintenance log book for steel tape
Weight (stainless steel, iron, or other noncontaminating material – do not use lead)
Strong ring and wire, for attaching weight to end of tape. Wire should be strong enough to hold weight securely, but not as strong as the tape, so that if the weight becomes lodged in the well the tape can still be pulled free.
Carpenters' chalk (blue) or sidewalk chalk
Disinfectant wipes, and deionized or tap water for cleaning tape.
(d) Electric sounding tape method
DWR field form 1213 (see Table 5)
Steel tape, graduated in feet, tenths, and hundredths of feet
An electric tape, double-wired and graduated in feet, tenths, and hundredths of feet, accurate to 0.01 ft. Electric sounding tapes commonly are mounted on a hand-cranked and powered supply reel that contains space for the batteries and some device ("indicator") for signaling when the circuit is closed.
Electric-tape calibration and maintenance log book; manufacturer's instructions.
Disinfectant wipes, and deionized or tap water for cleaning tape.
Replacement batteries, charged.
(e) Sonic water-level meter method
DWR field form 1213 (see Table 5)
Temperature probe with readout and cable
Sonic water-level meter with factory cover plate
Custom sized cover plates for larger well diameters
Replacement batteries
(f) Automated measurements with pressure transducer
Transducer field form (see Figures 1 and 2 in Drost, 2005: http://pubs.usgs.gov/of/2005/1126/pdf/ofr20051126.pdf)
Transducer, data logger, cables, suspension system, and power supply.
Data readout device (i.e., laptop computer loaded with correct software) and data storage modules.
Spare desiccant, and replacement batteries.
Well cover or recorder shelter with key.
Steel tape (with blue carpenters' chalk or sidewalk chalk) or electric sounding tape, both graduated in hundredths of feet.
Tools, including high-impedance (digital) multimeter, connectors, crimping tool, and contact-burnishing tool or artist's eraser.

GUIDELINES FOR MEASURING WATER LEVELS

Monitoring wells typically have a cap on the wellhead. After the cap is removed, the open top of the well is easily accessible for sampling water levels and water quality. If the well is to be sampled for water quality in addition to water level, the water-level measurement should be made before the well is purged. Before discussing the detailed measurement steps for different methods, some guidance is provided on the common issues of well caps, recovery time after pumping, and cascading water in a well.

Well caps are commonly used in monitoring wells to prevent the introduction of foreign materials to the well casing. There are two general types of well caps, vented and unvented. Vented well caps allow air movement between the atmosphere and the well casing. Unvented well caps provide an airtight seal between the atmosphere and the well casing.

In most cases it is preferred to use vented well caps because the movement of air between the atmosphere and the well casing is necessary for normal water level fluctuation in the well. If the cap is not vented the fluctuation of groundwater levels in the well will cause increased or decreased air pressure in the column of air trapped above the water in the casing. The trapped air can prevent free movement of the water in the casing and potentially impact the water level that is measured. Vented caps will allow both air and liquids into the casing so they should not be used for wells where flooding with surface water is anticipated or contamination is likely from surface sources near the well.

Unvented well caps seal the top of the well casing and prevent both air and liquid from getting into the well. They are necessary in areas where it is anticipated that the well will be flooded from surface water sources or where contamination is likely if the casing is not sealed. Because the air above the water in the casing is trapped in the casing and cannot equalize with the atmospheric pressure, normal water level fluctuation may be impeded. When measuring a well with an unvented cap it is necessary to remove the cap and wait for the water level to stabilize. The wait time will vary with many different factors, but if several sequential water-level measurements yield the same value it can be assumed the water level has stabilized.

Unlike monitoring wells, production wells have obstructions in the well unless it is an abandoned production well and the pump has been removed. In addition, the wellhead is not always easily accessible for monitoring water levels. Since pumping from the production wells will create a non-static water level, the water-level measurement should ideally not be made until the water level has returned to static level. However, this recovery time will vary from site to site. Some wells will recover from pumping level to static level within a few hours, while many wells will take much longer to recover. Some wells will recover from pumping level to static level within a few hours, while many wells will take much longer to recover. Thus, as a general recommendation, measurements should not be collected until 24 hours after pumping has ceased, however, site specific

conditions may require deviating from this. The time since pumping should be noted on the field form.

Water may enter a well above the water level, drip or cascade down the inside of the well, and lead to false water level measurements. Sometimes cascading water can be heard dripping or flowing down the well and other times it is discovered when water levels are abnormally shallow and/or difficult to determine. Both steel tapes and electric sounding tapes can give false readings. A steel tape may be wet from the point where water is entering the well making it hard to see the water mark where the tape intersects the water level in the well. An electric sounding tape signal may start and then stop as it is lowered down the well. If this happens, you can lightly shake the tape. The signal often becomes intermittent when water is running down the tape, but remains constant in standing water. On most electric sounding tapes, the sensitivity can be turned down to minimize false readings. It should be noted when a water level measurement is taken from a well with cascading water.

(1) Steel Tape Method

The graduated steel-tape (wetted-tape) procedure is considered to be the most accurate method for measuring water levels in nonflowing wells. A graduated steel tape is commonly marked to 0.01 foot. When measuring deep water levels (>500 ft), thermal expansion and stretch of the steel tape starts to become significant (Garber and Koopman, 1968). The method is most accurate for water levels less than 200 feet below land surface. The equipment and supplies needed for this method are shown in Table 4.

The following issues should be considered with this method:

- It may be difficult or impossible to get reliable results if water is dripping into the well or condensing on the well casing.
- If the well casing is angled, instead of vertical, the depth to water should be corrected, if possible. This correction should be recorded in the field folder.
- **Check that the tape is not hung up on obstructions.**

Before making a measurement:

1. Maintain the tape in good working condition by periodically checking the tape for rust, breaks, kinks, and possible stretch. Record all calibration and maintenance data associated with the steel tape in a calibration and maintenance log book.

2. If the steel tape is new, be sure that the black sheen on the tape has been dulled so that the tape will retain the chalk.

3. Prepare the field forms (DWR Form 1213; see Table 5). Place any previous measured water-level data for the well into the field folder.

4. Check that the RP is clearly marked on the well and accurately described in the well file or field folder. If a new RP needs to be established, follow the procedures above.

5. In the field, wipe off the lower 5 to 10 feet of the tape with a disinfectant wipe, rinse with de-ionized or tap water, and dry the tape.

6. If possible, attach a weight to the tape that is constructed of stainless steel or other noncontaminating material to protect groundwater quality in the event that the weight is lost in the well. **Do not attach a weight for production wells.**

Making a measurement:

1. If the water level was measured previously at the well, use the previous measurement(s) to estimate the length of tape that should be lowered into the well. Preferably, use measurements that were obtained during the same season of the year.

2. Chalk the lower few feet of the tape by pulling the tape across a piece of blue carpenter's chalk or sidewalk chalk (the wetted chalk mark identifies that part of the tape that was submerged).

3. Slowly lower the weight (for monitoring wells only) and tape into the well to avoid splashing when the bottom end of the tape reaches the water. Develop a feel for the weight of the tape as it is being lowered into the well. A change in this weight will indicate that either the tape is sticking to the side of the casing or has reached the water surface. Continue to lower the end of the tape into the well until the next graduation (a whole foot mark) is at the RP and record this number on DWR Form 1213 (Table 5) next to "Tape at RP" as illustrated on Figure 4.

4. Rapidly bring the tape to the surface before the wetted chalk mark dries and becomes difficult to read. Record the number to the nearest 0.01 foot in the column labeled as "Tape at WS."

5. If an oil layer is present, read the tape at the top of the oil mark to the nearest 0.01 foot and use this value for the "Tape at WS" instead of the wetted chalk mark. Mark an "8" in the QM column of DWR Form 1213 (see Table 5) to indicate a questionable measurement due to oil in the well casing. There are methods to correct for oil, such as the use of a relatively inexpensive water-finding paste. The paste is applied to the lower end of the steel tape and the top of the oil shows as a wet line and the top of the water shows as a distinct color change. Since oil density is about three-quarters that of water, the water level can be estimated by adding three-quarters of the thickness of the oil layer to the oil-water interface elevation (U.S. Geological Survey, 2006).

6. Subtract the “Tape at WS” number from the “Tape at RP” number and record the difference (to the nearest 0.01 ft) as “RP to WS”. This reading is the depth to water below the RP.

7. Wipe and dry off the tape and re-chalk based on the first measurement.

8. Make a second measurement by repeating steps 3 through 5, recording the time of the second measurement on the line below the first measurement (Table 5). The second measurement should be made using a different “Tape at RP” than that used for the first measurement. If the second measurement does not agree with the original within 0.02 of a foot **(0.2 of a foot for production wells)**, make a third measurement, recording this measurement and time on the row below the second measurement with a new time. If more than two readings are taken, record the average of all reasonable readings.

After making a measurement:

1. Clean the exposed portion of the tape using a disinfectant wipe, rinse with de-ionized or tap water, and dry the tape. Do not store a steel tape while dirty or wet.

GROUNDWATER LEVEL DATA FORM
MANUAL MEASUREMENTS

WELL ID NUMBER	WELL NAME	STATE WELL NUMBER	COUNTY	B-118 BASIN OR SUBBASIN	MEASURING AGENCY	LAND SURFACE DATUM (LSD) ELEV.	RP TO LAND SURFACE DATUM (LSD), IN FT	REFERENCE POINT (RP) ELEV.

NO MEASUREMENT (NM)
0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaky or wet
9. Temporarily inaccessible

QUESTIONABLE MEASUREMENT (QM)
0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaky or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

MEASUREMENT METHOD (MM)
0. Steel tape
1. Electric sounding tape
2. Other

DATE	TIME	N M	Q M	MM	TAPE at RP	TAPE at WS	RP to WS	LSD to WS	OBS	COMMENTS

[For explanation of terms, see figure 1.]

DWR Form 1213 (modified 6/28/2010) (data for Water Data Library)

Table 5. Groundwater level data form for manual measurements (DWR Form 1213).

(2) Electric Sounding Tape Method

The electric sounding tape procedure for measuring depth to the water surface is especially useful in wells with dripping water or condensation, although there are still precautions needed as noted in the beginning of this section. Other benefits of this method include:

- Easier and quicker than steel tapes, especially with consecutive measurements in deeper wells.
- Better than steel tapes for making measurements in the rain.
- Less chance for cross-contamination of well water than with steel tapes, as there is less tape submerged.

The accuracy of electric sounding tape measurements depends on the type of tape used and whether or not the tape has been stretched out of calibration after use. Tapes that are marked the entire length with feet, tenths, and hundredths of a foot should be read to 0.01 ft. Electric sounding tapes are harder to keep calibrated than are steel tapes. As with steel tapes, electric sounding tapes are most accurate for water levels less than 200 ft below land surface, and thermal expansion and stretch start to become significant factors when measuring deep water levels (>500 ft) (see Garber and Koopman, 1968). Equipment and supplies needed for this method are shown in Table 4.

The following issues should be considered with this method:

- If the well casing is angled, instead of vertical, the depth to water will have to be corrected, if possible. This correction should be recorded in the field folder.
- **Check that the electric sounding tape is not hung up on an obstruction in the well.**
- The electric sounding tape should be calibrated annually against a steel tape in the field (using monitoring wells only) as follows: Compare water-level measurements made with the electric sounding tape to those made with a steel tape in several wells that span the range of depths to water encountered in the field. The measurements should agree to within ± 0.02 ft. If this accuracy is not met, a correction factor should be applied. All calibration and maintenance data should be recorded in a calibration and maintenance log book for the electric sounding tape.
- **Oil on the surface of the water may interfere with obtaining consistent readings and could damage the electrode probe. If oil is present, switch to a steel tape for the water-level measurement.**
- If using a repaired/spliced tape: see section A4-B-3(b) (page B16) of the NFM (U.S. Geological Survey, 2006).

Before making a measurement:

1. Inspect the electric sounding tape and electrode probe before using it in the field. Check the tape for wear, kinks, frayed electrical connections and possible stretch; the

cable jacket tends to be subject to wear and tear. Test that the battery and replacement batteries are fully charged.

2. Check the distance from the electrode probe's sensor to the nearest foot marker on the tape, to ensure that this distance puts the sensor at the zero foot point for the tape. If it does not, a correction must be applied to all depth-to-water measurements. Record this in an equipment log book and on the field form.

3. Prepare the field forms (DWR Form 1213; see Table 5) and place any previous measured water-level data for the well into the field folder.

4. After reaching the field site, check that the RP is clearly marked on the well and is accurately described in the well file or field folder. If a new RP needs to be established, follow the procedures above.

5. Check the circuitry of the electric sounding tape before lowering the electrode probe into the well. To determine proper functioning of the tape mechanism, dip the electrode probe into tap water and observe whether the indicator needle, light, and/or beeper (collectively termed the "indicator" in this document) indicate a closed circuit. For an electric sounding tape with multiple indicators (sound and light, for instance), confirm that the indicators operate simultaneously. If they do not operate simultaneously, determine which is the most accurate and use that one.

6. Wipe off the electrode probe and the lower 5 to 10 feet of the tape with a disinfectant wipe, rinse with de-ionized or tap water, and dry.

Making a measurement:

1. If the water level was measured previously at the well, use the previous measurement(s) to estimate the length of tape that should be lowered into the well. Preferably, use measurements that were obtained during the same season of the year.

2. Lower the electrode probe slowly into the well until the indicator shows that the circuit is closed and contact with the water surface is made. Avoid letting the tape rub across the top of the well casing. Place the tip or nail of the index finger on the insulated wire at the RP and read the depth to water to the nearest 0.01 foot. Record this value in the column labeled "Tape at RP", with the appropriate measurement method code and the date and time of the measurement (see Table 5).

3. Lift the electrode probe slowly up a few feet and make a second measurement by repeating step 2 and record the second measurement with the time in the row below the first measurement in Table 5. Make all readings using the same deflection point on the indicator scale, light intensity, or sound so that water levels will be consistent between measurements. If the second measurement does not agree with the first measurement within 0.02 of a foot **(0.2 of a foot for production wells)**, make a third measurement,

recording this measurement with the time in the row below the second measurement. If more than two readings are taken, record the average of all reasonable readings.

After making a measurement:

1. Wipe down the electrode probe and the section of the tape that was submerged in the well water, using a disinfectant wipe and rinse thoroughly with de-ionized or tap water. Dry the tape and probe and rewind the tape onto the tape reel. Do not rewind or otherwise store a dirty or wet tape.

(3) Sonic Water-Level Meter Method

This meter uses sound waves to measure water levels. It requires an access port that is 5/8 – inch or greater in diameter and measurement of the average air temperature in the well casing. The meter can be used to quickly measure water levels in both monitoring wells and production wells. Also, since this method does not involve contact of a probe with the water, there is no concern over cross contamination between wells. However, the method is not as accurate as the other methods, with a typical accuracy of 0.2 ft for water levels less than 100 ft or 0.2% for water levels greater than 100 ft. Equipment and supplies needed for this method are shown in Table 4.

The following issues should be considered with this method:

- The accuracy of the meter decreases with well diameter and should not be used with well diameters greater than 10 inches.
- An accurate air temperature inside the well casing is necessary so that the variation of sound velocity with air temperature can be accounted for.
- **Obstructions in the well casing can cause erroneous readings, especially if the obstruction is close to half the well diameter or more.**

Before making a measurement:

1. Check the condition of the meter, especially the batteries. Take extra batteries to the field.

2. Take a temperature probe with a readout and 50-ft cable.

3. If open wellheads with diameter greater than the factory cover plate and less than 10 inches will be monitored, fabricate appropriately-sized cover plates using plastic or sheet metal.

4. Prepare the field forms (DWR Form 1213; see Table 5). Place any previous measured water-level data for the well into the field folder.

5. Check that the RP is clearly marked on the well and accurately described in the well file or field folder. If a new RP needs to be established, follow the procedures above.

Making a measurement:

1. If the water level was measured previously at the well, lower the temperature probe to about half that distance in the well casing. Preferably, use measurements that were obtained during the same season of the year.

2. Record this temperature in the comments column of DWR form 1213 (see Table 5). Use this temperature reading to adjust the temperature toggle switch on the sonic meter.

3. Select the appropriate depth range on the sonic meter.

4. For a covered wellhead, insert the meter duct into the access port and push the power-on switch. Record the depth from the readout.

5. For an open wellhead, slip the provided cover plate onto the wellhead to provide a seal. If the cover plate is not large enough, use a fabricated cover plate for diameters up to 10 inches. Record the depth from the readout.

After making a measurement:

1. Make sure the temperature probe and the sonic meter are turned off and put away in their cases.

(4) Pressure Transducer Method

Automated water-level measurements can be made with a pressure transducer attached to a data logger. Care should be taken to choose a pressure transducer that accurately measures the expected range of groundwater levels in a well. Pressure-transducer accuracy decreases linearly with increases in the depth range (also known as pressure rating). A pressure transducer with a depth range of 0 to 10 ft (0 to 4.3 psi) has an accuracy of 0.01 ft while a pressure transducer with a depth range of 0 to 100 ft (0 to 43 psi) has an accuracy of 0.1 ft. But if the measurement range exceeds the depth range of a pressure transducer, it can be damaged. So it is important to have a good idea of the expected range of groundwater levels in a well, and then refer to the manufacturer's specification when selecting a pressure transducer for that well.

Some of the advantages of automated monitoring include:

- No correction is required for angled wells, as pressure transducers only measure vertical water levels.
- A data logger can be left unattended for prolonged periods until data can be downloaded in the field.
- Downloaded data can be imported directly into a spreadsheet or database.

Some of the disadvantages of automated monitoring include:

- It may be necessary to correct the data for instrument drift, hysteresis, temperature effects, and offsets. Most pressure transducers have temperature compensation built-in.
- Pressure transducers operate only in a limited depth range. The unit must be installed in a well in which the water level will not fluctuate outside the operable depth range for the specific pressure transducer selected. Wells with widely fluctuating water levels may be monitored with reduced resolution or may require frequent resetting of the depth of the pressure transducer.
- With some data loggers, previous water-level measurements may be lost if the power fails.

There are two types of pressure transducers available for measuring groundwater levels; non-vented (absolute) and vented (gauged). A non-vented pressure transducer measures absolute pressure, is relative to zero pressure, and responds to atmospheric pressure plus pressure head in a well (see Figure 5). A vented pressure transducer measures gauge pressure, is relative to atmospheric pressure, and only responds to pressure head in a well.

Non-vented pressure transducer data require post processing. Barometric pressure data must be collected at the same time as the absolute pressure data at the well, and subtracted from each absolute pressure data record before the data can be used to calculate groundwater levels. Thus, if a non-vented pressure transducer is used, a barometric pressure transducer will also be needed near the well. This subject is usually covered in more detail by the manufacturer of the pressure transducer. In an area with little topographic relief, a barometer at one site should be sufficient for use by other sites within a certain radius (9 miles reported by Schlumberger http://www.swstechnology.com/ groundwater-monitoring/groundwater-dataloggers/baro-diver and 100 miles reported by Global Water http://www.globalw.com/support/barocomp.html). In an area of significant topographic relief, it would be advisable to have a barometer at each site.

Vented pressure transducers can be programmed so no post processing of the data is necessary. The vent is usually a small tube in the communication cable that runs from the back of the pressure transducer to the top of the well. This vent enables the pressure transducer to cancel the effect of atmospheric pressure and record groundwater level as the distance from the RP to the WS (see Figure 5). However, if the vent is exposed to excessive moisture or submerged in water it can cause failure and damage to the pressure transducer.

The existing well conditions should be considered when deciding which type of pressure transducer to use. Non-vented pressure transducers should be used when the top of a well or its enclosure may at any time be submerged in water. This can happen when artesian conditions have been observed or are likely, the well is completed at or below the LSD, or the well or its enclosure are susceptible to periods of high water. Otherwise, it is advisable to use a vented pressure transducer.

The following guidelines are USGS guidelines from Drost (2005) and Freeman and others (2004) for the use of pressure transducers. These USGS guidelines have not been incorporated as yet in the NFM. The equipment and supplies needed for automated measurements of water level using a pressure transducer are shown in Table 4.

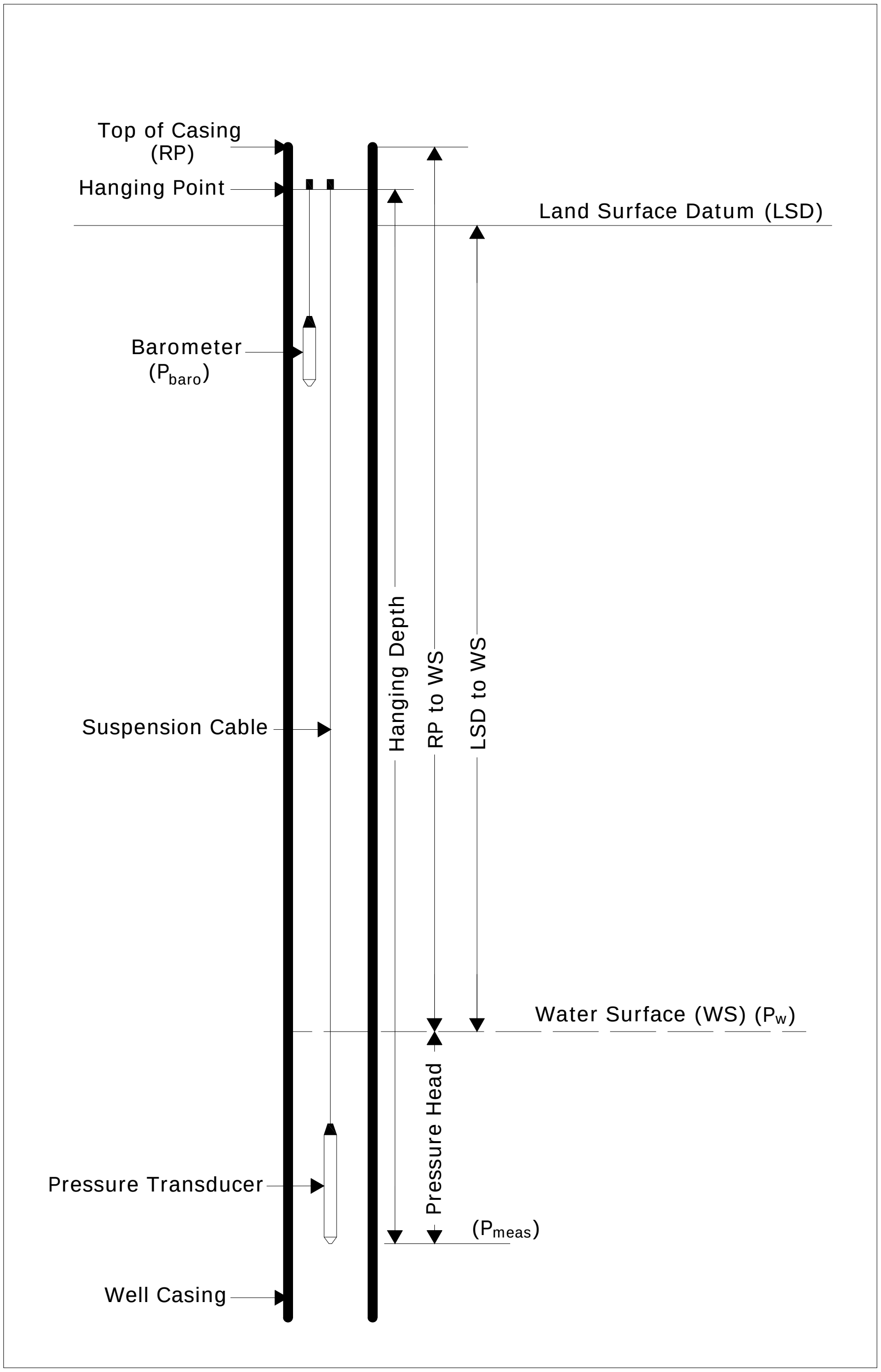

Figure 5. Groundwater-level measurements using a pressure transducer (vented or non-vented) (modified from Drost, 2005).

Before making a measurement:

1. Keep the pressure transducer packaged in its original shipping container until it is installed.

2. Fill out the DWR field form (Table 6), including the type, serial number, and range of measurement device; and what units are being measured (ft, psi).

3. Take a reading from the pressure transducer before placing into the well. For a vented pressure transducer the reading should be zero. For a non-vented pressure transducer the reading should be a positive number equivalent to atmospheric pressure. Configure the units (ft, psi) on a barometric pressure transducer the same as the non-vented pressure transducer. A reading from the barometric pressure transducer should be the same as the non-vented pressure transducer reading.

4. Lower the pressure transducer into the well slowly. Conduct a field calibration of the pressure transducer by raising and lowering it over the anticipated range of water-level fluctuations. Take two readings at each of five intervals, once during the raising and once during the lowering of the pressure transducer. Record the data on the DWR field form (see Table 6). If using a non-vented pressure transducer, take a reading from the barometric pressure transducer at the same time as the other readings.

5. Lower the pressure transducer to the desired depth below the water level (caution: do not exceed the depth range of the pressure transducer).

6. Fasten the cable or suspension system to the well head using tie wraps or a weatherproof strain-relief system. If the vent tube is incorporated in the cable, make sure not to pinch the cable too tightly or the vent tube may be obstructed.

7. Make a permanent mark on the cable at the hanging point, so future slippage, if any, can be determined.

8. Measure the static water level in the well with a steel tape or electric sounding tape. Repeat if measurements are not consistent within 0.02 ft **(0.2 ft for production wells)**.

9. Record the well and RP configuration, with a sketch. Include the RP height above the LSD, the hanging point, and the hanging depth (see Figure 5).

GROUNDWATER LEVEL DATA FORM
VENTED OR NON-VENTED PRESSURE TRANSDUCER WITH DATALOGGER

Station Information						Transducer Information						
Well ID Number	Well Name	State Well Number	County	Bulletin 118 GW Basin or Subbasin	Measuring Agency	Type of Pressure Transducer -- (A) Gauged (vented) or (B) Absolute (non-vented)?	Manufac-turer	Model	Serial Number	PSI Rating	Cable Length	Barometer Serial Number

Datum Measurements (in feet) [Date of Measurements:]				
Reference Point (RP) Elevation (MSL) [from DWR Form 429]	RP to Land Surface Datum (LSD)	(1) RP to Hanging Point	(2) Hanging Depth	(3) RP to Pressure Transducer

Manual Readings									Datalogger Readings						Datalogger Servicing		
Date	Time	Obser-ver	NM	QM	MM	(4) Tape at RP	(5) Tape at WS	(6) RP to WS	(7) Transducer pressure (psi)	(8) Barometric pressure (psi)	(9) WS pressure (psi)	(10) WS above transducer (ft)	(11) RP to WS (ft)	Test Name	Download-ed data? (Y/N)	Batt. life left / new batteries? (%; Y/N)	Comments

These cells only need to be filled out for non-vented transducers (which will have a barometer at the well in addition to the transducer)

Notes about calculated entries in form (referenced by number in cell): (3) = (1) + (2); (6) = (4) - (5) for steel tape; (6) = (4) for electric sounding tape; (9) = (7) - (8) for non-vented transducer; (9) = (7) for vented transducer; (10) = 2.3067 * (9); (11) = (3) - (10) [for explanation of terms, see figure 2]

NM (No Measurement) Codes: 0--Measurement discontinued 1--Pumping 2--Pump house locked 3--Tape hung up 4--Can't get tape in casing 5--Unable to locate well 6--Well has been destroyed 7--Special 8--Casing leaky or wet 9--Temporarily inaccessible

QM (Questionable Measurement) Codes: 0--Caved or deepened 1--Pumping 2--Nearby pump operating 3--Casing leaky or wet 4--Pumped recently 5--Air or pressure gauge measurement 6--Other 7--Recharge operation at or nearby well 8--Oil in casing

MM (Measurement Method) Codes: 0--Steel tape 1--Electric sounding tape 2--Other

DWR Form xxxx (data for Hydstra)

Table 6. Groundwater level data form for vented or non-vented pressure transducer with data logger.

10. Connect the data logger, power supply, and ancillary equipment. Configure the data logger to ensure the channel, scan intervals, units, etc., selected are correct. Activate the data logger. Most data loggers will require a negative slope in order to invert water levels for ground-water applications (i.e., distance from the RP to the WS). If using a non-vented pressure transducer the data logger will not require a negative slope, but atmospheric pressure data will need to be collected by a barometric pressure transducer.

Making a measurement:

1. Retrieve water-level data (to 0.01 ft) using instrument or data logger software. If using a non-vented pressure transducer, retrieve barometric pressure data.

2. Measure the water level with a steel tape or electric sounding tape (to 0.01 ft) and compare the reading with the value recorded by the pressure transducer and data logger. Record the reading and time in the file folder. If using a non-vented pressure transducer, subtract the barometric pressure value from the transducer pressure value to obtain the water level pressure value. The water level pressure can then be multiplied by 2.3067 to convert from psi of pressure to feet of water (Freeman and others, 2004). Report the calculated water level to the nearest 0.01 ft.

3. If the tape and pressure transducer readings differ by more than **(the greater of 0.2 ft or)** two times the accuracy of the specific pressure transducer, raise the pressure transducer out of the water and take a reading to determine if the cable has slipped, or whether the difference is due to drift. The accuracy of a pressure transducer is typically defined as 0.001 times the full scale of the pressure transducer (e.g., a 0 to 100 ft pressure transducer has a full scale of 100 ft). The accuracy of a specific pressure transducer should be specified by the manufacturer's specifications.

4. If drift is significant, recalibrate the pressure transducer as described using a steel tape. If using a non-vented pressure transducer, keep the pressure transducer out of the water and calibrate to the barometric pressure transducer value. If field calibration is not successful, retrieve the transducer and send back to the manufacturer for re-calibration.

5. Use the multimeter (see Table 4) to check the charge on the battery, and the charging current supply to the battery. Check connections to the data logger, and tighten as necessary. Burnish contacts if corrosion is occurring.

6. Replace the desiccant, battery (if necessary), and data module. Verify the data logger channel and scan intervals, document any changes to the data logger program and activate the data logger.

7. If possible, wait until data logger has logged a value, and then check for reasonableness of data.

Glossary of Terms

The following terms are used in this document. Although many are commonly used in the groundwater- and data-management fields, they are defined here to avoid confusion.

Aquifer – A geologic formation from which useable quantities of groundwater can be extracted. A confined aquifer is bounded above and below by a confining bed of distinctly less permeable material. The water level in a well installed in a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above it. In some cases, the water level can rise above the ground surface, yielding a flowing well. An unconfined aquifer is one with no confining beds between the saturated zone and the ground surface. The water level in a well installed in an unconfined aquifer stands at the same level as the groundwater outside of the well and represents the water table. An alternative and equivalent definition for an unconfined aquifer is an aquifer in which the groundwater surface is at atmospheric pressure.

Atmospheric or barometric pressure – The force per unit area exerted against a surface by the weight of the air above that surface at any given point in the Earth's atmosphere. At sea level, the atmospheric pressure is 14.7 psi. As elevation increases, atmospheric pressure decreases as there are fewer air molecules above the ground surface. The atmospheric pressure is measured by a barometer. This pressure reading is called the barometric pressure. Weather conditions can increase or decrease barometric pressure.

Blue carpenter's chalk – A primarily calcium carbonate chalk with some silica. It is primarily used to make chalk-lines for long lasting bright marks. Some other formulations of chalk (e.g., sidewalk chalk) substitute different ingredients such as rice starch for silica.

Data logger – A microprocessor-based data acquisition system designed specifically to acquire, process, and store data. Data usually are downloaded from onsite data loggers for entry into office data systems. The storage device within a data logger is called the data module. A desiccant, such as, silica gel, calcium sulfate, or calcium chloride, is used to absorb and keep moisture away from the data module.

Dedicated monitoring well – A well designed for the sole purpose of long-term monitoring.

Domestic well – A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer service connections.

DWR Bulletin 118 – DWR publication on the status of California's groundwater. Prior to this 2003 update, the latest Bulletin 118 was published in 1980. This publication defines the 515 basins to be monitored in the SB 6 monitoring program. The report reference is: California Department of Water Resources, 2003, California's groundwater: Bulletin 118, 246 p., available online at: http://www.water.ca.gov/pubs/groundwater/bulletin_118/california's_groundwater__bulletin_118_-_update_2003_/bulletin118_entire.pdf

Electric sounding tape – This term is used in this document to mean both the electric tape and the electrode probe attached to the end of the tape. This water-level measuring device is also known by many other names, including a sounder, an electric tape, an E tape, an electric sounder, an electric well sounder, a depth sounder, etc.

Electrode probe – This is the electronic sensor in the electronic sounder attached to the end of the electric tape. It senses water based on the electrical conductivity and triggers an alert.

GPS – This stands for global positioning system. These devices come in many sizes and costs. The handheld devices are capable of very accurate locations in the xy plane (latitude longitude). However, only very expensive and large GPS units are currently capable of accurate readings for the altitude (z direction).

Groundwater – Water occurring beneath the ground surface in the zone of saturation.

Groundwater basin – An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and having a definable bottom.

Groundwater elevation – The elevation (generally referenced to mean sea level as the datum) to which water in a tightly cased well screened at a given location will rise. Other terms that may be used include groundwater level, hydraulic head, piezometric head, and potentiometric head.

Groundwater surface – The highest elevation at which groundwater physically occurs in a given location in an aquifer (i.e., top of aquifer formation in a confined aquifer and the groundwater level or water table in an unconfined aquifer). Also referred to as a water surface in this document.

Groundwater subbasin – A subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

Hysteresis – The maximum difference in output, at any measured value within the specified range, when the value is approached first with an increasing and then a decreasing measured property. Hysteresis is expressed in percent of the full-scale output.

Instrument Drift – A change in instrument output over a period of time that is not a function of the measured property. Drift is normally specified as a change in zero (zero drift) over time and a change in sensitivity (sensitivity drift) over time.

Irrigation well – A well used to irrigate farmland. The water from the well is not intended for domestic purposes.

Metadata – "data about data"; it is the data describing context, content and structure of records and their management through time.

NFM – This stands for National Field Manual. This is a living, online, document of the USGS. It is the protocol document for USGS methods of surface water, groundwater, and water quality field activities. The portion of the NFM that related to the field methods of collecting groundwater levels is in the following reference: U.S. Geological Survey, 2006, Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, September, accessed 12/30/09 at: http://pubs.water.usgs.gov/twri9A4/

Nonflowing well – A well in which the water level is below the land surface.

Pressure head – The height of a column of groundwater above a point that is supported by pressure at that point.

Pressure transducer – A type of measurement device that converts pressure-induced mechanical changes into an electrical signal.

Production well – A well with a pump installed that is used to bring groundwater to the land surface. This is a general term that can be applied to a domestic well, irrigation well, or public-supply well.

Public-supply well – A well that pumps groundwater from a relatively extensive saturated area and is used as part of a public water system, supplying water for human consumption to at least 3,300 people.

SOGW – This stands for Subcommittee on Groundwater. This is a subcommittee of the Advisory Committee on Water Information, which is developing a national framework for groundwater in the United States. The reference for the SOGW work is: Subcommittee on Ground Water of the Advisory Committee on Water Information, 2009, A national framework for ground-water monitoring in the United States: final version approved by the Advisory Committee on Water Information, June 2009, 78 p., accessed 1/11/10 at: http://acwi.gov/sogw/pubs/tr/index.html

Static water level – Groundwater level in a well during non-pumping conditions.

Vent tube – A tube in the cable which connects to the pressure transducer, allowing atmospheric pressure to be in contact with one side of the strain gauge in the pressure sensor. It cancels out the barometric effects in the readings.

Well casing – The metal or plastic pipe separating the well from the surrounding geologic material.

Wellhead – The top of the well containing the casing hanger and the point at which the motor is attached for a vertical line shaft turbine pump or where the seal is secured for a submersible pump.

Well purging – Pumping out standing groundwater from a monitoring well. This is done prior to water quality sampling of wells, but **not** before taking a water-level measurement.

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Appendix B

CASGEM Monitoring Plan Summary

CASGEM Monitoring Plan Summary

The goal of the CASGEM program is to regularly and systematically monitor groundwater elevations that demonstrate seasonal and long-term trends in California's groundwater basins and to make this information readily and widely available to the public. The CASGEM program will rely and build on the many, established local long-term groundwater monitoring and management programs.

In determining what information should be reported to DWR, the department will defer to existing monitoring programs if those programs result in information that demonstrates seasonal and long-term trends in groundwater elevations. Monitoring Entities may submit an existing groundwater monitoring plan that is part of a groundwater adjudication program, an AB3030 program, an IRWM program, or any other groundwater management program that satisfies the goals of CASGEM. If there are future changes in a monitoring plan that is already established with CASGEM, the Monitoring Entity should provide an update to DWR at that time.

Monitoring Plan Overview

Phase 2 of the CASGEM Online Submittal System will be available on May 18, 2011 for prospective Monitoring Entities to submit their groundwater elevation monitoring plans and detailed well information. Each CASGEM monitoring plan should describe the monitoring network and the monitoring plan rationale. The description of the well network should allow users of the CASGEM database to understand well coverage within the basin or subbasin. The monitoring plan rationale explains how the proposed monitoring is designed to capture the seasonal highs and lows and long-term groundwater elevation trends.

The basic components of a CASGEM monitoring plan include the following:

- discussion of the well network,
- map(s) of the well network,
- monitoring schedule,
- description of field methods,
- discussion of the role of cooperating agencies, if applicable, and
- description of the monitoring plan rationale.

The monitoring rationale, which explains how the plan will result in groundwater elevation data that demonstrates seasonal and long-term trends, may discuss any or all of the following information:

- history of groundwater monitoring in the basin,
- principal aquifer features of the basin (for example, multiple aquifers),

- groundwater conditions in the basin (for example, types, locations and timing of recharge and discharge),
- selection of wells for the CASGEM monitoring program (number, depths and distribution of the wells), and
- selection of the monitoring schedule.

If the well network contains any data gaps, the monitoring plan should also discuss the following:

- location and reason for gaps in the well monitoring network,
- local issues and circumstances that limit or prevent groundwater monitoring, and
- recommendations for future well locations (assuming funding for new wells or permission for access to existing wells becomes available).

Maps

The monitoring plan can include maps that show well locations, the boundaries of the area to be monitored and, ideally, the Monitoring Entity's jurisdictional boundary. The optimal density of monitoring locations will depend on the complexity of the basin. If multiple aquifers are present in a basin, maps depicting how each of the aquifers is monitored are useful. The location of gaps in the monitoring network and the location of potential future monitoring wells can also be identified on each map. A table that provides a list of wells could also be used to identify the wells in the network.

Schedule

The monitoring schedule should provide a clear description of the frequency and timing of monitoring. To demonstrate seasonal and long-term trends in groundwater elevations, basin-wide monitoring should be conducted at least twice a year to measure the seasonal high and seasonal low groundwater elevations for the basin. The seasonal high and low groundwater elevations typically occur in early spring and in summer or fall, respectively, but may vary from basin to basin. Monitoring data collected in more frequent intervals can also be submitted to CASGEM. The online system will be designed to accept a maximum frequency of daily measurements for each well. To ensure that each round of monitoring represents a snapshot in time for conditions in the basin or subbasin, it will be important to schedule each round of measurements for all the wells in the network within the narrowest possible window of time. To provide the details of the monitoring schedule, the plan should contain a table detailing the time and frequency of monitoring for each of the wells in the monitoring network.

Field Methods

Field methods are the standard procedures for the collection and documentation of groundwater elevation data. A description of field methods provides an indicator of the quality, consistency and reliability of monitoring data to the users of the CASGEM database. Many Monitoring Entities already have established field methods for their groundwater monitoring programs that meet the following basic requirements:

- step-by-step instructions to establish the Reference Point,
- methods for recording measurements,
- methods to ensure the measurement of static (non-pumping) groundwater conditions,
- step-by-step instructions to measure depth to water, and
- forms for recording measurements.

Each Monitoring Entity will develop and implement monitoring protocols appropriate for the local groundwater basin conditions. Monitoring Entities who do not have established monitoring protocols can request assistance from DWR Region Offices to help develop appropriate protocols.

Well Information

In addition to the monitoring plan, each Monitoring Entity will also input the following detailed well information into the CASGEM Online Submittal System:

- Local well ID and/or State Well Number
- Reference Point Elevation (feet, NAVD88)
- Reference Point description
- Ground Surface Elevation (feet NAVD88)
- Method of determining elevation
- Accuracy of elevation method
- Well Use
- Well Status (active or inactive)
- Well coordinates (decimal lat/long, NAD83)
- Method of determining coordinates
- Accuracy of coordinate method
- Well Completion type (single or multi-completion)
- Total depth (feet)
- Top and bottom of screened intervals (up to 10 intervals)
- Well Completion Report number
- Groundwater basin of well (or subbasin or portion)
- Written description of well location
- Any additional comments

Groundwater Elevation Information (to be developed under Phase 3)

Phase 3 development of the CASGEM Online Submittal System will be available in late fall 2011. Phase 3 will enable Monitoring Entities to submit their groundwater elevation data and will provide public access to view the CASGEM database.

Monitoring Entities will submit the following groundwater elevation information for each well during each round of monitoring:

- Well identification number
- Measurement date
- Reference point elevation of the well (feet) using NAVD88 vertical datum
- Elevation of land surface datum at the well (feet) using NAVD88 vertical datum
- Depth to water below reference point (feet) (unless no measurement was taken)
- Method of measuring water depth
- Measurement Quality Codes
    - If no measurement is taken, a specified "no measurement" code, must be recorded. Standard codes will be provided by the online system. If a measurement is taken, a "no measurement" code is not recorded.)
    - If the quality of a measurement is uncertain, a "questionable measurement" code can be recorded. Standard codes will be provided by the online system. If no measurement is taken, a "questionable measurement" code is not recorded.)
- Measuring agency identification
- Measurement time (PST/PDT with military time/24 hour format)
- Comments about measurement, if applicable

Appendix E: Groundwater Quality Reports

PCWA UPDATE
water • energy • stewardship
PLACER COUNTY WATER AGENCY
VOL 26 NO 2 APRIL-MAY 2012

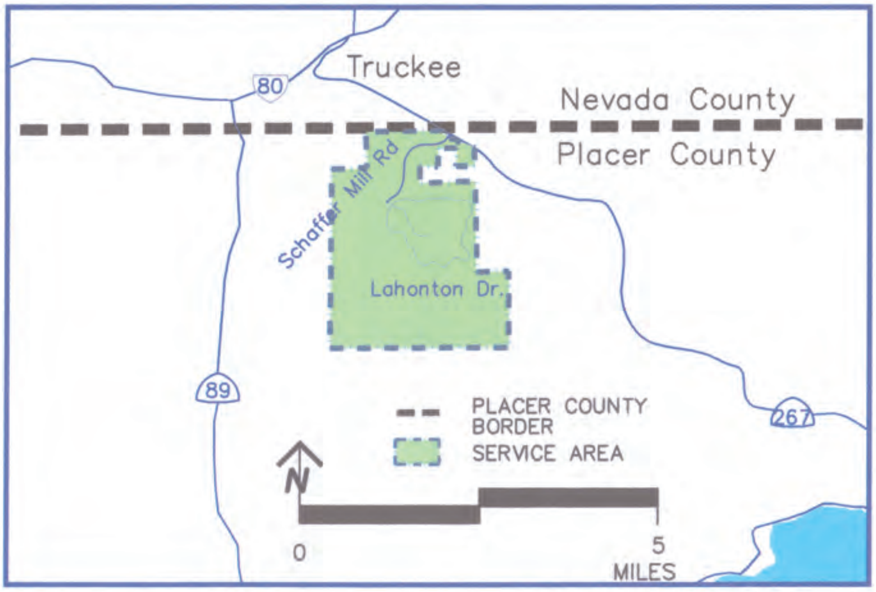
IN THIS ISSUE: *WATER QUALITY REPORT*
MARTIS VALLEY WATER SYSTEM for 2011 (Reported in 2012)

PCWA Water is Safe and Healthy

Placer County Water Agency is proud to supply safe and healthy water. We are pleased to report that the drinking water supplied to you meets or exceeds state and federal public health standards for drinking water quality and safety.

California water retailers, including PCWA, are required by law to inform customers about the quality of their drinking water. The results of PCWA's testing and monitoring programs of 2011 are reported in this newsletter.

If you have any questions about this report, please contact the PCWA Customer Services Center at (530) 823-4850 or (800) 464-0030.



Martis Valley Service Area

About Your Drinking Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the U.S. Environmental Protection Agency's **Safe Drinking Water Hotline:**

1-800-426-4791

Groundwater Supply

The Source of Your Water Supply

Water for the PCWA Martis Valley service area in eastern Placer County is pumped from the Martis Valley aquifer. Groundwater is drawn from two wells, approximately 900 feet in depth, located adjacent to Lahontan Drive and Schaffer Mill Road. Water is distributed to customers via pipeline.

Ensuring The Safety of Your Drinking Water Supply

In order to ensure that tap water is safe to drink, the U.S. Environmental Protection Agency (USEPA) and the state Department of Public Health prescribe regulations which limit the amount of certain contaminants in water provided by public water systems. State regulations also establish limits for contaminants in bottled water that must provide the same protection for public health.

Placer County Water Agency

Consumer Confidence Report for 2011 (Reported in 2012)

MARTIS VALLEY Water System

Primary Drinking Water Standards

Constituent	No. of Samples Collected	90th Percentile Level Detected	No. of Sites exceeding AL	AL	PHG	Typical Source of Contaminant
Copper (mg/L)	5	0.14	0	1.3	0.3	Internal corrosion of household water plumbing systems; erosion of natural deposits; leaching from wood preservatives

Constituent	Units	State MCL or {MRDL}	PHG (MCLG) or {MRDLG}	Range and Average or (HRAA)	Typical Source of Contaminant
Chlorine	mg/L	{4}	{4}	0.4-1.17 (0.89)	Drinking water disinfectant added for treatment
Arsenic	ug/L	10	0.004	0-2 1	Erosion of natural deposits; runoff from orchards, glass and electronics production wastes

Secondary Drinking Water Standards

Total Dissolved Solids	mg/L	1000	None	120-130 125	Runoff, leaching from natural deposits
Specific Conductance	uS/cm	1600	None	180-190 185	Substances that form Ions when in water
Chloride	mg/L	500	None	1.3-1.8 1.55	Runoff, leaching from natural deposits
Sulfate	mg/L	500	None	0.93-1.3 1.12	Runoff, leaching from natural deposits

STATEMENT ON LEAD *(None found in this system),* If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. PCWA is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at *http://www.epa.gov/safewater/lead.*

DEFINITIONS: Understanding Your Water Quality Report

MCL: Maximum Contaminant Level. The highest level of a contaminant that is allowed in drinking water. Primary MCL's are set as close to the PHG's (or MCLG's) as is economically and technologically feasible. Secondary MCL's are set to protect the odor, taste and appearance of drinking water.
MCLG: Maximum Contaminant Level Goal. The level of a contaminant in drinking water below which there is no known or expected risk to health. Set by the U.S. Environmental Protection Agency.
MRDL: Maximum Residual Disinfectant Level. The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
MRDLG: Maximum Residual Disinfectant Level Goal. The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLG's do not reflect the benefits of the use of disinfectants to control microbial contaminants.
Primary Drinking Water Standard. MCL's and MRDL's for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.
PHG: Public Health Goal. The level of a contaminant in drinking water below which there is no known or expected risk to health. PHG's are set by the California Environmental Protection Agency.
AL: Action Level. The concentration of a contaminant, which if exceeded, triggers treatment or other requirements which a water system must follow.
NTU: Nephelometric Turbidity Units. A measure of the clarity of water. Turbidity is monitored because it is a good indicator of water quality. High turbidity can hinder the effectiveness of disinfectants.
TT: Treatment Technique. A required process intended to reduce the level of a contaminant in drinking water.
pCi/L: picocuries per liter. A measure of radiation.
mg/L: milligrams per liter or parts per million (ppm)
ug/L: micrograms per liter or parts per billion (ppb)
uS/cm: MicroSiemens per centimeter.
HRAA: Highest Running Annual Average
<: Less Than
ND: ND or Non-Detected: An analysis result below detectable levels.
NA: Non-Applicable

Monitoring of Unregulated Substances

Constituent	Units	State MCL (or MRDL)	PHG (MCLG) (or MRDLG)	Range (Average)	Typical Source of Contaminant
Sodium	mg/L	None	None	7.9-8.7 (8.3)	Runoff, leaching from natural deposits
Hardness	mg/L	None	None	75-80 (77.5)	Runoff, leaching from natural deposits
Radon 222	pCi/L	None	None	930-1600 (1198)	Erosion of natural deposits

Radon samples were last collected in 2001. There is no current requirement to monitor for Radon in drinking water. See below.

FOR INFORMATION on water quality or questions about this report, customers are invited to contact the Placer County Water Agency Customer Services Center at (530) 823-4850 or (800) 464-0030.

Environmental Influences on Drinking Water

The sources of drinking water (both tap and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- Inorganic contaminants, such as salt and metals, which can be naturally-occurring or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.
- Pesticides and herbicides, that may come from a variety of sources such as agriculture, urban storm water runoff and residential uses.
- Organic chemical contaminants, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban storm water runoff, agricultural application and septic systems.
- Radioactive contaminants, that can be naturally-occurring or be the result of oil and gas production and mining activities.

Note to At-Risk Water Users

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline at (800) 426-4791.

2011 Testing Results

Measurements reported here were collected in 2011 (unless otherwise noted). In accordance with federal regulations, data is from the most recent tests. We are allowed to monitor for some contaminants less than once per year because concentrations of these contaminants do not change frequently.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo o hable con alguien que lo entienda bien.

Martis Valley System

About Your Water Supply

Note on Radon

Radon is a radioactive gas that you can't see, smell, or taste. It is found throughout the U.S. Radon can move up through the ground and into a home through cracks and holes in the foundation. Radon can build up to high levels in all types of homes. Radon can also get into indoor air when released from tap water from showering, washing dishes, and other household activites. Compared to radon entering a home through soil, radon entering through tap water will in most cases be a small source of radon in indoor air. Radon is a known human carcinogen. Breathing air containing radon can lead to lung cancer. Drinking water containing radon may also cause increased risk of stomach cancer. If you are concerned about radon in your home, test the air. Testing is inexpensive and easy. Fix your home if the level of radon is 4 pCi/L or higher. There are simple ways to fix a radon problem that aren't too costly.

For additional information, call your State radon program (800-745-7236), the EPA Safe Drinking Water Act Hotline (800-426-4791) or the National Safe Council Radon Hotline (1-800-SOS-RADON).

PCWA
PLACER COUNTY WATER AGENCY
144 Ferguson Road (P.O. Box 6570)
Auburn, California 95604

Annual Water Quality Report to PCWA Customers *(For 2011)*

Martis Valley Treated Water System

PCWA

Public Meetings

The Placer County Water Agency Board of Directors meets regularly the first and third Thursdays of each month at 2 p.m. at the Placer County Water Agency Business Center, 144 Ferguson Road, in Auburn.
The public is welcome.

Contacting Your Elected Directors

DISTRICT 1: Gray Allen
DISTRICT 2: Alex Ferreira
DISTRICT 3: Lowell Jarvis
DISTRICT 4 & 2012 Board Chair: Mike Lee
DISTRICT 5 & 2012 Vice Chair: Ben Mavy

If you would like to contact a member of the board, please call the PCWA Customer Service Center at (530) 823-4850 or (800) 464-0030. We will be pleased to put you in touch with the elected representative from your area.

This newsletter is published as a public service of the

PCWA
PLACER COUNTY WATER AGENCY
144 Ferguson Road (P.O. Box 6570)
Auburn, California 95604

(530) 823-4850 • (800) 464-0030

General Manager: David A. Breninger
Newsletter Editor: Dave Carter

www.pcwa.net

Primary Business Address
Your Address Line 2
Your Address Line 3
Your Address Line 4

Truckee Donner Public Utility District
11570 Donner Pass Road
Truckee, CA 96161

Truckee Donner Public Utility District

2011 Water Quality Report
Truckee Main Water System #2910003

Truckee Donner Public Utility District (TDPUD) vigilantly safeguards its mountain groundwater supplies

Last year, your tap water met all EPA and State drinking water health standards. This brochure is a snapshot of the quality of water provided to customers for the 2011 calendar year. Included in this pamphlet are details about where your water comes from, what it contains, and how it compares to State and USEPA Standards.

TDPUD is committed to providing you with the information about your water supply because customers who are well informed are the District's best allies in supporting improvements that are necessary to maintain the highest drinking water standards.

For More Information

- About this report or the water treatment process, contact Truckee Donner Public Utility District's Senior Water Quality Tech, Paul Rose at (530) 582-3926.
- About a group or class presentation, contact the Truckee Donner Public Utility District at (530) 587-3896.
- About water conservation and efficiency, the TDPUD has new water conservation programs that will help customers save water and save money. Information can be found on the TDPUD's website at www.tdpud.org or by calling (530) 582-3931.

Customer Views Are Welcome

If you are interested in participating in the decision-making process of the Truckee Donner Public Utility District, you are welcome to attend Board meetings. The Board of Directors meet at 6:00 PM on the first and third Wednesday of each month in the TDPUD Board room located at 11570 Donner Pass Road, Truckee, California. Agendas for upcoming meetings may be obtained on our website at www.tdpud.org or from the Deputy District Clerk's office, (530) 582-3909.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo ó hable con alguien que lo entienda bien.

Where Does Our Water Come From?

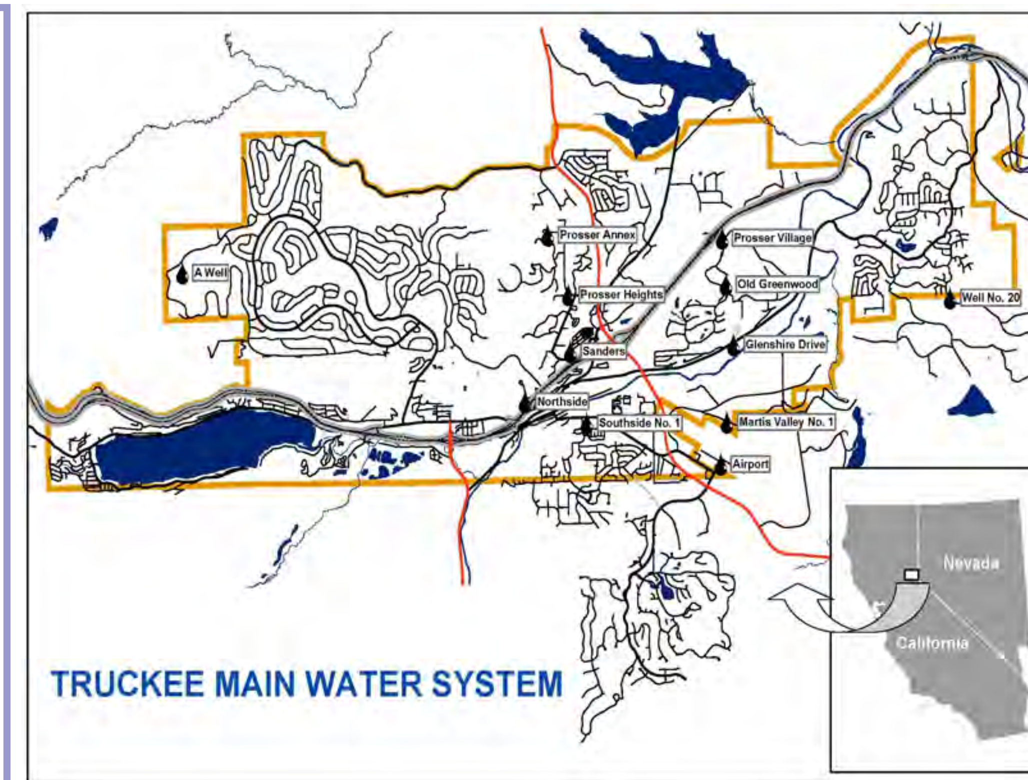
The drinking water served to Truckee Donner Public Utility District customers in the Truckee system is groundwater coming from 12 deep wells.

Each week the system is sampled for microbial quality. Because of natural filtration, the groundwater aquifer is protected from surface contamination. This gives us high quality water.

Source Water Assessment

A source water assessment was prepared in 2002 for the wells serving the Truckee area. The wells are considered most vulnerable to the following activities not associated with any detected contaminants: sewer collection systems, utility stations, railroads, and herbicide use. A copy of the complete assessment may be viewed at the Truckee Donner Public Utility District office located at 11570 Donner Pass Road, Truckee, CA or by calling Mark Thomas at (530) 582-3957.

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, people who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline at 1-800-426-4791.



Radon

Radon is a radioactive gas that you cannot see, taste, or smell. It is found throughout the U.S. Radon can move up through the ground and into a home through cracks and holes in the foundation. Radon can build up to high levels in all types of homes. Radon can also get into indoor air when released from tap water from showering, washing dishes, and other household activities. Compared to radon entering the home through soil, radon entering the home through tap water will in most cases be a small source of radon in indoor air. Radon is a known human carcinogen. Breathing air containing radon can lead to lung cancer. Drinking water containing radon may also cause increased risk of stomach cancer. If you are concerned about radon in your home, test the air in your home. Testing is inexpensive and easy. You should pursue radon removal for your home if the level of radon in your air is 4 picocuries per liter of air (pCi/L) or higher. There are simple ways to fix a radon problem that are not too costly. For additional information, call your State radon program (1-800-745-7236), the EPA Safe Drinking Water Hotline (1-800-426-4791), or the National Safety Council Radon Hotline (1-800-SOS-RADON).

Lead

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Truckee Donner Public Utility District is responsible for providing high quality water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

No Cryptosporidium or Giardia in District Water

You may have seen or heard news reports about Cryptosporidium and Giardia, microscopic organisms that can enter surface waters from run-off containing animal wastes. If ingested, Cryptospridium and Giardia can cause diarrhea, fever and other gastro-intestinal symptoms. Because the Truckee Donner Public Utility District's water comes from deep wells rather than surface water, it is almost impossible to have these contaminants in the District's water supply.

DETECTED COMPOUNDS

The data presented in this table is from the most recent monitoring done in compliance with regulations. Some data is more than a year old.

Primary Contaminants (PDWS)	MCL	PHG (MCLG)	Airport Well	Northside Well	Martis Valley Well	Southside Well # 2	"A" Well	Glenshire Dr Well	Sanders Well	Prosser Annex Well	Prosser Heights Well	Well 20	Prosser Village Well	Old Greenwood Well	Violation	Major Origins in Drinking Water
Arsenic (ppb)	10	0.004	9.8	N/D	8	N/D	N/D	9.4	8.9	N/D	N/D	N/D	N/D	2.4	NO	Erosion of natural deposits
Fluoride (ppm)	2	1	N/D	0.011	N/D	N/D	N/D	N/D	N/D	0.05	N/D	N/D	0.11	N/D	NO	
Nitrate (asNO_3) (ppm)	45	45	2.9	N/D	1.9	3.7	N/D	2	N/D	N/D	N/D	1.2	2.1	N/D	NO	Leaching of natural deposits, sewage, runoff from fertilizer use.
Nitrite (ppm)	1	1	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	0.79	NO	
Radionuclides																
Radon (pCi/L)	N/A	N/A	1600	990	N/T	885	540	765	1050	740	N/D	293	560	530	N/A	Erosion of natural deposits
Regulated Contaminants with Secondary MCLs (a) (SDWS)																
Color (ACU)	15	15	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	3	N/D	5	N/D	NO	Natural-occurring organic materials
Odor	3	3	2	1	N/D	1	1	N/D	1	1	1	1	N/D	1	NO	
Iron (ppb)	300	300	N/D	N/D	6	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	NO	Leaching from natural deposits
Chloride (ppm)	500	500	5.5	17	7.1	5.7	N/D	12	53	N/D	N/D	N/D	6.4	2.2	NO	
Copper (ppm)	1	1	N/D	N/D	87	0.04	N/D	N/D	0.28	0.02	N/D	N/D	N/D	N/D	NO	
Manganese (ppb)	50	50	N/D	N/D	6.4	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	26	NO	
Total Dissolved Solids (ppm)	1000	1000	126	170	120	112	68	140	230	112	110	110	108	110	NO	
Sulfate (ppm)	500	500	4.1	8.9	3.5	1.3	N/D	6.7	16	N/D	N/D	N/D	1.4	1.1	NO	
Specific Conductance (µS/cm)	1600	1600	187	241	160	160	107	200	360	166	166	166	180	160	NO	Substances that form ions when in water
pH	N/A	N/A	8.1	8.3	8.1	7.1	7.4	8.3	8	8.1	8.3	8.1	8.2	8	N/A	Leaching of natural deposits
Unregulated General Minerals																
Hardness (ppm)	N/A	N/A	67	77	57	92	44	72	97	41	72	56	55	62	N/A	Leaching of natural deposits
Sodium (ppm)	N/A	N/A	10	32	9.3	4.9	3.5	12	29	15	6.4	12	16	8.5	N/A	

Microbial Contaminants	MCL	TDPUD System Highest Month		
Total Coliform Bacteria	> Than 2 positive samples or more than 5% positive samples per month	0.0 %	NO	Naturally present in the environment

Copper/Lead	AL	MCLG	TDPUD Water System 90th Percentile Value	# of Sites Sampled	# of Sites that Exceeded Action Level		
Copper (ppm)	1.3	0.3	0.074	30	0	NO	Corrosion of household plumbing systems. Flushing prior to use recommended
Lead (ppb)	15	2	2	30	0	NO	

Disinfection Residual	MRDL	MRDLG	Average	Range for TDPUD Water System		
Chlorine (ppm)	4	4	0.35	0.32 - 0.47	NO	Drinking Water Disinfectant added for treatment

Disinfection Byproducts	MCL	PHG (MCLG)	Average	Range for TDPUD Water System	Sample Date		
Total Trihalomethanes (ppb)	80	N/A	3.8	N/D - 6.2	08/04/2011	NO	By-product of drinking water disinfection

Arsenic above 5 ppb up to 10 ppb: While your drinking water meets the current Federal and State standards for arsenic, it does contain low levels of arsenic. The standard balances the current understanding of arsenic's possible health effects against the costs of removing arsenic from drinking water. The USEPA continues to research the health effects of low levels of arsenic, which is a mineral known to cause cancer in humans at high concentrations and is linked to other health effects such as skin damage and circulatory problems.

GENERAL INFORMATION

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- ***Microbial contaminants***, such as viruses and bacteria, that may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.
- ***Inorganic contaminants***, such as salts and metals, that can be naturally-occurring or result from urban storm-water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- ***Pesticides and herbicides***, that may come from a variety of sources such as agricultural, urban storm-water runoff and residential uses.
- ***Organic chemical contaminants***, including synthetic and volatile organic chemicals, that are by-products of industrial processes and petroleum production, and can also come from gas stations, urban storm-water runoff, agricultural application, and septic systems.
- ***Radioactive contaminants***, that can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the U.S. Environmental Protection Agency (USEPA) and the State Department of Public Health (Department) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that must provide the same protection for public health.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline at 1-800-426-4791 or at http://water.epa.gov/drink/index.cfm.

TERMS USED IN THIS REPORT

Detected Compounds: The State allows us to monitor for some contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of our data, though representative, are more than one year old. Not listed are the hundreds of other compounds for which we tested that were not detected.
Regulated Contaminants with Secondary MCLs (a): There are no PHGs, MCLGs, or mandatory standard health effects language for these constituents because secondary MCLs are set on the basis of aesthetics.
Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the PHGs (or MCLGs) as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste and appearance of drinking water.
Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency.
Public Health Goal (PHG): The level of a contaminate in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.
Primary Drinking Water Standards (PDWS): MCLs and MRDLs for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.
Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk of health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
Secondary Drinking Water Standards (SDWS): MCLs for contaminants that affect taste, odor, or appearance of the drinking water. Contaminants with SDWSs do not affect the health a the MCL levels.
Regulatory Action Level (AL) : The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.
Radiochemical Parameters—Compounds found in drinking water which emit radiation.
Microbial Parameters—Disease-causing organisms that, at certain levels, may be harmful. Additional information about Cryptosporidium and Giardia is supplied in this report.
Unregulated Compounds Analyzed—Unregulated Compounds Analyzed— Unregulated compounds that the Truckee Donner Public Utility District has tested for. These compounds are not known to be associated with adverse health effects.

N/D– not detectable at testing limit **ppm**—Parts per million, or milligrams per liter (mg/L) **ppb**—Parts per billion, or micrograms per liter (ug/L) **µS/cm—**Micro Siemens per centimeter **>** - Greater than	**pCi/L** (Picocuries per Liter) - A measure of radioactivity. **N/T**– not tested **N/A**—Not Applicable **ACU** (Apparent Color Unit) - A measure of color in drinking water.

TABLE 8 - SAMPLING RESULTS SHOWING TREATMENT OF SURFACE WATER SOURCES	
Treatment Technique [(a)] (Type of approved filtration technology used)	Pall membrane microfiltration with chlorination.
Turbidity Performance Standards [(b)] (that must be met through the water treatment process)	Turbidity of the filtered water must: 1 – Be less than or equal to 0.1 NTU in 95% of measurements in a month. 2 – Not exceed 1.0 NTU for more than eight consecutive hours. 3 – Not exceed 1 NTU at any time.
Lowest monthly percentage of samples that met Turbidity Performance Standard No. 1.	100%
Highest single turbidity measurement during the year	0.018
Number of violations of any surface water treatment requirements	0

(a) A required process intended to reduce the level of a contaminant in drinking water.
(b) Turbidity (measured in NTU) is a measurement of the cloudiness of water and is a good indicator of water quality and filtration performance. Turbidity results which meet performance standards are considered to be in compliance with filtration requirements.
** Any violation of a TT is marked with an asterisk. Additional information regarding the violation is provided earlier in this report.*

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline (1-800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (1-800-426-4791).

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

In 2003, the NCSD conducted a source water assessment on the Big Springs source. The source is considered most vulnerable to the following activities: recreational areas, sewer collection systems, automobile repair shops, chemical/petroleum pipelines, and machine shops. These activities are not associated with any detected contaminants.

In order to ensure that tap water is safe to drink, the USEPA and the State Department of Public Health (Department) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that provide the same protection for public health.

Contaminants that may be present in source water include:

- *Microbial contaminants,* such as viruses and bacteria, that may come from sewage treatment plants, septic systems, agricultural livestock operations, pets and wildlife.
- *Inorganic contaminants*, such as salts and metals that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- *Pesticides and herbicides* that may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
- *Organic chemical contaminants,* including synthetic and volatile organic chemicals, that are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, agricultural application, and septic systems.
- *Radioactive contaminants* that can be naturally-occurring or be the result of oil and gas production and mining activities.

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The NCSD is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Our Mission Statement: To provide our services to the Northstar Community in a high quality, safe, efficient, professional, and courteous manner

Northstar Community Services District
908 Northstar Drive
Northstar, Calif. 96161

Northstar Community Services District Annual Water Quality Report

2011

This state-mandated annual report contains important information about the quality of your drinking water.

Dear Customer:

The Northstar Community Services District (NCSD) is proud to provide some of the nation's cleanest drinking water. In 2011, as in years past, our water met or exceeded federal and state standards for drinking water. The State of California mandates that we send this Annual Water Quality Report to you, which includes important information about your drinking water.

The NCSD draws its source water from two locations. The first source is a natural mountain spring located in the mid-mountain region of the Northstar-at-Tahoe Resort. The water is collected in the Big Springs collection system and then treated at the District's state-of-the-art Water Treatment Facility prior to being delivered to the customers' tap. The second source is a well (TH-2) located in the Martis Valley that was developed in 2007 to help meet future water demands as the community continues to expand.

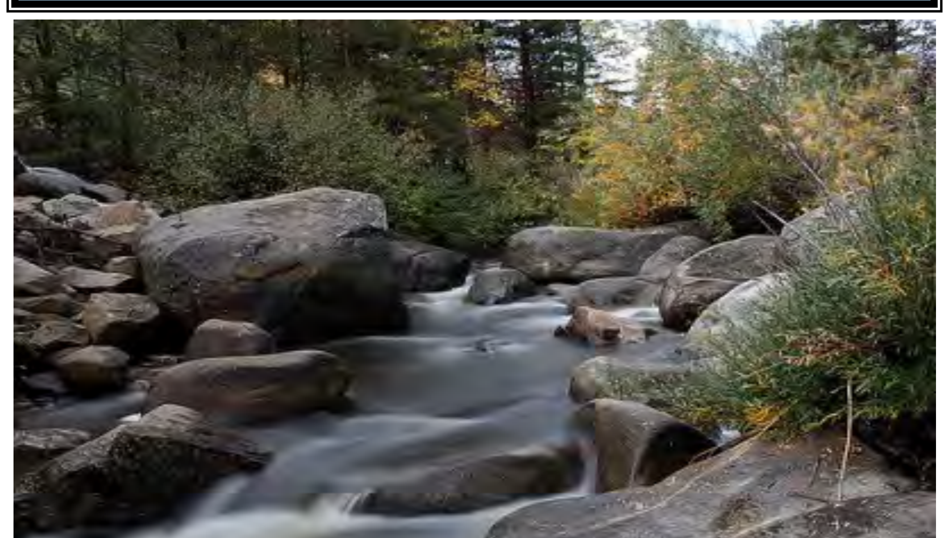
We are committed to delivering the highest quality drinking water, ensuring that our customers receive clean, safe water from their taps.

In 2011 the District delivered over 182 million gallons of drinking water through 30 miles of pipeline to over 1,800 residential and commercial services throughout the Northstar community.

Should you have any questions or would like to obtain additional information, please contact the Northstar Community Services District:

Phone: (530) 562-0747
Fax: (530) 562-1505
www.northstarcsd.com

In case of a water or sewer emergency, please call
530-562-0747



KEY WATER QUALITY TERMS

AL—Regulatory Action Level: The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

MCL—Maximum Contaminant Level: The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the MCLGs as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste, and appearance of drinking water.

MCLG—Maximum Contaminant Level Goal: The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency (USEPA).

MRDL—Maximum Residual Disinfectant Level: The level of a disinfectant added for water treatment that may not be exceeded at the consumer's tap.

ND: Not Detectable at testing limit.

PHG—Public Health Goal: The level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.

ppm: parts per million or milligrams per liter (mg/L)

ppb: parts per billion or micrograms per liter (ųg/L)

TT—Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Want More Information? The NCSD Board of Directors meets regularly each month. Please feel free to participate in these meetings. For meeting dates, times and locations please contact our main office at (530) 562-0747. You may also find more information by visiting our website: www.northstarcsd.org.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo ó hablcon alguien que lo entienda bien.

NSCD WATER QUALITY TEST RESULTS THROUGH DECEMBER 31, 2011

TABLE 1 - SAMPLING RESULTS FOR COLIFORM BACTERIA

Microbiological Contaminant	Highest No. of detections	No. of months in violation	MCL	MCLG	Typical Source of Bacteria
Total Coliform Bacteria	(In a mo.) 0	0	More than 1 sample in a month with a detection	0	Naturally present in the environment
Fecal Coliform or *E. coli*	(In the year) 0	0	A routine sample and a repeat sample detect total coliform and either sample also detects fecal coliform or *E. coli*	0	Human and animal fecal waste

TABLE 2 - SAMPLING RESULTS FOR LEAD AND COPPER

Lead & Copper (units) Sample Dates	No. of samples collected	90th %tile level detected	No. sites exceeding AL	AL	PHG	Typical Source of Contaminant
Lead (ppb) 2009	20	4.0	0	15	2	Erosion of natural deposits; internal corrosion of household water plumbing; discharges from industrial manufacturers
Copper (ppb) 2009	20	202	0	1300	170	Erosion of natural deposits; internal corrosion of household plumbing; leaching from wood preservatives

TABLE 3 - SAMPLE RESULTS FOR SODIUM AND HARDNESS

Chemical or Constituent (units)	Source	Sample Date	Level Detected	MCL	PHG (MCLG)	Typical Source of Contaminant
Sodium (ppm)	Big Springs Well TH2	2005 2007	5.2 25.3	none	none	Generally found in ground & surface water
Hardness (ppm)	Big Springs Well TH2	2005 2007	51 90	none	none	Generally found in ground & surface water

TABLE 4 - DETECTION OF CONTAMINANTS WITH A PRIMARY DRINKING WATER STANDARD

Chemical or Constituent (units)	Source	Sample Date	Level Detected	MCL	PHG (MCLG)	Typical Source of Contaminant
Nickel (ppb)	Big Springs Well TH2	2005 2007	11 ND	100	12	Erosion of natural deposits; discharge from metal factories

TABLE 5 - DETECTION OF CONTAMINANTS WITH A SECONDARY DRINKING WATER STANDARD

Chemical or Constituent (units)	Source	Sample Date	Level Detected	MCL	PHG (MCLG)	Typical Source of Contaminant
Chloride (ppm)	Big Springs Well TH2	2005 2007	0.3 4.5	500	none	Substances that form ions when in water; seawater influence
Specific Conductance (µS/cm)	Big Springs Well TH2	2005 2007	130 262	1600	none	Substances that form ions when in water; seawater influence
Sulfate (ppm)	Big Springs Well TH2	2005 2007	ND 12.9	50	none	Runoff/leaching from natural deposits; industrial wastes
Total Dissolved Solids (ppm)	Big Springs Well TH2	2005 2007	101 192	1000	none	Runoff/leaching from natural deposits

TABLE 6 - DETECTION OF UNREGULATED CONTAMINANTS

Chemical or Constituent (units)	Source	Sample Date	Level Detected	Notification Level	Typical Source of Contaminant
Vanadium (ppb)	Well TH2	2007	8.0	50	Runoff/leaching from natural deposits

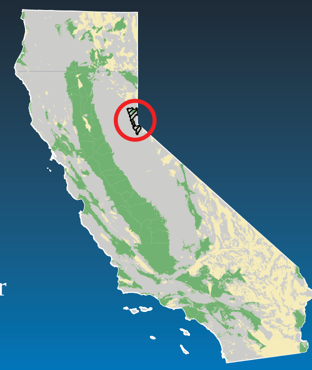
TABLE 7 - DISINFECTANTS & DISINFECTION BYPRODUCTS IN THE DISTRIBUTION SYSTEM

Chemical or Constituent (units)	Sample Date	Level Detected	MCL	MRDL	Typical Source of Contaminant
Chlorine Residual (ppm)	2011	0.81	4.0	4	Water additive used to control microbes
Total Trihalomethanes (ppb)	2011	1.2	80	N/A	By-product of drinking water chlorination
Halocetic Acids (ppb)	2011	ND	60	N/A	By-product of drinking water chlorination

Tables 1, 2, 3, 4, and 5 list all of the drinking water contaminants that were detected during the most recent sampling for the constituent. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. The Department allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of the data, though representative of the water quality, are more than one year old.

U.S. Geological Survey and the California State Water Resources Control Board

Groundwater Quality in the Tahoe and Martis Basins, California

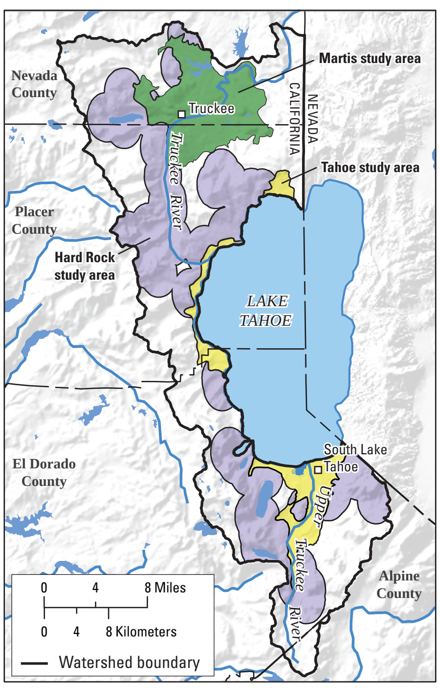


Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The Priority Basin Project of the GAMA Program provides a comprehensive assessment of the State's groundwater quality and increases public access to groundwater-quality information. The Tahoe and Martis Basins and surrounding watersheds constitute one of the study units being evaluated.

The Tahoe-Martis Study Unit

The Tahoe-Martis study unit is approximately 460 square miles and includes the groundwater basins on the south, north, and west shores of Lake Tahoe, and the Martis Valley groundwater basin (California Department of Water Resources, 2003). The study unit was divided into three study areas based primarily on geography: the Tahoe study area composed of the three Tahoe Valley basins, the Martis study area, and the Hard Rock study area composed of the parts of the watersheds surrounding the basins (Fram and others, 2009).

The primary aquifers in the Tahoe study area consist of glacial outwash sediments (mixtures of sand, silt, clay, gravel, cobbles, and boulders), interbedded with lake sediments. The primary aquifers in the Martis study area are interbedded volcanic lavas, volcanic sediments, and glacial outwash sediments. In the Hard Rock study area, groundwater is present in fractured granitic rocks in the south and fractured volcanic rocks in the north. Aquifers composed of different materials commonly contain groundwater with different chemical compositions.

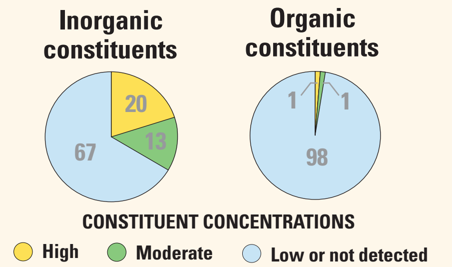


The primary aquifers in the study unit are defined as those parts of the aquifers corresponding to the screened or open intervals of wells listed in the California Department of Public Health database. In the Tahoe study area, these wells typically are drilled to depths between 175 and 375 feet, consist of solid casing from land surface to a depth of about 75 to 125 feet, and are screened or open below the solid casing. In the Martis study area, these wells typically are 200 to 900 feet deep, and are screened or open below 75 to 300 feet. Water quality in the shallower and deeper parts of the aquifer system may differ from that in the primary aquifers.The Hard Rock study area includes wells and developed springs.

The Tahoe-Martis study unit has warm, dry summers and cold, wet winters. Average annual precipitation ranges from 30 inches at Lake Tahoe to 80 inches in the surrounding mountains, and the majority of precipitation falls as snow. Land use in the study unit is approximately 88 percent (%) undeveloped (forests, grasslands, and bare rock), and 12% urban. The undeveloped lands are used mostly for recreation. The largest urban areas are the cities of South Lake Tahoe and Truckee.

Municipal and community water supply accounts for nearly all of the total water use in the study unit, with most of the remainder used for recreation, including landscape irrigation and snow-making. Groundwater provides nearly all of the water supply in the study unit, with limited use of surface water in some areas. Recharge to the groundwater flow system is mainly from mountain-front recharge at the margins of the basins, stream-channel infiltration, and direct infiltration of precipitation. Groundwater leaves the aquifer system when it is pumped for water supply or flows into streams and lakes.

Overview of Water Quality



Values are a percentage of the area of the primary aquifers with concentrations in the three specified categories. Values on pie chart may not equal 100 due to rounding of percentages.

GAMA's Priority Basin Project evaluates the quality of untreated groundwater. However, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of *high*, *moderate*, and *low* concentrations are discussed in the inset box on page 3.

Many inorganic constituents occur naturally in groundwater. The concentrations of the inorganic constituents can be affected by natural processes as well as by human activities. In the Tahoe-Martis study unit, one or more inorganic constituents were present at high concentrations in about 20% of the primary aquifers and at moderate concentrations in 13%.

Human-made organic constituents are found in products used in the home, business, industry, and agriculture. Organic constituents can enter the environment through normal usage, spills, or improper disposal. In this study unit, one or more organic constituents were present at high concentrations in about 1% of the primary aquifers and at moderate concentrations in about 1%.

U.S. Department of the Interior
U.S. Geological Survey

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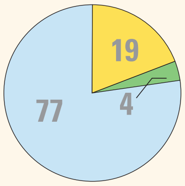
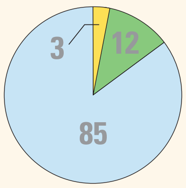
Fact Sheet 2011–3143
April 2012

RESULTS: Groundwater Quality in the Tahoe-Martis Study Unit

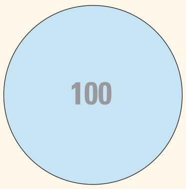
INORGANIC CONSTITUENTS



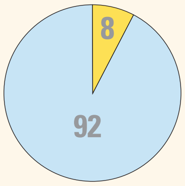
Trace elements



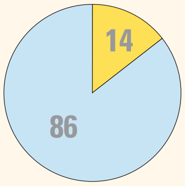
Radioactive constituents



Nutrients

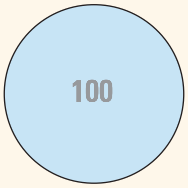


Total dissolved solids



Manganese

SPECIAL-INTEREST CONSTITUENTS



Perchlorate

Inorganic Constituents with Human-Health Benchmarks

Trace and minor elements are naturally present in the minerals in rocks and soils, and in the water that comes into contact with those materials. In the Tahoe-Martis study unit, trace elements were present at high concentrations in about 19% of the primary aquifers, and in moderate concentrations in about 4%. Arsenic was the trace element that most frequently occurred at high and moderate concentrations. Three trace elements with non-regulatory health-based benchmarks, boron, molybdenum, and strontium, also were detected at high concentrations.

Radioactivity is the emission of energy or particles during spontaneous decay of unstable atoms. Humans are exposed to small amounts of natural radioactivity every day. Most of the radioactivity in groundwater comes from decay of naturally occurring uranium and thorium in minerals in the rocks or sediments of the aquifers. Radioactive constituents occurred at high levels in about 3% of the primary aquifers, and at moderate levels in about 12%. Gross alpha particle and radon-222 activities were the radioactive constituents that most frequently occurred at high and moderate levels.

Nutrients, such as nitrogen, are naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities. Common sources of nutrients include fertilizer applied to crops and landscaping, seepage from septic systems, and human and animal waste. In the Tahoe-Martis study unit, nutrients were not detected at high or moderate concentrations in the primary aquifers.

Inorganic Constituents with Non-Health Benchmarks

(Not included in water-quality overview charts shown on the front page)

Some constituents affect the aesthetic properties of water, such as taste, color, and odor, or may create nuisance problems, such as staining and scaling. The State of California has a recommended and an upper limit for total dissolved solids (TDS). All water naturally contains TDS as a result of the weathering and dissolution of minerals in soils and rocks. Iron and manganese are naturally occurring constituents that commonly occur together in groundwater. Anoxic conditions in groundwater (low amounts of dissolved oxygen) may result in release of manganese and iron from minerals into groundwater.

In the Tahoe-Martis study unit, TDS was present at high concentrations (greater than the upper limit) in about 8% of the primary aquifers, and at low concentrations (less than the recommended limit) in about 92% of the primary aquifers. Manganese, with or without iron, was present at high concentrations in about 14% of the primary aquifers.

Perchlorate

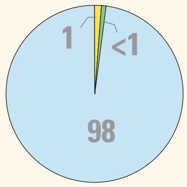
(Not included in water-quality overview charts shown on the front page)

Perchlorate is an inorganic constituent that has been regulated in California drinking water since 2007. It is an ingredient in rocket fuel, fireworks, safety flares, and other products, may be present in some fertilizers, and occurs naturally at low concentrations in groundwater. Perchlorate was not detected in the primary aquifers.

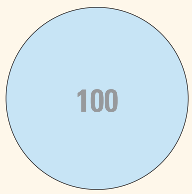
RESULTS: Groundwater Quality in the Tahoe-Martis Study Unit

ORGANIC CONSTITUENTS

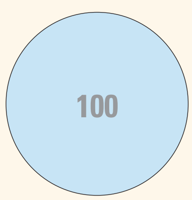
Solvents



Other volatile organic compounds



Pesticides



Organic Constituents

The Priority Basin Project uses laboratory methods that can detect the presence of low concentrations of volatile organic compounds (VOCs) and pesticides, far below human-health benchmarks. VOCs and pesticides detected at these low concentrations can be used to help trace water from the landscape into the aquifer system.

Volatile Organic Compounds with Human-Health Benchmarks

VOCs are in many household, commercial, industrial, and agricultural products, and are characterized by their tendency to volatilize (evaporate) into the air.

Solvents are used for a number of purposes, including manufacturing and cleaning. In the Tahoe-Martis study unit, solvents were present at high concentrations in about 1% of the primary aquifers. The solvent detected at high concentrations was tetrachloroethylene (PCE), which mainly was used in dry-cleaning businesses. Solvents were present at moderate concentrations in about 1% of the primary aquifers, and at low concentrations (or not detected) in about 98%.

Other VOCs include trihalomethanes, gasoline additives and oxygenates, refrigerants, and organic synthesis reagents. Trihalomethanes form during disinfection of water supplies, and may enter groundwater by the infiltration of landscape irrigation water, or leakage from distribution lines. Gasoline additives and oxygenates increase the efficiency of fuel combustion. Other VOCs were not detected at high or moderate concentrations in the primary aquifers. Trihalomethanes and gasoline oxygenates were detected at low concentrations in the primary aquifers.

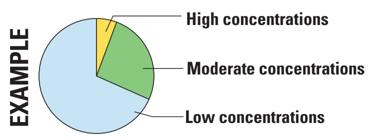
Pesticides with Human-Health Benchmarks

Pesticides, including herbicides, insecticides, fungicides, and fumigants, are applied to crops, gardens, lawns, around buildings, and along roads to help control unwanted vegetation (weeds), insects, fungi, and other pests. In the Tahoe-Martis study unit, pesticides were not detected at high or moderate concentrations in the primary aquifers. Herbicides were occasionally detected at low concentrations.

BENCHMARKS FOR EVALUATING GROUNDWATER QUALITY

GAMA's Priority Basin Project uses benchmarks established for drinking water to provide context for evaluating the quality of untreated groundwater. After withdrawal, groundwater may be disinfected, filtered, mixed, and exposed to the atmosphere before being delivered to consumers. Federal and California regulatory benchmarks for protecting human health (Maximum Contaminant Level, MCL) were used when available. Nonregulatory benchmarks for protecting aesthetic properties, such as taste and odor (Secondary Maximum Contaminant Level, SMCL), and nonregulatory benchmarks for protecting human health (Notification Level, NL, and Lifetime Health Advisory, HAL) were used when Federal or California regulatory benchmarks were not available.

CONSTITUENT CONCENTRATIONS



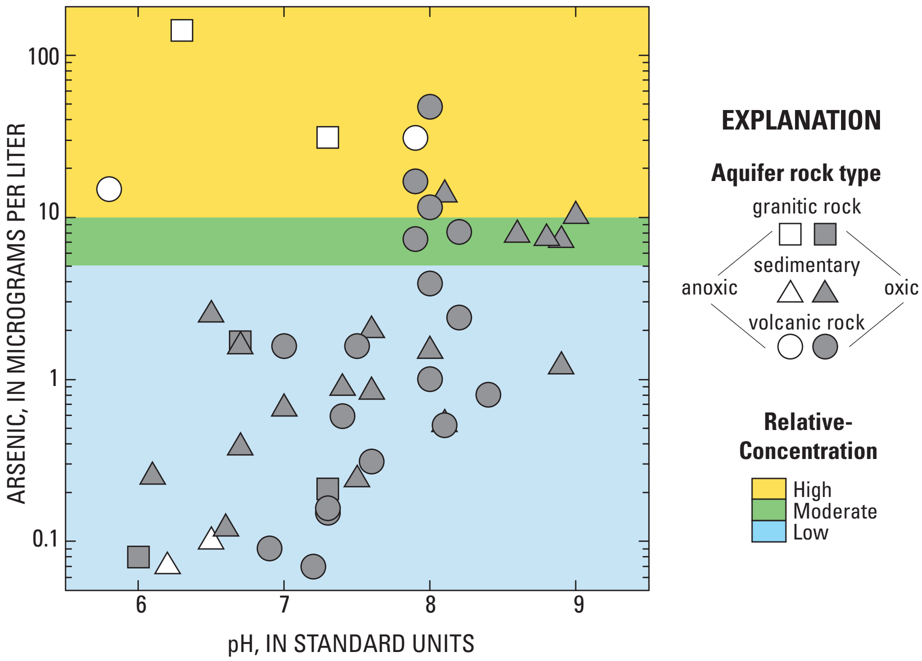
Values are a percentage of the area of the primary aquifers with concentrations in the three specified categories. Values on pie chart may not equal 100 due to rounding of percentages.

High, moderate, and low concentrations are defined relative to benchmarks

Concentrations are considered *high* if they are greater than a benchmark. For inorganic constituents, concentrations are *moderate* if they are greater than one-half of a benchmark. For organic constituents and perchlorate, concentrations are *moderate* if they are greater than one-tenth of a benchmark; this lower threshold was used because organic constituents are generally less prevalent and have smaller concentrations relative to benchmarks than inorganic constituents. *Low* values include nondetections and values less than moderate concentrations. Methods for evaluating water quality are discussed in Fram and Belitz (2012).

Factors that Affect Groundwater Quality

In the Tahoe-Martis study unit, arsenic was the constituent that most frequently occurred at high concentrations. About 18% of the primary aquifers had arsenic concentrations greater than the human-health regulatory benchmark Federal MCL) of 10 µg/L (micrograms per liter). Natural sources of arsenic to groundwater include dissolution of arsenic-bearing sulfide minerals, desorption of arsenic from the surfaces of manganese- or iron-oxide minerals (or dissolution of those oxide minerals), and mixing with geothermal waters (Welch and others, 2000).



In the Tahoe-Martis study unit, elevated arsenic concentrations likely are caused by two different processes (Fram and Belitz, 2012). In aquifers composed of sediments or volcanic rocks, high and moderate arsenic concentrations were found in groundwater that was oxic (high dissolved oxygen concentration) and alkaline (pH values greater than about 8). The elevated arsenic concentration in oxic, alkaline groundwater likely is due to desorption of arsenic from the surfaces of manganese- and iron-oxide minerals (Smedley and Kinniburgh, 2002). Oxic, alkaline conditions increase arsenic solubility in groundwater by inhibiting arsenic from adhering to mineral surfaces (sorption). In aquifers composed of granitic and volcanic rocks, high arsenic concentrations also were found in anoxic (low dissolved oxygen concentration) groundwater with low pH values. Dissolution of manganese- and iron-oxide minerals under anoxic conditions likely results in release of arsenic associated with these minerals.

By Miranda S. Fram and Kenneth Belitz

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Fram, M.S., and Belitz, Kenneth, 2012, Status and understanding of groundwater quality in the Tahoe-Martis, Central Sierra, and Southern Sierra study units,2006–2007—California GAMA Program Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011-5216, 222 p. (Also available at http://pubs.usgs.gov/sir/2011/5216.)

Smedley, P.L., and Kinniburgh, D.G., 2002, A review of the source, behavior, and distribution of arsenic in natural waters: Applied Geochemistry, v. 17, p. 517–568.

Welch, A.H., Westjohn, D.B., Helsel, D.R., and Wanty, R.B., 2000, Arsenic in ground water of the United States—occurrence and geochemistry: Ground Water, v. 38, no. 4, p. 589–604.

Priority Basin Assessments

GAMA's Priority Basin Project (PBP) assesses water quality in that part of the aquifer system used for drinking water, primarily public supply. Water quality in the primary aquifers, assessed by the PBP, may differ from that in the deeper parts of the aquifer, or from the shallower parts, which are being assessed by GAMA's Domestic Well Project. Ongoing assessments are being conducted in more than 120 basins throughout California.

The PBP assessments are based on a comparison of constituent concentrations in untreated groundwater with benchmarks established for protection of human health and for aesthetic concerns. The PBP does not evaluate the quality of drinking water delivered to consumers.

The PBP uses two scientific approaches for assessing groundwater quality. The first approach uses a network of wells to statistically assess the status of groundwater quality. The second approach combines water-quality, hydrologic, geographic, and other data to help assess the factors that affect water quality. In the Tahoe-Martis study unit, data were collected by the PBP in 2007, and from the CDPH database for 2004–2007. The PBP includes chemical analyses generally not available as part of regulatory compliance monitoring, including measurements at concentrations much lower than human-health benchmarks, and measurement of constituents that can be used to trace the sources and movement of groundwater.

For more information

Technical reports and hydrologic data collected for the GAMA PBP Program may be obtained from:

GAMA Project Chief
U.S. Geological Survey
California Water Science Center
4165 Spruance Road, Suite 200
San Diego, CA 92101
Telephone number: (619) 225-6100
WEB: http://ca.water.usgs.gov/gama

GAMA Program Unit
State Water Resources Control Board
Division of Water Quality
PO Box 2231, Sacramento, CA 95812
Telephone number: (916) 341-5779
WEB: http://www.waterboards.ca.gov/gama

Appendix F: DRI Technical Note

Technical Note

To: Tony Firenzi, Placer County Water Agency; Tina Bauer, Brown and Caldwell

From: Seshadri Rajagopal, Donald M. Reeves, Justin Huntington, Greg Pohll (Desert Research Institute)

Date: September 10, 2012

Re: Estimates of Ground Water Recharge in the Martis Valley Ground Water Basin

Purpose and Scope

This technical note provides spatially-distributed estimates of annual ground water recharge in the Martis Valley Ground Water Basin using a physically-based hydrologic model: Precipitation Runoff Modeling System (PRMS). PRMS simulates land surface hydrologic processes of evapotranspiration, runoff, infiltration, and interflow by balancing energy and mass budgets of the plant canopy, snowpack, and soil zone on the basis of distributed climate information (Leavesley et al., 1983), and has been used in several other basins to estimate ground water recharge (e.g., Lichty and McKinley, 1995; Vaccaro and Olsen, 2007; Cherkauer and Ansari, 2005; Cherkauer, 2004). Recharge in the current study is defined as the infiltration of water to the subsurface beyond the root zone (where present) or the soil zone, in case of bare soil absent of vegetation (Figure 1). Thus, the recharge estimates contained within this report represent total annual recharge within the delineated Martis Valley Ground Water Basin. The Martis Valley Ground Water Basin was first delineated by Hydro-Search, Inc. and was later adopted by the California DWR as the official ground water basin. In this report we refer to this region as the HSI ground water basin or Martis Valley Ground Water Basin (Figure 2). Total recharge consists of both recharge to the deep ground water system and shallow recharge that ultimately discharges into streams. The technical note describes the use of climate data in PRMS, the PRMS method used to compute recharge, and recharge estimates. Recharge estimates from previous studies and an additional method are provided to place the PRMS computed results in the context of other estimates.

Previous Estimates of Recharge for Martis Valley

Past studies primarily relied on empirical and water balance methods to estimate recharge within the Martis Valley Ground Water Basin (Figure 2). One of the earliest recharge studies was conducted by Hydro-Search, Inc. (1974) which was subsequently updated in 1980 and 1995. Hydro-Search Inc. (HSI) utilized a water balance method to estimate ground water recharge to the Martis Valley Ground Water Basin of approximately 18,000 ac-ft/yr. In 2001 Nimbus Engineers used a water balance approach to compute a recharge value of 24,700 ac-ft/yr to the ground water basin. Kennedy/Jenks Consultants in 2001 published a report titled "Independent Appraisal of Martis Valley Ground Water Availability, Nevada and Placer Counties, California" where they concluded that the earlier studies by Hydro-Search, Inc (1974 and updates) and Nimbus Engineers (2001) were conservative, as the total amount of ground water discharge to streams was considered under predicted; however, updated recharge estimates were not provided in this report. Interflow Hydrology, Inc. and Cordilleran Hydrology, Inc. prepared a 2003 report indicating that ground water discharge to tributary Truckee River streams in the Martis Valley Ground Water Basin is 34,560 ac-ft/yr, of which approximately 24,240 ac-ft/yr is contributed by high altitude areas of the basin (e.g., in the vicinity of Northstar) and the remaining 10,320 ac-ft/yr occurs in lower elevation areas. In summary, previous recharge estimates based on water balance approaches range from 18,000 to 34,560 ac-ft/yr.

Description of PRMS Recharge Method

The PRMS model (Leavesley et al., 1983) is driven by daily values of precipitation and maximum and minimum air temperature, and simulates snow accumulation, ablation, canopy interception, evapotranspiration, surface runoff, infiltration, water storage in the soil zone and deep percolation through the bottom of the root or soil zone – PRMS recharge is defined as the model computed excess water leaving the root or soil zone after abstractions for surface runoff and evapotranspiration are accounted for (Figure 1). The system is modeled in its natural transient state from 1981 to 2011. Reservoir operations, irrigation within the basin, septic drainfields, and diversion of effluent to the Truckee Tahoe Sanitation Agency and subsequent release of treated effluent to the Truckee River are not explicitly simulated in the model. However, the Martis Valley PRMS model utilizes naturalized flows that remove the effects of reservoir operations during model calibration.

The current PRMS model developed for Martis Valley encompasses the entire Martis Valley hydrologic basin (Figure 2), and is subdivided into 14 watersheds for model calibration to internal stream gauges. Computation of recharge for the Martis Valley Ground Water Basin requires aggregation of the PRMS results for all cells within the delineated ground water basin (Figure 3). The model domain was discretized into square grid cells of 300 m resolution; each of these cells represents a hydrologic response unit (HRU). The model is parameterized from the National Elevation Dataset (NED), STATSGO soils database, and USGS land use land cover (LULC) dataset. The depth of the root or soil zone is determined by the LULC of the HRU. Five categories of LULC are used to assign these depths viz. bare soils, grasses, shrubs, trees, and water. For the category water, recharge is assumed zero.

Daily weather data from the Truckee #2 SNOTEL site is used to drive the PRMS model. This station is used to develop monthly ratios based on PRISM maps to distribute precipitation over the entire basin. To account for days when temperature inversions within the valley occur, an additional weather station, Mt. Rose SNOTEL, is implemented.

PRMS Recharge Estimates

The estimated mean annual ground water recharge for the Martis Valley Ground Water Basin computed from PRMS is presented in Figure 4. PRMS simulated recharge varies from year to year based on annual cycles of precipitation (Figure 5). The annual average recharge estimate from the PRMS model is 32,745 ac-ft, which is slightly lower than the Interflow Hydrology 2003 estimate of 34,560 ac-ft.

We also applied a modified Maxey-Eakin (1949) method to estimate recharge which relates mean annual precipitation to recharge using recharge coefficients applied to precipitation amounts (Figure 3) (Epstein et al., 2010). Epstein et al., 2010 computed revised Maxey-Eakin coefficients that are based on the PRISM precipitation distribution (Daly et al., 1994), which was used in this study. As shown in Figure 3, the modified Maxey-Eakin estimate of 35,168 ac-ft/yr is very close to the Interflow Hydrology estimate. Figure 6 shows the ratio of recharge computed by the PRMS model to annual precipitation. This ratio, which we term as 'recharge efficiency', can be used to describe the fraction (or percentage) of precipitation that is converted to recharge. Computed recharge efficiencies for the Martis Valley ground water basin varies annually within a range of 18-26%.

Discussion of Recharge Estimates

PRMS computed recharge presented in Figures 4, 6 and 8 show that recharge to the Martis Valley Ground Water Basin varies both spatially and temporally. The spatial variability in recharge is primarily driven by precipitation trends (Figures 7 and 8). This is clearly observed in Figure 7 where the higher elevation areas, in general, receive greater amounts of precipitation than the rest of the basin. Note that the PRMS recharge shown in Figure 8 represents infiltrated water given the processes presented in Figure 1. The PRMS model neglects the influence of low permeable bedrock areas on the potential reduced rate of infiltration of precipitation. For example, the highest infiltration rates correspond to areas with the most precipitation. In reality, the highest elevation areas within the basin that receive the greatest amount of precipitation are located in the low-permeability mountain block. The low-permeability of the mountain block restricts the amount of infiltrating water, and forces water to redistribute as run-off and infiltrate downslope near the 'bench' areas of the slope with deposits of higher permeability alluvium. This redistribution has been simulated in integrated models (e.g., Huntington et al. 2012, in press) and inferred from ground water isotopes (Singleton et al., 2010). Thus, the spatial distribution of recharge, as shown in Figure 8, will change once the PRMS modeled recharge is combined with MODFLOW. This spatial redistribution will primarily change the pattern of recharge in the mountain block watersheds with only minimal changes to the lower elevation areas, and minimal changes in the total volume of recharge.

Previous recharge estimates by Interflow Hydrology (34,560 ac-ft/yr), the Maxey-Eakin method (35,168 ac-ft/yr), and mean annual PRMS (32,745 ac-ft/yr) estimates are very similar and in agreement. Only the PRMS estimates provide insight as to annual variability in recharge with a range between 12,143 and 56,792 ac-ft/yr (Figure 4). These fluctuations in annual ground water recharge estimates are natural and primarily based on fluctuations in annual precipitation (Figure 5). Perhaps most importantly are the water years when the amount of recharge is lower than the mean (~33,000 ac-ft). As shown in Figure 4, this variability can be significant with 'wet' and 'dry' year-end members. Pumpage during dry years may deplete the ground water basin as water is extracted from storage, whereas wet years increase the storage of water in the basin. If the number of wet and dry years and the amount of recharge oscillates evenly, then the mean recharge estimates from Interflow, modified Maxey-Eakin and PRMS methods are suitable for mean annual water budget analysis. However, future changes in temperature and/or precipitation (both timing and annual quantity) can disrupt the balance between pumping and basin storage.

The PRMS computed recharge consists of the sum of shallow infiltrated water that discharges into the Truckee River and its tributaries as well as deep percolation of ground water to deeper aquifers with water supply wells. Perennial basin yield, defined by the State of Nevada as the maximum amount of groundwater that can be salvaged each year over the long term without depleting the ground water reservoir, is not an appropriate metric to determine sustainable basin pumpage as values of perennial yield for a basin are usually limited to the maximum amount of natural discharge. Natural discharge from Martis Valley Basin consists of groundwater evapotranspiration, groundwater discharge to the Truckee River, along with a small quantity of groundwater outflow. As an alternative, we suggest that an analysis that utilizes the Martis Valley ground water model to define the 'capturable' amount of streamflow by pumping within the basin (e.g., Leake and Haney, 2010) would better quantify the relationship between sustainable pumpage and natural discharge.

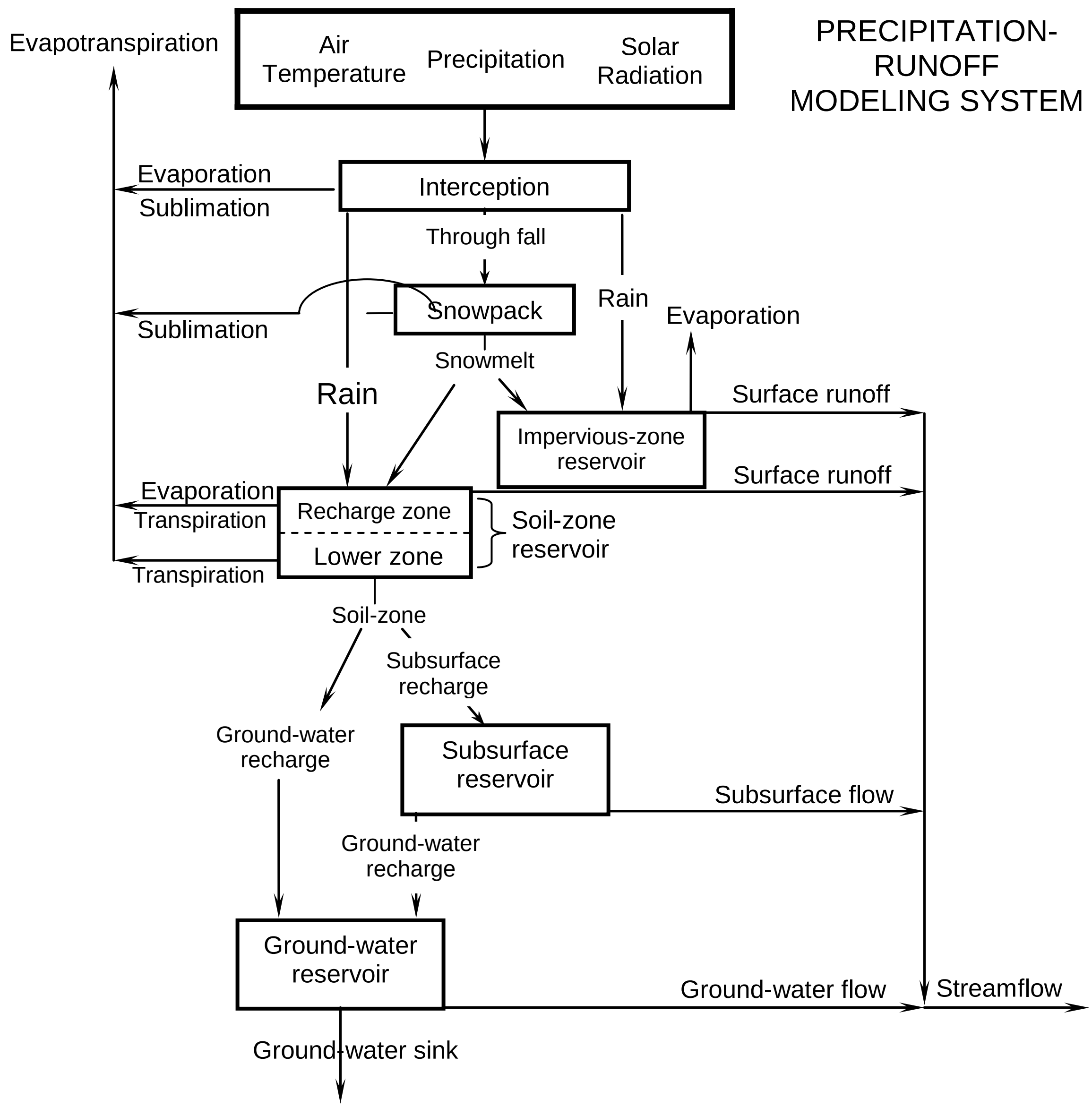

Figure 1. PRMS conceptual model schematic highlighting all simulated hydrologic processes and how ground water recharge is computed in the model (based on Leavesley et al., 1983).

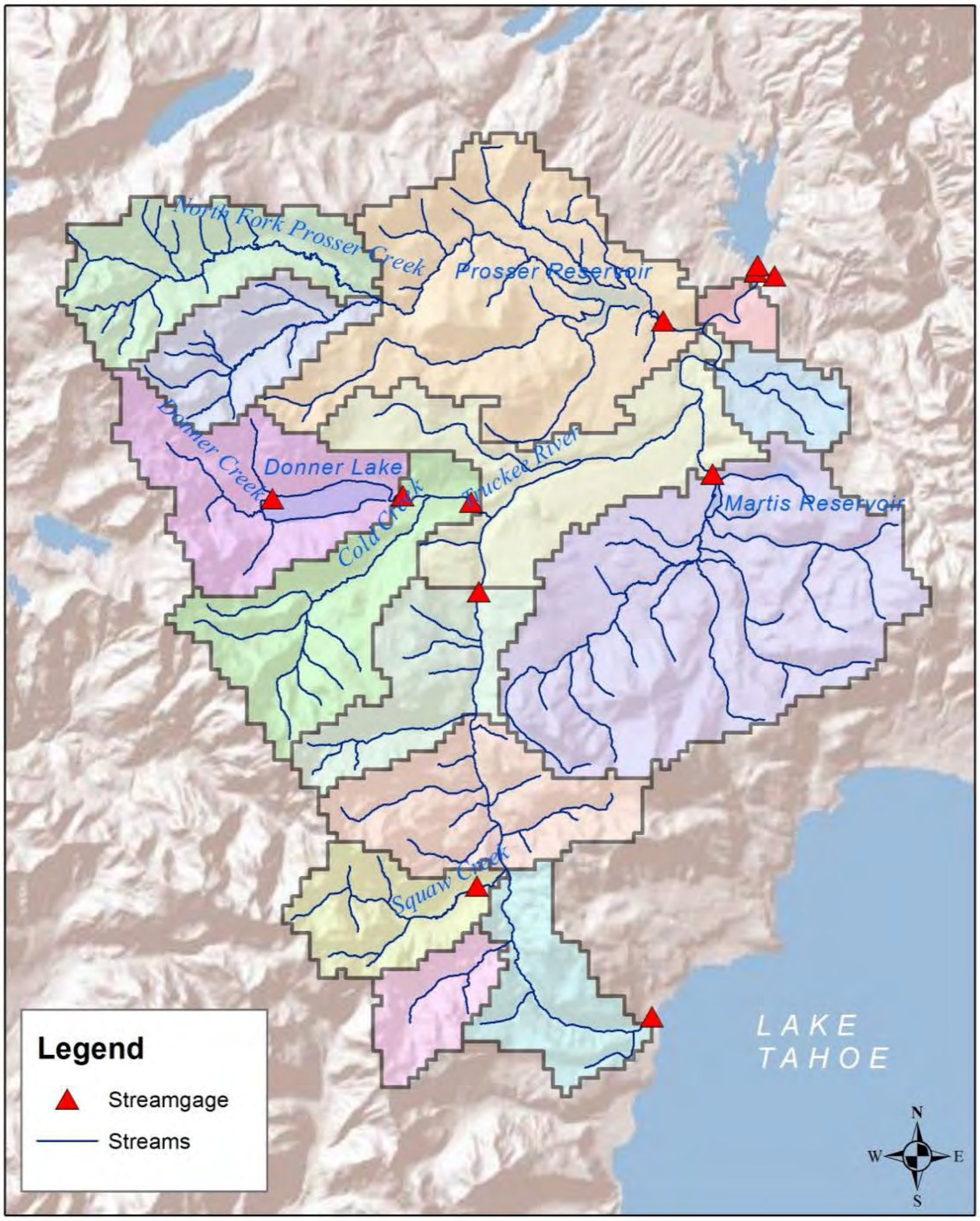

Figure 2. PRMS model domain with 14 sub-watersheds denoted by color. Stream gauges used in the PRMS calibration are denoted by triangles.

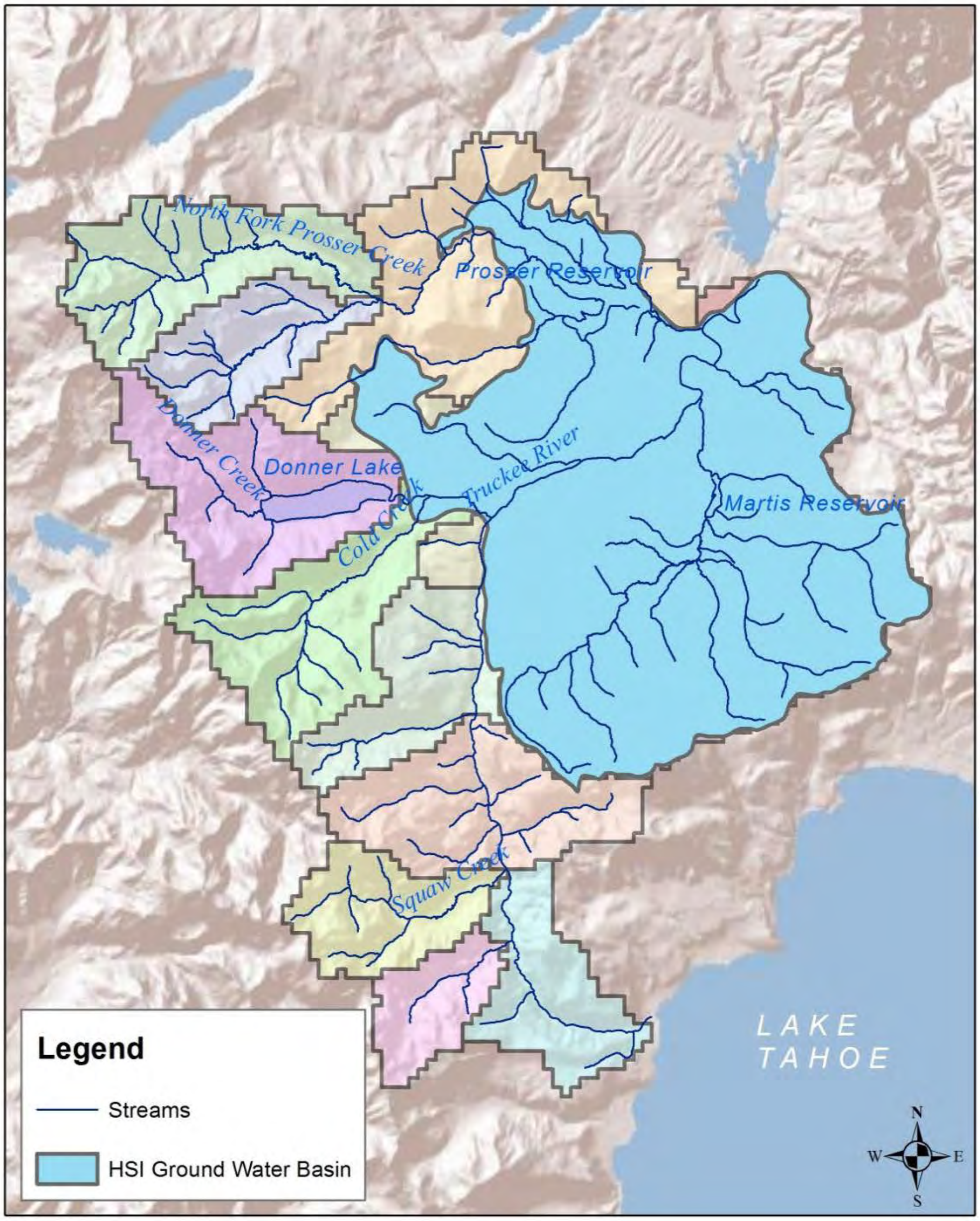

Figure 3. PRMS model domain with a portion of the sub-watersheds combined to adhere to the delineated Martis Valley Ground Water Basin inset (blue). All recharge estimates in this study are computed over the blue area. The Martis Valley Ground Water Basin area was delineated by Hydro Search Inc. (HSI).

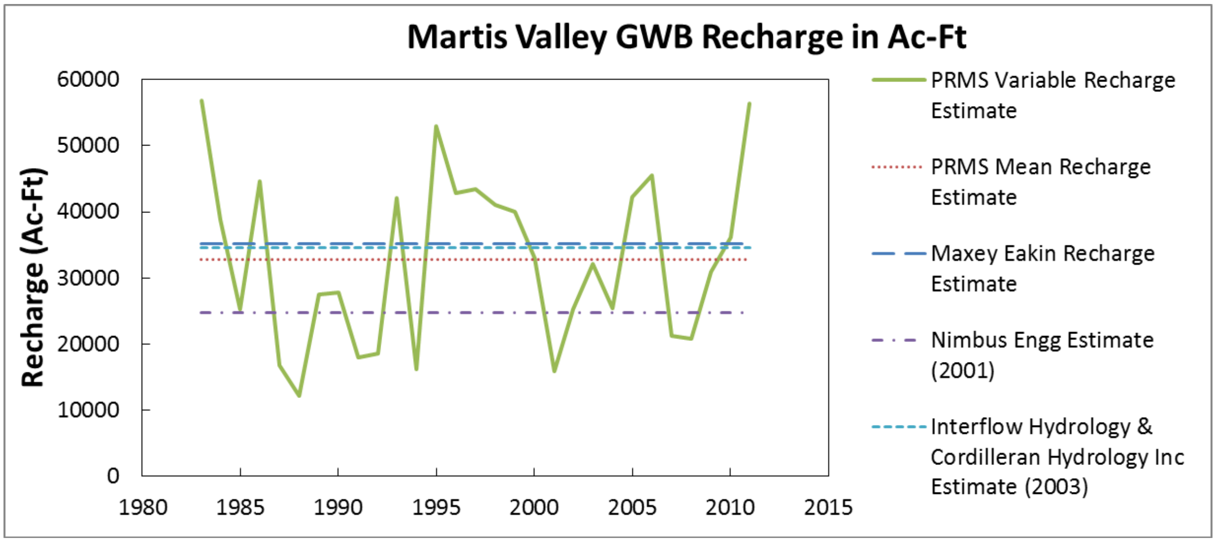

Figure 4. Annual recharge volumes computed by PRMS with comparison to recharge estimates from other methods and past studies.

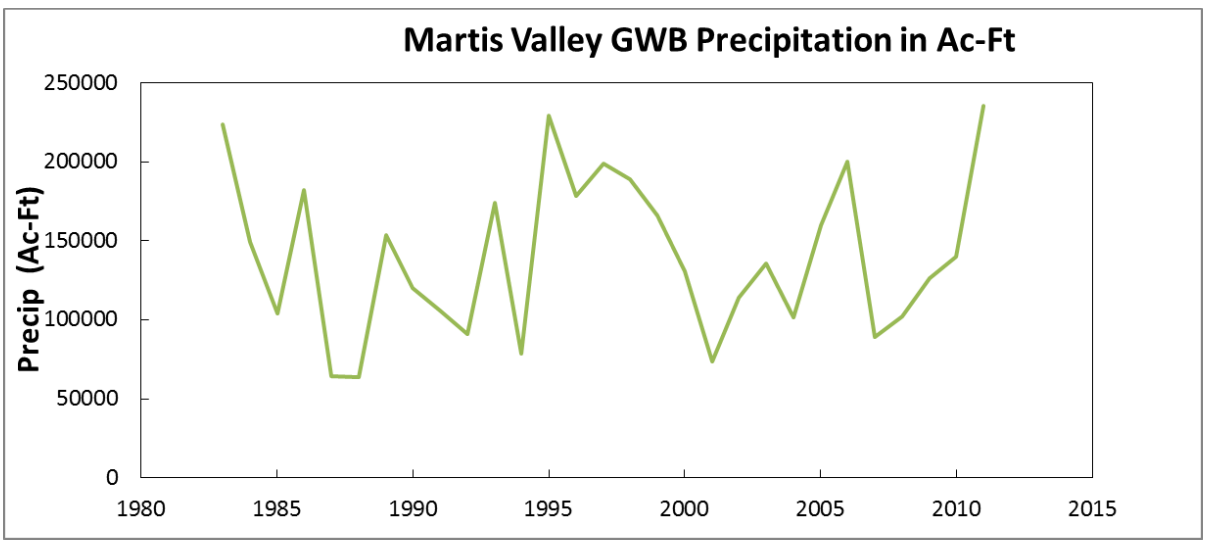

Figure 5. Annual precipitation volume over the Martis Valley Ground Water Basin

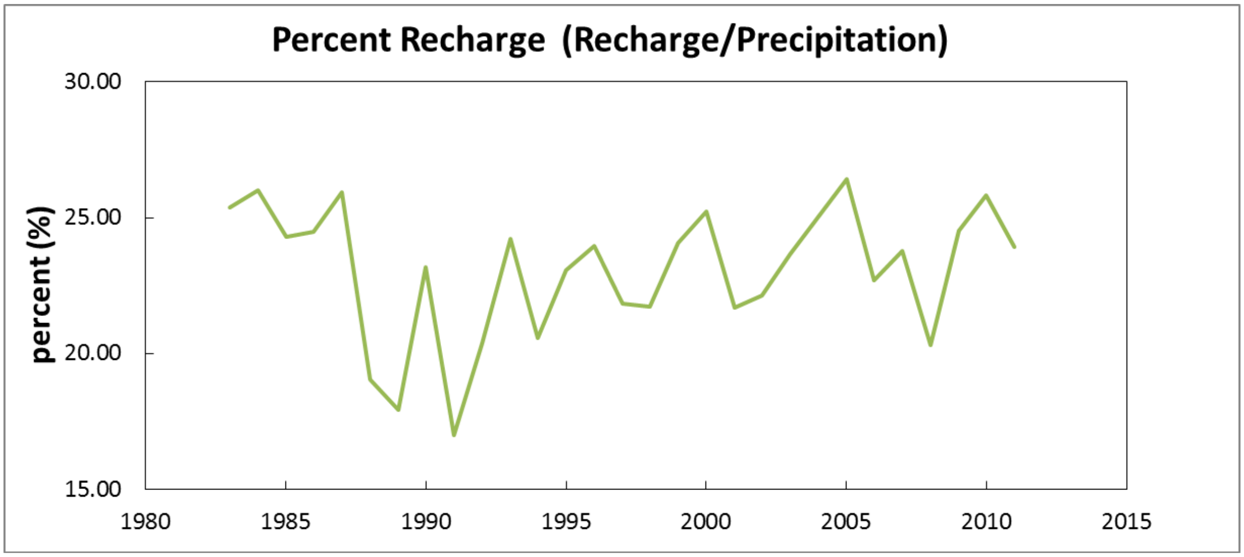

Figure 6. Value of recharge efficiency computed as the ratio of annual recharge to annual precipitation. The mean recharge efficiency value is 23%.

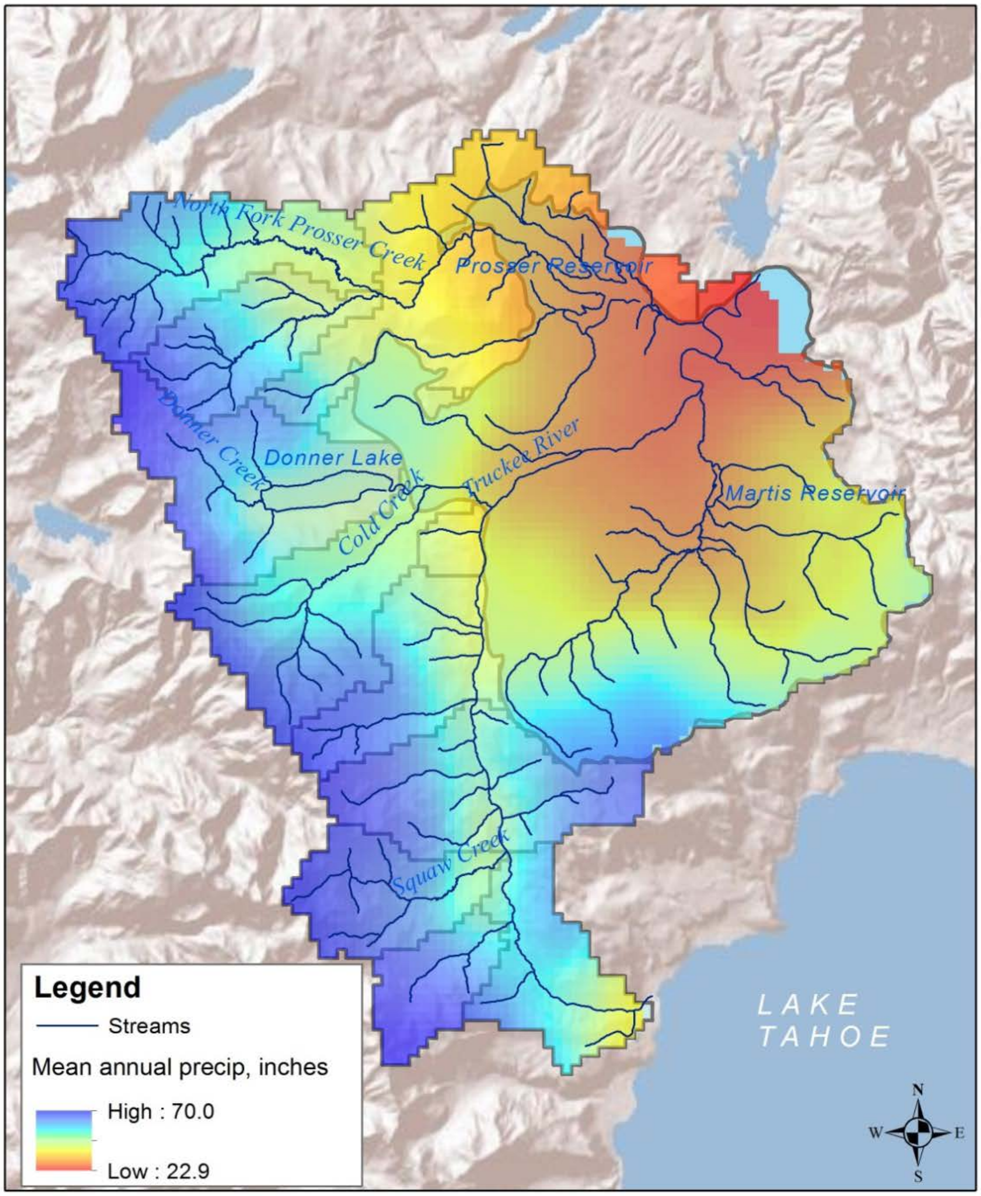

Figure 7. Mean annual precipitation (inches) in the Martis Valley PRMS model domain from PRISM (Daly et al., 1994).

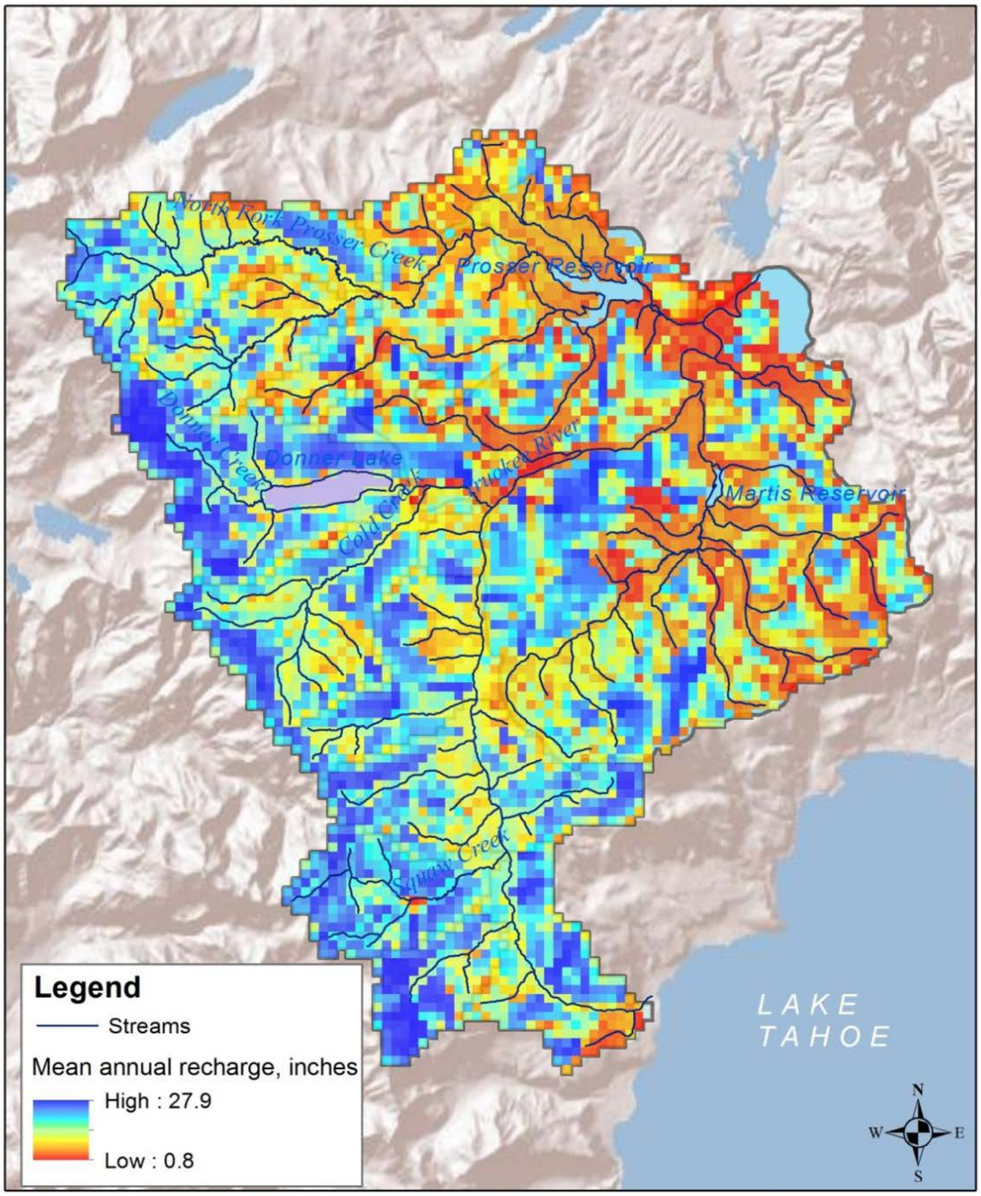

Figure 8. Mean annual recharge (inches) in the Martis Valley PRMS model domain. Note that the greatest quantities of recharge occurs in the high elevation areas which receive more precipitation (Figure 7).

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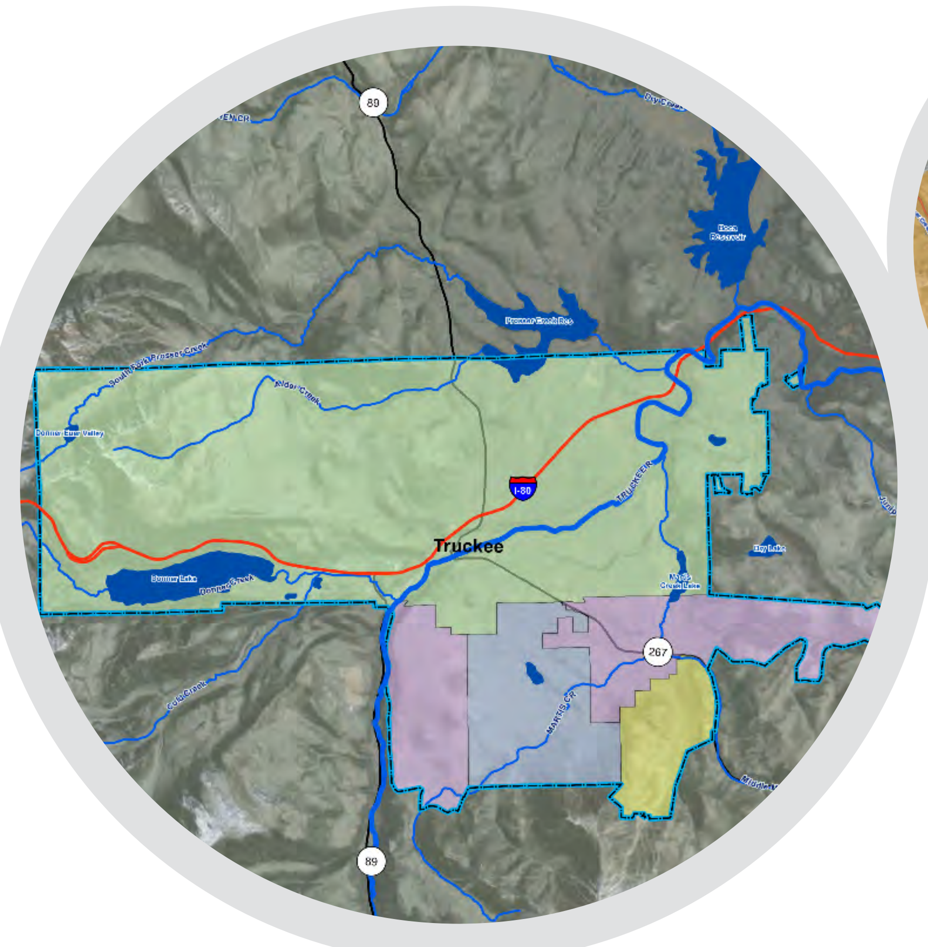

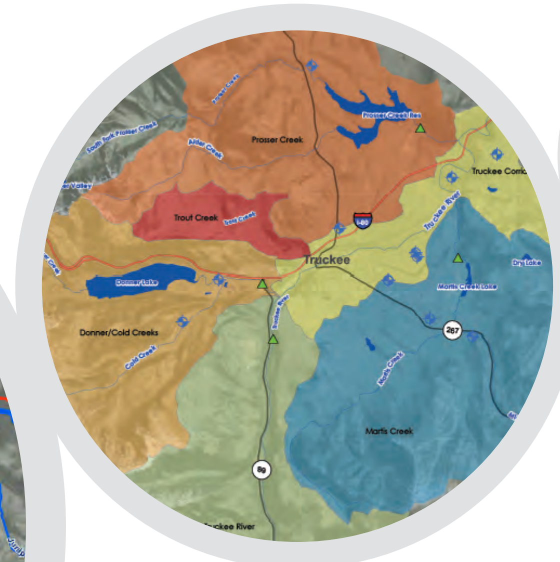

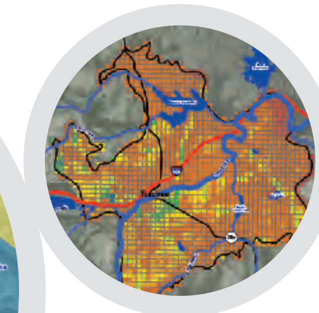

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