Groundwater Management Plan
For
The Mammoth Basin Watershed

Prepared for and by:

Mammoth Community Water District

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EXECUTIVE SUMMARY

The intent of the Mammoth Community Water District's Groundwater Management Plan is to ensure that groundwater resources are managed in a manner that ensures sufficient, high quality groundwater resources for the community of Mammoth Lakes while minimizing potential environmental impacts. The priorities for groundwater management are protecting the environment, establishing sustainable yields, and meeting the needs of the community. This plan has been developed utilizing information from existing reports and data, guidance from the Groundwater Management Act (AB 3030), funding assistance from the California Department of Water Resources, and a local advisory committee.

The Mammoth creek watershed is located on the eastern side of the Sierra Nevada Mountain Range along the southwestern edge of the Long Valley caldera. The Mammoth groundwater basin is located in the middle of the larger watershed region and consists of a complex system of water-bearing glacial deposits and fractured volcanic rock formations. Precipitation within the basin is directly influenced by elevation and is the sole source of recharge in the form of snowmelt and rainfall events. The District's service area covers a region slightly larger than urbanized area of the Town of Mammoth Lakes. The District is the primary extractor of groundwater resources within the groundwater basin, which are used primarily for domestic purposes and landscape irrigation.

Water demands in the District's service area vary significantly depending upon the time of year. As growth in the community continues to occur, the District has strived to meet demands and plan for future needs. The District is currently exploring alternatives such as water conservation, water system loss reduction, recycled water, and the development of new supplies to meet projected future shortfalls in multiple dry years. Groundwater extractions are currently projected at a rate not to exceed a maximum volume of 4,000 acre-feet per year.

The District currently utilizes eight groundwater production wells, located within the town boundaries and on the western edge of the watershed. Production wells are connected to a computerized data system that allows personnel to monitor and control static water levels, pumping water levels, and pumping rates at the District office. The District maintains extensive historical data relating to static levels, pumping levels and production volumes for each water supply well. The District also has fifteen monitor wells, seven shallow and eight deep, to measure potential impacts that may occur to the groundwater system. Five of these wells have been equipped with continuous, hourly monitoring equipment to track water levels, while the rest are manually measured on a weekly basis in the summer and monthly in the snowy winter months.

In response to concerns over potential impacts to streamflow and spring flow rates from groundwater pumping, the District has prepared groundwater monitoring reports annually since 1993 that provide an evaluation of groundwater level, surface flow, and water quality monitoring data accumulated throughout the year. The results from each of these reports have been unable to detect a connection between District groundwater pumping and streamflows in Mammoth Creek or springs within the Mammoth Basin.

An extensive surface water monitoring program is also maintained which includes the measurement of flows through the Lake Mary surface water treatment plant, the Bodle Ditch, inflows and outflows to Lake Mary, Lake Mamie outflow, Twin Lakes outflows, and a gage on Mammoth Creek near Old Mammoth Road.

Plans to expand to the current monitoring program have been developed to enhance information about groundwater pumping, surface water flows, spring flows, and possible connections between these elements. These changes include the installation of continuous water level monitoring on all production wells, the development of seven additional monitor wells, spring flow measurement on the Valentine Reserve, improved monitoring of Bodle Ditch flows, and the development of a groundwater modeling computer program.

The District works hard to protect environmental resources within the Mammoth Basin. In order to maintain high quality groundwater resources, the District regularly monitors production wells and monitor wells for various constituents. The District has established a series of monitoring objectives to ensure that high ground and surface water quality standards are preserved. In addition, the District has recently enhanced its existing water conservation program to ensure that water resources are utilized in an efficient manner and are available for generations to come. The conservation program consists of a toilet rebate program, water conservation education, the development of low water use demonstration gardens, recycled water planning, and a leak detection program. Well pumping strategies, well priority lists, and conjunctive use plans have been developed to streamline ground and surface water production and to prevent negative impacts to existing supplies.

To ensure that supplies of groundwater acquired from the Mammoth Basin are not depleted over time, steps are taken to prevent overdraft, utilize conjunctive use between surface and groundwater supplies, and replenish groundwater extracted.

The needs of the community are met through working with and developing relationships with other local agencies. As the Town is currently going through a transition in future growth plans with the development of a draft 2005 General Plan update, the District strives to meet the challenges of the communities water needs.

This management plan will continue to assist in meeting the needs of the community, ensuring sustainable yields, and protecting the environment through regular updates and review in the future. An advisory committee and the District’s hydrologist will assist in periodic review of the plan. The Board will approve any changes to the document.

CHAPTER 1

INTRODUCTION

Background

The Mammoth Community Water District (District) has been providing water supplies to the community of Mammoth Lakes since 1958. These water supplies consist of both volumes of surface and groundwater. Currently, the District maintains eight production wells, which provide nearly half of the water needed by the Town under normal precipitation year conditions and nearly 70 percent of water needed during multiple dry year conditions.

Groundwater management is the focus of this management plan, which relies on previously published reports, results of recent research and on District data compilations on hydrologic conditions, facility locations, and water production data for the Mammoth Basin watershed. In 1998, the District compiled the original draft document of this plan. While this draft was never finalized or approved by the District's Board of Directors, it provided a significant basis of information for this 2005 document. Work on the 2005 Groundwater Management Plan (GWMP) began following an award of grant funding provided by the California Department of Water Resources. This grant funding was received in summer 2004 and has enabled the District to complete a comprehensive groundwater management plan, expand the groundwater and surface water monitoring program, and develop a groundwater model.

In 1992, Assembly Bill 3030 (AB 3030), the Groundwater Management Act, was signed into law in California. The State Legislature declared that groundwater was a valuable natural resource in California and should be managed to ensure both its safe production and quality. The intent of the Legislature is to encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions. AB 3030 provides the opportunity for water agencies throughout California to demonstrate their ability to manage their groundwater resources. The foundation of AB 3030 is voluntary groundwater management with the ultimate adoption of a plan resting on the acceptance of landowners within a water district. Since it became law, AB 3030 has become not only the preferred groundwater management method for local water users and managers, but for state and federal officials as well.

In 1993, the Mammoth Community Water District adopted an ordinance regarding private groundwater wells within the District boundaries. The ordinance includes requirements for permits, permit fees, environmental review, well development standards, and well abandonment standards. Although the District's well ordinance addresses the issue of private wells, it does not relate to an overall groundwater management plan for the District. Therefore, as a good management practice, the District has developed a groundwater management plan that generally follows the guidelines set forth in AB 3030.

Project Purpose

The purpose of this project is to develop a management strategy for the use of groundwater within the Mammoth Basin watershed by the Mammoth Community Water District. This report provides information to evaluate the water resources in the basin so that groundwater can be managed to maximize the total water supply while protecting groundwater quality, riparian corridors or vegetation, and surface water resources.

Objectives

The priorities for groundwater management can be placed into the following three general categories.

1. Protecting the environment
2. Obtaining sustainable yields from the groundwater basin
3. Meeting the needs of the community

The overall objective of this management plan is to provide specific action recommendations for groundwater protection and management in the Mammoth Basin and to provide a technical basis and justification for these recommendations based on the best available information.

The objective of developing this groundwater management plan is to develop a best management strategy that can be utilized to establish the amount of groundwater that can safely be withdrawn annually under various conditions without producing significant environmental impacts. This strategy would include maximization of groundwater withdrawals from the Mammoth Groundwater Basin in conjunction with available surface water supplies.

Advisory Committee

In December 2004, an advisory committee was formed to provide guidance on monitoring in the Mammoth Basin as well as guidance on this document. Each entity represented on the committee has an interest in the development of groundwater resources and fully supports a management plan that can be utilized for future planning purposes and for the protection of the environment that each depends on for its livelihood. This committee, or one similar to it, may be formed in the future to help revise and update this management plan. The following local advisors were directly involved on the committee.

Table 1
GWMP Advisory Committee

Name	**Organization**
Alex Fabbro	Mammoth Mountain Ski Area
Chris Farrar	USGS
Dan Dawson	Valentine Reserve/UCSB
Doug Jung	PE, Geologist
Ericka Spies	MCWD
Gary Sisson	MCWD
Karl Schnadt	MCWD
Kit Custis	Department of Conservation
Michael Grossblatt	Town of Mammoth Lakes
Rob Lusardi	Cal Trout
Robert Sullivan	Mammoth Pacific LP
Sue Burak	Snow Survey Associates
Steve Parmenter	Department of Fish and Game

CHAPTER 2

GROUNDWATER BASIN CONDITIONS

Mammoth Creek Watershed

The Mammoth creek watershed is located on the eastern side of the Sierra Nevada Mountain Range along the southwestern edge of the Long Valley caldera. The caldera was formed by the subsidence of the region following a volcanic explosion of 35 cubic miles of Bishop Tuff about 710,000 years ago. The Long Valley caldera consists of a variety of volcanic rocks, which are associated with geothermal activity, particularly in the southwest section of the caldera where the Mammoth Basin is located. The Mammoth Creek watershed is characterized by elevated areas on the north and west that are comprised largely of extrusive igneous rocks; a central trough filled with alluvial and glacial debris; and an abrupt southern flank of igneous intrusive and metamorphic rocks. The central trough area opens and drains to the east to the Owens River and Lake Crowley.

Surface elevations within the watershed range from about 12,000 feet at the Mammoth Crest to 7,000 feet at the downstream easterly extremity near the county road near Cashbaugh ranch. Mammoth Creek originates in small streams flowing off the upper elevations of the Mammoth Lakes Basin, which often holds snow throughout most of the summer. The watershed is bounded on the south by the drainage divide of Convict Creek; on the west, by the Mammoth Crest; on the north by the drainage divide of Dry Creek; and on the east extending along the watershed of Hot Creek. Mammoth Mountain forms the southwest rim of the Long Valley caldera, one of the largest recent rhyolitic caldera centers in the United States. The area of the Mammoth Basin is about 71 square miles and extends approximately 13 miles west to east and 9 miles north to south. The area of the Mammoth Basin, together with the internal drainage basins, is shown on Appendix A.

Mammoth Groundwater Basin

Groundwater in the Mammoth Creek basin is related to the water-bearing characteristics of the underlying rock formations. The underlying geology is very complex and not well characterized. Previous studies (Bierman 1973 and SWA Group 1977) suggest subsurface flow occurs in permeable undefined channels throughout the upper Lakes Basin. Generally, water-bearing capacity is high in local glacial deposits and fractured volcanic rock formations. Glacial deposits vary in thickness from a few feet to more than 100 feet, whereas the volcanic formations range in depth to more than 3,000 feet (Wildermuth 1996). Glacial deposits are interbedded with volcanic flow and tuffaceouos materials and reflect alternate periods of volcanic activity and climatic changes governing glacial advance and retreat (SWA Group 1977).

Wildermuth (1996 and 2003) suggests that underlying the Mammoth Basin is a groundwater regime that does not correspond to the boundaries of the surface drainage systems (Wildermuth 1996, p. 12). The groundwater basin lies largely within the central part of the Mammoth Basin watershed.

Boundaries of the groundwater basin have not been specifically defined due to the complex hydrogeologic conditions of the basin. Mark J. Wildermuth prepared a general outline of the basin considering surface drainages, ground elevations, surface geology, and subsurface exploration in his 1996 study. The basin extends from near Mammoth Mountain Ski Lodge in the west, through the areas of Old Mammoth and Mammoth Lakes, on eastward past the Casa Diablo Hot Springs and Hot Creek fish hatchery, then continues eastward to the county road near Cashbaugh ranch. Both surface and groundwater enter the groundwater basin area from the north, west, and south. A generalized outline of this groundwater basin is shown on Appendix B.

Wildermuth subdivided the Mammoth Basin into eastern and western areas in a September 1996 report for purposes of determining total water produced in the watershed. District production wells are located within this western area of the basin. Mammoth Creek flows through the center of the area and drains the upper Lakes Basin and Old Mammoth, an area of about 34.5 square miles. Of this total acreage, approximately 14.4 square miles are included within the groundwater basin in the western area. Geothermal groundwater is also extracted and re-injected in the extreme eastern portion of the western basin area. Appendix A shows the surface water drainage map that included six sub-drainage areas of the Mammoth Basin was used to identify the dividing line between the eastern and western areas. This dividing line follows the eastern boundary of sub-drainage areas E and D of the surface water drainage map.

The primary recharge area for the groundwater basin includes the western section of the Mammoth Basin and includes Mammoth Creek that flows from west to east within the basin. Naturally occurring isotopes of deuterium and O^{18} show that the Sherwin Range to the south contributes mountain front recharge. Various authors (Vorster 1985 and Cayan 1996) estimate that 75% to 90% of precipitation in the Sierra Nevada occurs during the period of October 1 through April 1.

Average annual precipitation ranges from about 42.5 inches at Mammoth Pass (9,500 ft) at the western boundary of the Basin to 10 inches at the Crowley Lake dam (CDEC, LADWP records) in the extreme eastern part of the basin, showing the elevation gradient of snow-water equivalent within the Mammoth Basin. District production wells are located at elevations ranging from 7,900 feet to 8,000 feet.

Based on pumping responses, well logs, and other data, aquifers within the western area of the groundwater basin exhibit characteristics of three main types of aquifers; confined, semi-confined and unconfined (Wildermuth 1996, p. 17). Groundwater recharge to the basin is derived from direct percolation, and infiltration of snowmelt and some summer rainfall along Mammoth Creek and other minor streams tributary to the basin. This part of the groundwater basin can potentially receive substantial subsurface recharge because of its western location where basin precipitation is greatest.

Aquifer Characteristics

Mark Wildermuth notes in his 2003 groundwater investigation (Wildermuth 2003, p. 3-3) multiple groundwater systems appear to be present in the Mammoth groundwater basin because of the complex geology, hydrology, and hydrogeology of the area. Wildermuth states that two distinct aquifer systems exist in the area where the District produces water. District production wells tap the deep system, consisting of fractured basalts and other water yielding rock, which is highly responsive to District groundwater production and responds slowly to recharge.

A shallow and generally highly transmissive system of glacial till and alluvium with interbedded volcanics lies over the deep system and seems to range from less than 100 feet to 200 feet in total thickness. This hydrostratigraphic layer consists of four distinct geologic units (Wildermuth, 2003); these units are listed below by age:

Quaternary alluvial deposits comprised of clay, silts, sand, and cobbles. This unit is anticipated to be a few feet to 60 feet in thickness with a permeability of low to moderate.

Quaternary lake (lacustrine) deposits comprised mostly of unconsolidated fine-grained sediments that are of low permeability. This unit tends to be no more than a few tens of feet in thickness within the Mammoth Basin and represent little of the alluvial aquifer.

Quaternary glacial deposits within the Mammoth Basin tend to be slightly to moderately consolidated and consist of clay to boulder size glacial debris. This unit varies from a few feet to 100 feet in thickness with moderate permeability.

Quaternary and Tertiary igneous rock consist of lava flows, breccias, and tuffs interbedded with glacial debris. Secondary porosity of these rocks allows them to be significant portions of the aquifers (primarily deep) with moderate to high permeability.

Based on examination of District water level records, the shallow system responds rapidly to recharge. Evidence at and near District wells indicates a downward gradient from the shallow to the deep aquifer (Schmidt, 1992). Aquifers tapped by production wells appear to be generally confined due to alternating layers of glacial till and alluvial material, clays and volcanic rock.

Historical Groundwater Development

Except for possible activities of the Native Americans, development of groundwater in the Mammoth area did not commence until the late 1800s. This limited early development included the construction of shallow hand-dug wells and the improvement of cool and hot springs. Many of these springs continue to yield water for various purposes.

Recent groundwater production began in 1979 with the completion of District well 1 and related pipelines and storage tanks. This well was tested to produce at a rate of 512 gallons per minute (gpm). In response to multiple dry year conditions and resulting water supply deficiencies, District wells 6 and well 10 were completed in 1988. These wells penetrate fractured basalts to depths of about 700 feet and are capable of producing approximately 1,000 gallons per minute each. Water from these wells contained iron and manganese in concentrations that exceeded drinking water standards; therefore, a treatment plant was constructed to remove iron and manganese from the water before delivery to District customers. During this same period, the District drilled twelve groundwater monitor wells (seven shallow and five deep) within the area for monitoring potential impacts to the existing groundwater basin.

Additional drilling and development of production wells occurred in the early and mid 1990s to provide new water supplies for the District to meet the demand for water created by continued growth in the community. Five new production wells were drilled, including wells 15, 16, 17, 18, and 20. Wells 15 and 18 were connected to the existing groundwater treatment facility constructed for wells 6 and 10. The other wells also required treatment for removal of iron and manganese and a new treatment facility was constructed. The total projected production capability of these five new wells amounted to 2,500 acre-feet per year with flow rates ranging from 300 gallons per minute to 1,000 gallons per minute.

In addition, associated with the construction of the five new production wells, the District constructed two new additional deep monitor wells (wells 5A and 24) for improved monitoring of the groundwater basin. This was in response to concerns by the Department of Fish and Game and the University of California over potential impacts to spring flows at their facilities. Monitor well 24 was originally planned to collect data on both deep and shallow groundwater, but upon construction only deep water was found despite its close proximity to Mammoth Creek.

In 1992, Dempsey Construction Corporation drilled a well on their property to provide water for irrigation of the Snowcreek Golf Course. This well produces a maximum of 200 gallons per minute.

There have also been two private domestic wells drilled on residential lots within the District's service area. Both wells are located in the Old Mammoth area, one near Crawford Street, and the other near the intersection of Summit Street and Ski Trail Lane.

Projected Water Demand

Water demands in the District's service area vary significantly depending upon the time of year. The summer months show the greatest water demands as the snow melts and customers begin using their irrigation systems. In the late spring and early fall when irrigation does not take place and only the local population resides in town water demands average about 1.7 million gallons per day (mgd). However, in the early summer when sprinklers are turned on and the visitor population continues to be minimal, water demand spikes two and a half times to 4.5 mgd.

The Town of Mammoth Lakes has experienced a resident population increase of approximately 80 percent in the past twenty years and over 48 percent over the past ten years. This far exceeds the State of California as a whole, which experienced a population increase of 13.8 percent in the past ten years. Current population estimates (Enviroscientists 2005) include 7,570 permanent and 2,266 seasonal residents with an average peak period population of approximately 34,269. The peak population on holiday weekends can rise far beyond this value.

As the town continues to grow, the District continues to plan for future water demands. The District provided a Water Source Assessment to the Town of Mammoth Lakes in the fall of 2004 to determine if existing supplies are sufficient to meet growth projections as described in the Town of Mammoth Lakes 2005 General Plan. This assessment determined that the volume of existing water supplies is insufficient to meet demands from any scenario during multiple dry-year conditions. To meet this shortfall, the District is currently exploring alternatives such as water conservation, water system loss reduction, recycled water, and the development of new supplies. The 2004 Mammoth Community Water District Water Assessment for the Draft Town of Lakes General Plan is included as Appendix C.

The possibility of developing new production wells in the Mammoth Basin is dependant on the results of several additional years of monitoring. If the data shows that additional pumping would not have significant negative environmental impacts, then the District would consider proposing new production wells to the east of existing wells. Groundwater pumping in Dry Creek is a low priority that would be explored after the possibility of new production wells Mammoth Basin is analyzed.

Future groundwater production rates have been projected based on community growth projections and on type of climatic conditions. The following tables describe projected volumes of groundwater that will be pumped under normal and multiple dry-year water year conditions.

Annual groundwater pumping projections have been developed to meet anticipated demands for normal year and multiple dry year conditions. The following tables show these pumping projections for each of the District's production wells.

Table 2
Groundwater Pumping Projections (acre-feet)
In Normal Year Conditions

Well No.	2003	2005	2010	2015	2020
1	208	50	100	100	100
6	415	200	200	300	400
10	848	200	300	300	400
15	911	200	300	400	400
16	123	100	100	100	100
17	184	200	300	300	400
18	126	50	100	100	100
20	111	200	300	400	400
Future Well(s)	0	0	0	0	0
Total	2926	1200	1700	2000	2300
Groundwater projections based on utilizing 2500 ac-ft of surface water in normal year to meet projected demand.					

Table 3
Groundwater Pumping Projections (acre-feet)
In Multiple Dry Year Conditions

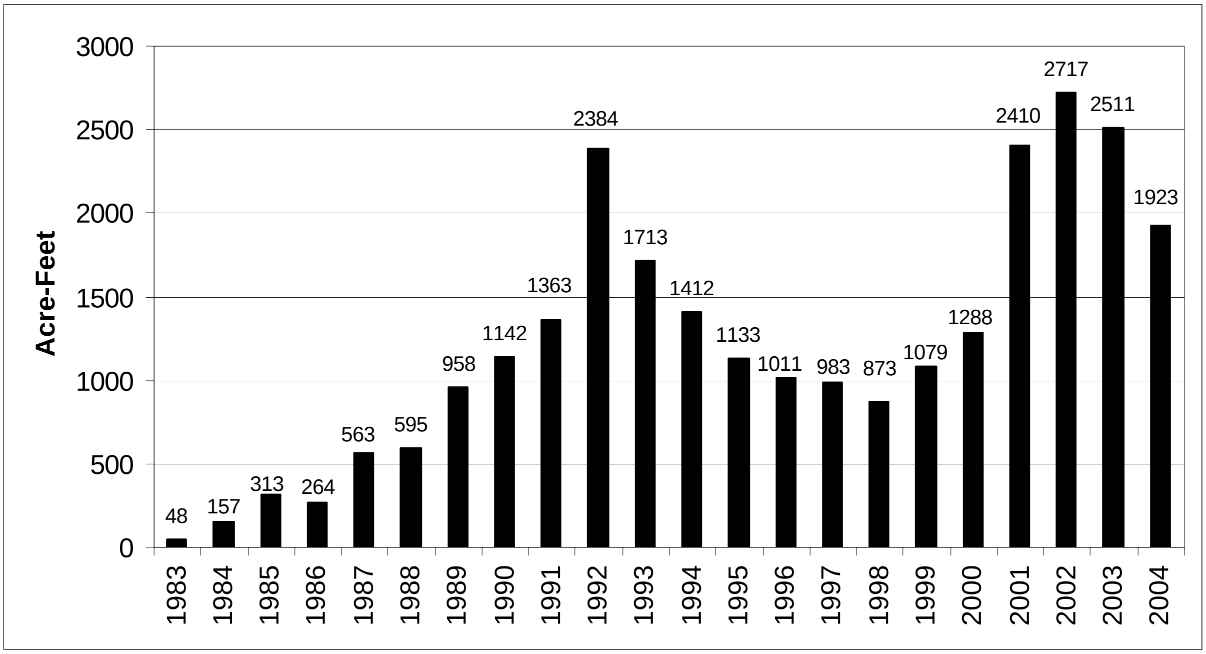
Well No.	2003	2005	2010	2015	2020
1	208	100	200	200	200
6	415	400	500	600	600
10	848	400	500	600	600
15	911	500	500	600	600
16	123	100	200	200	200
17	184	400	500	500	500
18	126	100	100	100	100
20	111	400	500	500	500
Future Well(s)	0	0	0	100	300
Total	2926	2400	3000	3400	3600
Groundwater projections based on utilizing 1200 ac-ft of surface water in multiple dry years to meet projected demand.					

Projected Water Supply

Water provided by the District to customers within the Town of Mammoth Lakes comes from both surface water and groundwater. While the amount of surface water is limited by the District's surface water permit, groundwater extractions are currently projected at a rate not to exceed a maximum volume of 4,000 acre-feet per year. Production volumes of groundwater in any one year are dependent on the type of precipitation year experienced and consequent availability of surface water.

The Mammoth Community Water District currently has developed eight extraction wells located within the western area of the Mammoth groundwater basin. Based on historical record, the maximum annual extraction of groundwater within the Mammoth Basin was during 1992 and amounted to 2,485 acre-feet. Figure 1 describes the volumes extracted from these wells from 1983 through 2004.

Figure 1
MCWD Well Extraction Volumes (1983-2004)



The Dempsey Construction Corporation has developed one extraction well on its property that it utilizes for golf course irrigation water. This well is capable of producing a maximum of 200 gallons per minute, although Dempsey Construction has rights to pump up to 450 gallons per minute for irrigation of open spaces. Irrigation water used on the golf course is pumped from this well and is generally supplemented by groundwater from District well 10. Table 4 provides groundwater extraction data for this well from 1991 through 2004.

Table 4
Snowcreek Golf Course Well Extraction

Year	Extraction (ac-ft)	Year	Extraction (ac-ft)
1991	27	1998	0
1992	100	1999	71
1993	37	2000	70
1994	155	2001	35
1995	165	2002	40
1996	97	2003	86
1997	108	2004	89

The United States Forest Service in 1996 installed an extraction well in the Lakes Basin that is located near the extreme western boundary of the Mammoth Basin watershed. Groundwater is extracted for domestic use in campgrounds and is considered minimal.

There are also two private extraction wells located within the community. This use is for irrigation of single-family residences and is considered minimal. As noted above, geothermal groundwater is also extracted and re-injected in the eastern portion of the western basin.

Availability of surface water from Lake Mary, through the District's water rights permit and licenses, is dependent on lake level and on streamflow conditions in Mammoth Creek. The status of lake level and streamflow rates affects the daily volume of surface water that can be delivered to the community. An increase or reduction in surface water available also influences the requirements for groundwater to meet community demand. Through full utilization of available surface water, groundwater extractions can be conserved and operated efficiently. In addition, more efficient groundwater basin recharge is allowed to occur when surface water use is optimized.

The 1973 DWR report estimated the available groundwater storage in the Mammoth groundwater basin to be about 57,000 acre-feet. This estimate was based on the idea that useful groundwater occurred only in unconsolidated sediments, utilizing groundwater data from only a few wells. The District has since drilled several successful extraction wells into the fractured basalts that underlie the unconsolidated sediments indicating that useful groundwater storage extends to the basalts. Wildermuth (1996) divided the Mammoth Basin into three areas to determine a storage analysis.

These areas included:

- Mammoth valley area from the fish hatchery westward about 7 miles and averaging about 1.5 miles wide;
- An area defined as the difference between the Mammoth groundwater basin and the Mammoth valley area described above; and
- An area defined by the difference between the Mammoth Basin drainage area upgradient of the AB and CD headsprings, and the Mammoth groundwater basin.

The Mammoth valley area is about 10.5 square miles and Wildermuth estimates the useful groundwater in storage in this area to be about 100,800 acre-feet. The remaining part of the groundwater basin area is about 9.5 square miles with a useful storage estimated to be about 24,300 acre-feet. This amounts to a total useful storage in the Mammoth groundwater basin of about 135,100 acre-feet (Wildermuth 1996, p. 22).

The Mammoth Basin drainage area outside of the groundwater basin is about 45.9 square miles with a useful storage estimated to be about 117,500 acre-feet. This brings the total useful groundwater storage tributary towards the eastern end of the Mammoth Basin to be approximately 242,600 acre-feet as estimated by Wildermuth (Wildermuth 1996, p. 22).

CHAPTER 3

MONITORING PROGRAM

Groundwater Monitoring Program

The District has eight water production wells within the Mammoth Basin. The locations of each supply well in relation to the Mammoth Basin are included on a production well location map shown on Appendix D. The District has also prepared a detailed description of its groundwater and surface water monitoring program and is attached as Appendix E.

The District has also installed fifteen monitor wells that include seven shallow wells and eight deep wells. A map showing a close-up of monitor well and production well locations is shown in Appendix F.

Table 5
Historical Production Well Profiles

Well No.	Period	Static Level (ft)	Pumping Level (ft)	Discharge Rate (gpm)	Aquifer Transmissivity (gpd/ft)
1	1989-2000	150-268	191-295	350-800	30,000
6	1989-2000	0-160	77-200	700-1000	11,500
10	1989-2000	8-164	41-200	900-1500	45,000
15	1992-2000	168-275	183-297	900-1000	10,700
16	1995-2000	414-484	471-492	350-500	25,000
17	1995-2000	364-387	370-386	700-850	426,000
18	1994-2000	40-88	82-156	350-500	12,500
20	1995-2000	399-437	429-489	900-1000	71,000

The District maintains extensive historical data relating to static levels, pumping levels and production volumes for each water supply well.

District production wells are connected to a computerized data system that allows personnel to monitor static water levels, pumping water levels, and pumping rates at the District office. This system also allows personnel to control well operation by providing the ability to change when a well will start and stop. This is a valuable tool in balancing production from individual wells.

The District has installed fifteen monitor wells to measure potential impacts that may occur to the groundwater system. Manual water level measurements are performed weekly except during the winter season when snow conditions inhibit access. During the winter season, data is collected on a monthly basis. The District has continuous monitoring equipment with hourly data collection at five of the sites including wells 14, 19, 21, 23, and 24.

Two additional monitor wells measured by the United States Geological Survey (USGS) are included in the District's monitoring program. Data is received from the USGS and reviewed by the District's hydrogeology consultant.

Flow rates of springs located within the Eastern Sierra Valentine Reserve were measured by University of California personnel and submitted to the District on an annual basis for review between 1993 and 2001. Problems with the University's equipment have precluded data collection in recent years and the District is working with reserve staff to install effective monitoring devices. Spring flow monitoring helps to determine if District well pumping has any impact on flow rates within the reserve.

Flow rates of springs located at the Hot Creek Fish Hatchery are also monitored and data is provided to the District for review. The purpose of this monitoring is to determine if District pumping has any impact on the flow rate of springs at the hatchery. These springs are critical to the production capabilities of the hatchery.

Streamflow data for Mammoth Creek is monitored on continuous recorders at three locations to determine any potential impacts to streamflow from District well pumping. Streamflows are also measured at the four inlets to Lake Mary, the outflow from Lake Mary, outflow from Lake Mamie, outflow from Twin Lakes, and on the Bodle Ditch. The District is planning to outfit the monitoring sites at Twin Lakes and Old Mammoth Road with radio transmission equipment so that data can be transmitted to the District office. This will provide valuable data relating to surface water availability, which relates directly to the daily requirements for groundwater extraction.

Annual Groundwater Monitoring Report

In 1992, the District proposed to construct five new water supply wells and a treatment facility to supply approximately 2,500 acre-feet of groundwater annually to the community. Concerns were expressed about the potential impact of pumping of these wells on Mammoth Creek, on spring flow at the Valentine Reserve, and at the Hot Creek Fish Hatchery headsprings located downstream of the District wells. In order to respond to these concerns, a hydrogeologic evaluation was completed and a specific monitoring program was established.

The District prepares an annual groundwater monitoring report that provides an evaluation of groundwater level, surface flow, and water quality monitoring data accumulated throughout the year. An annual interpretive report on results of the groundwater monitoring for the water year October through September is prepared and submitted by December 15 of each year. Reports have been prepared each year from 1993 through 2004 and are available on the District's website (www.mcwd.dst.ca.us) and at the District's offices for public review. The results from each of these reports have been unable to detect a connection between District groundwater pumping and streamflows in Mammoth Creek or springs within the Mammoth Basin.

Surface Water Monitoring and Data Transmission Equipment

District diversions of surface water from Lake Mary take place at the surface water treatment plant and are continuously monitored and controlled through a supervisory control and data acquisition (SCADA) system that is connected to computers located at the District's main office.

Surface water from Lake Mary is also diverted on a seasonal basis into what is known as the Bodle Ditch per an agreement with the U.S. Forest Service. Water is normally diverted into the ditch from May through October. The Bodle Ditch flows into the Old Mammoth meadow area and a portion is allowed to flow into Mill Creek, which flows through a small tract of cabins whose use is permitted by the USFS. Flows in the Bodle Ditch are physically inspected on a daily basis.

Surface inflow rates entering Lake Mary are monitored at four different streams that enter the lake including Mammoth Creek, Coldwater Creek, Coldwater Creek diversion, and George Creek. Flumes have been installed at each site for flow measurement and continuous chart recorders are utilized during the spring, summer, and fall months to record flow. The chart recorders are removed during winter months when snow accumulations can result in equipment damage and safety concerns. During these times, the flumes are physically inspected for flow rates on a weekly basis.

Water released at the Lake Mary dam is currently measured at the outlet of Lake Mamie as it flows into Twin Lakes using a combination flume/weir structure. Flow rates at this site are continuously monitored and recorded using a chart recorder. A diversion is also located on Lake Mamie that creates a small amount of flow into Twin Lakes. Flow rates at this site are generally consistent and are currently estimated at 0.5 cubic feet per second.

Surface water discharge from Twin Lakes is monitored at the dam using a level sensing instrument and chart recorder. Discharge is calculated using depth of water, length of the crest of the dam, and the shape of the crest.

The Districts remaining flow measuring station monitors flow in Mammoth Creek downstream of Twin Lakes and is located just upstream of where the creek intersects Old Mammoth Road within the community of Mammoth Lakes. This station includes a combination flume/weir structure with a continuous chart recorder. It is at this site that the District determines whether there is sufficient flow in the creek to allow for surface water diversion and/or storage at Lake Mary per its water rights licenses and permit.

The District has prepared a detailed description of its groundwater and surface water monitoring program and is attached as Appendix E. The District has also prepared a Drinking Water Source Assessment document that includes information on each water source location, and data including well construction, aquifer, well production, and pump information for each site. Copies of the Drinking Water Source Assessment document are available for public review at the District offices.

Groundwater Monitoring and Data Transmission Equipment

In order to prevent the basin from being over drafted, the District maintains an extensive groundwater monitoring system. The District currently has installed and collects data from fifteen monitor wells located within the Mammoth groundwater basin, four of which are equipped with water level transducers and data loggers for continuous monitoring. Data loggers were installed on all eight production wells in early 2005 to monitor groundwater levels on a continuous basis. These data acquired from these devices are also connected to the District's SCADA system, which allows operators to control pumping flows and well levels. A chart recorder is installed on one well to continuously record groundwater level. The remaining monitor well sites are manually inspected on a weekly basis during the summer and monthly basis during the winter months.

A concern has been expressed that District groundwater extraction may impact streamflow in Mammoth Creek and spring flow within the Valentine Reserve and Hot Creek Fish Hatchery, although evidence to date shows no influence. District shallow monitor wells located near Mammoth Creek and the reserve include 5M, 22, and 23. In order to track any potential impact from District pumping, continuous water level recording devices should be installed at these sites.

The power supply units on existing data loggers for the four monitor wells should be improved. Power supply problems in the past have resulted in inconsistent water level data being recorded at times, particularly during cold temperatures. It is recommended that solar panel units be installed at all four sites to provide a dependable power supply.

Expanded Future Monitoring Program

The District plans to expand to its current monitoring program to enhance information about groundwater pumping, surface water flows, spring flows, and possible connections between these elements. In the winter of 2004-05, the District installed pressure transducers on all eight of its production wells, which were then connected to the District's SCADA system. This new technology enables constant real-time monitoring of water levels and allows operators to turn pumps on or off as necessary.

Additional shallow and deep monitor wells will be developed to enhance monitoring capability. A deep well is projected to be located at the existing District administrative office site and will be used to monitor potential impacts from geothermal well development that will occur to the north. An additional deep well will be located at the eastern edge of the expanded Snowcreek Golf Course to monitor for potential impacts from pumping of District production wells. Shallow monitor wells will be located adjacent to the Snowcreek and Sierra Star golf courses in order to monitor for potential water quality impacts from golf course operations.

Modifications to existing District monitor wells will provide improved monitoring capability, specifically to determine any potential impact to streamflows in Mammoth Creek. A new well may be drilled near existing well 23 to provide for water level and water quality monitoring at specific depths. Existing well 22 will be developed further to enhance the effectiveness of groundwater level monitoring. If this is not effective, the District may drill a new well closer to Mammoth Creek.

The developments of monitor wells 22 and 23 will involve the construction of nested wells, meaning that two or more casing strings will be placed within the same borehole. Perforated casing will be located in each casing string to obtain water from different water-bearing zones. It is anticipated that construction in this manner will enable the District to determine possible interactions from groundwater pumping and streamflow on groundwater levels. Nested pipes would help to determine changes in head with depth and upward/downward flow of groundwater

The District is planning to install flumes at three locations within the Mammoth Basin. One flume will be placed on the Bodle Ditch as it flows into Mammoth Meadow. Although the District has a gage further upstream and closer to the diversion point, this device will provide information regarding groundwater recharge in the Mammoth Meadow area as well as influences from spring inputs and Mill City diversions. Two flumes are planned for the Valentine Reserve to help determine if District groundwater pumping influences the flow in these springs

Another planned improvement to monitoring capabilities includes the installation of a central computer unit at the Mammoth Creek flow monitoring station at Old Mammoth Road. This will provide for connection of data into the District's SCADA system for continuous monitoring of flow data at the main office. Additional improvements may include installation of water quality monitoring sensors at this site that will provide data such as turbidity, temperature, and dissolved oxygen.

Optimum utilization of surface water resources through transmission of monitoring data to a central office location will allow personnel to adjust production rates from the Lake Mary treatment facility. The installation of remote data processing and transmitting units at the Lake Mary outlet, Twin Lakes outlet, and Mammoth Creek at Old Mammoth Road monitoring stations will provide this capability.

The District is also planning to develop a MODular three-dimensional finite-difference groundwater FLOW model (MODFLOW) to model groundwater trends in the Mammoth Basin. MODFLOW is a computer program that simulates three-dimensional groundwater flow through a porous medium (McDonald and Harbaugh, 1988) that will enable the District to explore water budgets, surface water interactions, and operational scenarios. In addition, other programs can be used in conjunction with MODFLOW to evaluate advective transport and particle tracking. The District will be utilizing historical and future groundwater monitoring data to calibrate the groundwater model. The calibrated groundwater model will enable the District to test various operational scenarios, determine areas of uncertainty, and establish locations for future monitoring wells.

CHAPTER 4

PROTECTING THE ENVIRONMENT

The three primary management objectives for environmental protection within the Mammoth Basin for groundwater management are preservation of water quality, water conservation, and prevention of impacts to surface water. In addition to these identified objectives are several components of AB 3030 that have been included in this plan.-

Preservation of Water Quality

The preservation of groundwater quality is a high priority for the District. Not only is water quality important for those consuming the water, but also it is also essential to ensure a long-term supply of clean water.

As mentioned above, the District conducted a drinking water source assessment in 2002 as a first step in the development of a complete California Drinking Water Source Assessment and Protection Program, which will be developed and implemented by the California Department of Health Services. In addition to source location and specific source construction and equipment data, the assessment includes a vulnerability summary, delineation of groundwater protection zones, inventory of possible contaminating activities, a vulnerability ranking, and an assessment map for each source. Water sources available to the District are considered most vulnerable to activities associated with the recreational use of a surface water source (Lake Mary) and the nearby location of a sewer collection system. Recent activities associated with fertilization practices of golf course areas and fuel storage present additional concerns.

Appendix G includes a list of the most recent data on water quality constituents that have been detected in District water supply sources. This data can act as a guideline to track potential changes in water quality. While hundreds of other constituents are analyzed following the California Department of Health standards, the data in this appendix includes only those constituents that have been detected in District drinking water sources.

Water quality monitoring also occurs on a regular basis, as described below, on five lysimeter monitor wells that sample the vadose zone of the groundwater at a golf course. These wells were installed in 2002 to monitor water as it infiltrates downward toward the water table. The information collected from these wells will provide baseline water quality data that will be used in analyzing the possibility of using recycled water for golf course irrigation. The following charts show data from these wells over the last four years of monitoring for TDS (total dissolved solids) and nitrogen as nitrate.

Figure 2
Total Dissolved Solids in Sierra Star Lysimeter Wells 2002-2005

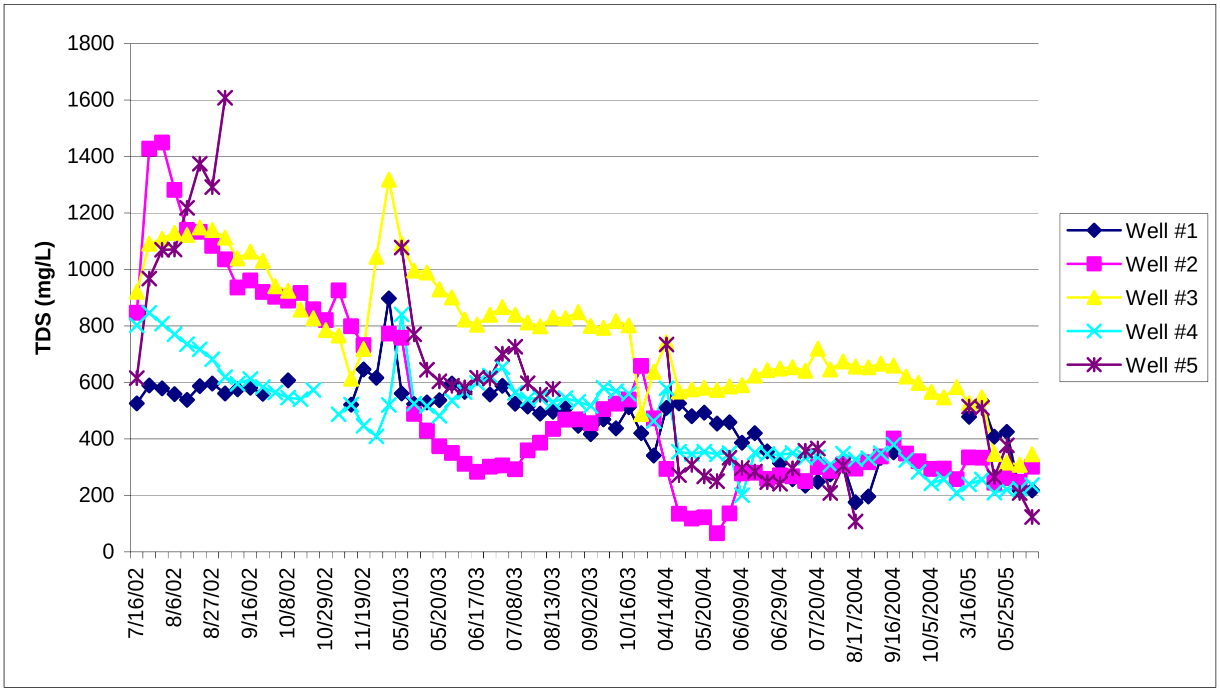
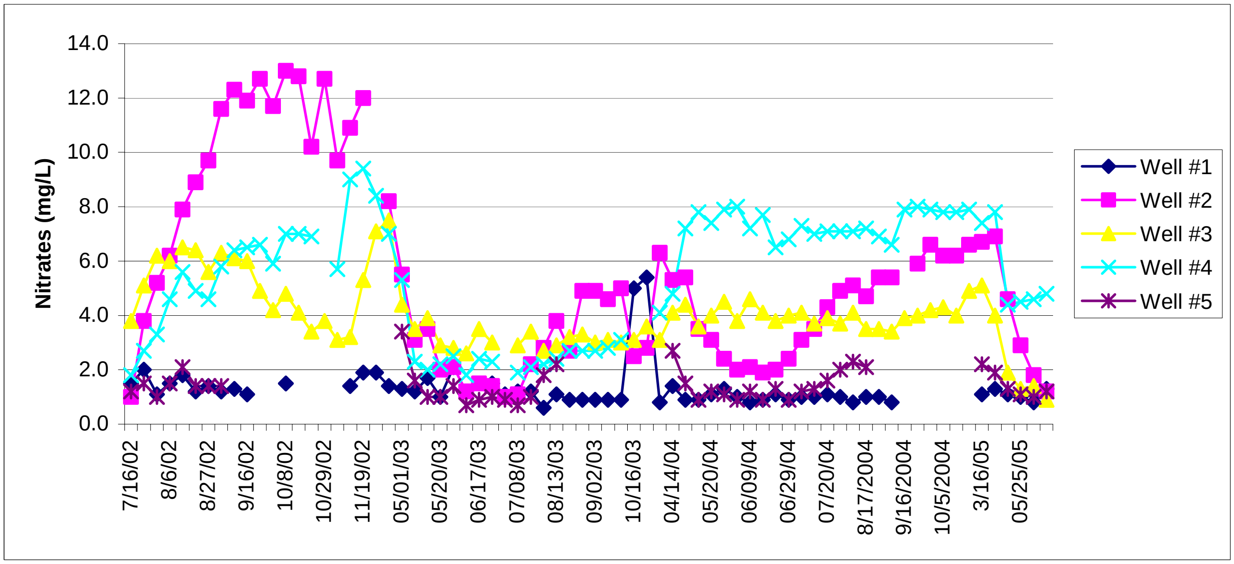


Figure 3
Nitrates in Sierra Star Lysimeter Wells 2002-2005



The District has established the following monitoring objectives to ensure that high groundwater quality standards are preserved. If the analysis for the various constituents listed shows a trend among multiple samples of either a decrease or increase in any parameter, investigation of the potential source of contamination will occur. Groundwater pumped for production purposes may require additional treatment or temporary well shutdown may occur if drinking water quality standards are exceeded.

1. Sample production wells on a monthly basis and analyze for the following constituents:
    - Temperature
    - pH
    - Specific Conductance

2. Sample monitor wells on a semi-annual basis and analyze for the following constituents:
    - Temperature
    - pH
    - Specific Conductance
    - Nitrate Nitrogen

3. Sample lysimeter wells on a weekly basis during summer and monthly during winter and analyze for the following constituents:
    - Temperature
    - pH
    - Specific Conductance
    - Nitrate Nitrogen

4. Indications of change in groundwater quality will trigger analysis for additional constituents including chloride, general mineral, inorganic chemical, and volatile organics.

5. Existing water quality data for each production well is attached as in Appendix G.

The District has established the following management objectives to ensure that surface water quality is protected. If the analysis for the various constituents shows a trend among multiple samples of either a decrease or increase in any parameter, investigation of the potential source of contamination will occur.

1. Collect samples on a weekly basis at the Mammoth Creek at Old Mammoth Road gage and analyze for the following constituents:
    - Temperature
    - pH
    - Suspended solids
    - Turbidity

2. Collect samples from the Sierra Star golf course during storm runoff events and analyze for the following constituents:
    - pH
    - Suspended Solids
    - Specific Conductance
    - Oil and Grease
    - Nitrate Nitrogen

3. Collect samples on a weekly basis during summer and monthly during winter from lysimeter wells located on the perimeter of the Sierra Star golf course and analyze for the following constituents:

Temperature
pH
TDS
Nitrate Nitrogen

4. Maintain graphs of monitoring data to track water quality and notice trends that may indicate potential impacts.

Water Conservation

For the 2005/2006 budget year, the District Board approved a budget that included an expanded water conservation program. This program will include both new and reinstated measures to assist the community in being more effective with water use. This program will educate and provide incentives to customers to ensure that surface and ground water resources are being used wisely. The conservation program consists of a toilet rebate program, water conservation education, the development of low water use demonstration gardens, recycled water planning, and a leak detection program.

One aspect of the water conservation program is reinstating the ultra low flush toilet rebate program, which the District operated in the early 1990s. The toilet rebate program was initially installed to help deal with the extended drought of the late 1980s and early 1990s. Eventually, the program was discontinued due to lack of participation following the end of the drought. This year, the ultra low flush toilet program will be reinstated to provide rebates to customers that replace their older, inefficient toilets with ones that use 1.6 gallons or less per flush.

Education is a large part of the enhanced water conservation program. The District will be providing educational information to hotels, restaurants, and residents about water conservation. The hotel card will provide guests with tips for conserving water while enjoying their stay, as well as providing techniques to reduce the need for laundering of sheets and towels. The restaurant cards will be provided to restaurants for placement on tables or within menus informing customers that water will be served upon request only. Finally, water conservation brochures will be mailed to residents and placed at strategic locations around town. These brochures will provide simple, low-cost or not cost tips for saving water inside the home and outdoors.

The District will also be pursuing the development of demonstration gardens at the District offices and possibly at another public location in Mammoth Lakes. These gardens will provide working examples of the beauty and simplicity of a garden that uses significantly less water than typical landscaping.

Another project the District is working on, not directly part of the 2005-2006 water conservation program but still involving conserving water resources, is the Recycled Water Project. Environmental review for the project began in spring of 2005 with an anticipated completion date of summer 2007. This project will provide tertiary treated recycled water to large turf irrigators from the District's wastewater treatment plant. Water that would have otherwise been piped to Laurel Pond will now offset demand for potable supplies in Mammoth Lakes.

The District maintains an ongoing leak detection and water pipeline replacement program to minimize water losses in the delivery system. These programs have enabled to cut water losses in half since the program was initiated in 2002.

Prevent Impacts to Surface Water and Groundwater Supplies

Through the Groundwater Management Plan Advisory Committee, the District has determined that additional monitoring is necessary to ensure that groundwater pumping does not negatively affect surface water or springs. The District regularly monitors water levels in its eight production wells and fifteen monitor wells.

In an effort to prevent potential impacts to surface waters and springs and groundwater dependent resources, the District prepares an annual groundwater monitoring report. This report provides an evaluation of groundwater level, surface flow, and water quality monitoring data accumulated throughout the year.

During dry-year periods, groundwater levels within the Mammoth Basin decrease due to increased pumping and less recharge. During normal and above-normal precipitation years, groundwater levels increase and tend to fully recover after two years of normal precipitation.

Certain District extraction wells have greater production capacities therefore a priority of use should be established. By April 1 of each year, it is generally known as to whether the precipitation season has been greater or lower than normal. If conditions of below normal precipitation exist, generally the District Board of Directors, by resolution, will declare the existence or threatened existence of a drought, or other threatened or existing water shortage. This action allows the Board to quickly implement restrictions on water use in the future by a simple motion rather than by resolution. Lake Mary (surface water supply) level trigger points have also been established that require additional water conservation if necessary.

When the existence or threatened existence of a drought has been declared, the following priority of use for each well should be followed. The priority list is based on pumping capacity, impacts to other wells, and drawdown for each well.

- Groundwater Treatment Plant 1: Set controls to establish well 10 as number one priority for pumping to meet required demand followed by well 15, well 6, and well 18.
- Groundwater Treatment Plant 2: Set controls to establish well 17 as number one priority for pumping to meet required demand followed by well 20 and then well 16.
- Well 1: Set as backup to zone three pumps at groundwater plants 1 and 2 to maintain level in Tank T-2 (Juniper Ridge).

Control instrumentation should also be set at both groundwater treatment plants so that production from each plant is similar. This procedure will equalize demands on all District production wells within the groundwater basin.

Restrictions on water use within the community may also need to be established in the event that groundwater depths in District production wells reach certain levels during pumping. As groundwater levels are drawn down towards the depth of pump settings, production rates decrease, which could affect the ability to meet demands from the community. Restrictions should be considered if the following pumping levels in District production wells listed in Table 6 are reached and it is evident that immediate future demand could not be met with available supplies.

Table 6
Well Pumping Level Trigger Points

Well Number	Depth of Pump (ft)	Pumping Water Level (ft)
1	310	250
6	273	250
10	260	230
15	380	350
16	546	510
17	420	385
18	315	285
20	530	510

Pumping control set points have been established for each District production wells to prevent excessive drawdown and potential damage to pumping equipment. Examples of the District's well pumping control charts are shown in Appendix H.

The following management objectives will help the District determine any potential impacts on surface water from groundwater pumping. The District will monitor and regulate surface water flows, where permitted, to provide for conjunctive use of surface water.

1. Monitor the streamflow rates entering Lake Mary on a continuous basis during summer months and weekly during winter months. Streams to be monitored include Mammoth Creek, Coldwater Creek, Coldwater diversion, and George Creek as required in Water Rights Permit 17332.

2. Monitor the level and rate of flow releases at the Lake Mary dam on a continuous basis as required in Water Rights Permit 17332.

3. Monitor the volumes of water diverted from Lake Mary through the surface water treatment facility on a continuous basis as required under Water Rights Permit 17332.

4. Monitor rate of flow released into the Bodle Ditch at the LADWP weir on a daily basis during the summer months as required under Water Rights Permit 17332.

5. Monitor rate of flow in the Bodle Ditch below Mill Creek diversion on a daily basis during the summer and monthly during winter.

6. Monitor streamflow rates at the Twin Falls flow-measuring gage on a continuous basis as required under Water Rights Permit 17332.

7. Monitor lake level and flow leaving Twin Lakes at the dam on a continuous basis as required under Water Rights Permit 17332.

8. Monitor flow rates in two springs located on the Valentine Reserve on a continuous basis.

9. Monitor flow rates in Mammoth Creek at the Old Mammoth Road gage on a continuous basis as required under Water Rights Permit 17332 and to determine available surface water diversion rates.

10. Monitor flow rates in Mammoth Creek at the Old Hwy 395 LADWP gage on a daily basis.

11. Monitor the water content of snow pack at the DWR Mammoth Pass measuring station to base potential surface water availability for season.

The following management activities describe how the District will monitor and regulate groundwater pumping to determine a safe yield of extraction, provide for conjunctive use with surface water, and determine any potential impact on surface water from groundwater pumping.

1. Monitor the static and pumping water levels of production wells on a continuous basis.

2. Monitor water levels at the seven shallow and eight deep monitor well sites (four continuous monitoring sites and eleven weekly sites).

3. Monitor the water content of snow pack at the DWR Mammoth Pass measuring station to base potential groundwater pumping projections for season.

4. Establish rotational well pumping protocol to calculate potential recharge of groundwater basin as described in the following table.

Table 7
Rotational Well Pumping Protocol

Site of reduced pumping	Sites to monitor recharge from reduced pumping
6,10	6, 10, MW4, MW14, MW10, MW11
16,17,20	16, 17, 20
15	15, 5A
1,25	1, 25
18	18, 5A

5. Restrict pumping of wells 1 and 15 during spring snowmelt runoff period. Initialize pumping of wells 1 and 15 when streamflow rates in Mammoth Creek have stabilized. Track closely the water levels in monitor wells 22 and 23 during these periods.

6. Develop a conceptual hydrogeologic model of the system, water budget, and numerical groundwater program.

7. Determine the water budget unknowns with the numerical groundwater model.

The Control of Saline Water Intrusion

Saline water can slowly degrade a groundwater basin and ultimately render all or part of a basin unusable. The concentration of minerals in water is also referred to as total dissolved solids (TDS). The dissolved minerals are classified as inorganic salts, thus the term salinity is another way to describe mineral concentration. Several sources can contribute to increased salinity in groundwater. In addition to sea water intrusion, saline degradation of groundwater can be caused by use and re-use of the water supply; lateral or upward migration of saline water; downward seepage of sewage and industrial wastes; downward seepage of mineralized surface water from streams, lakes, and lagoons; and inter-zonal or inter-aquifer migration of saline water.

Lateral or upward migration of saline water:

High quality groundwater in an aquifer can be degraded if a groundwater gradient is created that induces lower quality water to flow either laterally or vertically into the aquifer. In some areas, this may occur naturally when confining layers in the aquifer system are deposited in discontinuous lenses. The most common manmade pathway is a well. All District wells have been constructed according to the State of California water well standards to prevent the movement of lower quality water into portions of the aquifer with high quality water. Table 8 lists specific construction data for each District supply well.

There is a potential that groundwater supplies could be contaminated by thermal water located at lower depths. There may be some influence from thermal groundwater at District production well 16 as indicated by the increased temperature, dissolved solids, and pH of the pumped water.

Table 8
Production Well Construction Data

Well No.	Date Drilled	Drilled Depth (ft)	Casing Depth (ft)	Perforated Area (ft)	Annular Seal (ft)
1	1976	382	370	200-370	0-90
6	11/87	670	670	146-670	0-52
10	10/87	700	700	136-700	0-52
15	8/92	720	407	407-720	0-135
16	8/92	710	710	420-470 500-680	0-60
17	7/92	710	513	400-710	0-60
18	8/92	710	480	90-150 240-470	0-60
20	9/92	710	420	420-710	0-60

Downward seepage of sewage, agricultural, or industrial waste:

Sewage, agricultural and industrial waste that is disposed of indiscriminately will seep downward and eventually enter the aquifer and contaminate the groundwater. By law, such discharges must be permitted by the Regional Water Quality Control Board under waste discharge permits.

Currently, the entire District service area is served by a sewer collection system except for the presence of ten individual pit privies located on the upper side of Lake George. It is therefore not considered a threat that disposal of sewage could enter the Mammoth Basin groundwater supply.

Light industrial activity within the community is confined to an area located at the eastern edge of the town. This area is also approximately two miles east of the nearest District groundwater supply well and is downstream of the directional flow of groundwater within the basin.

The Mammoth Mountain Ski Area also uses chemicals during the spring ski season to stabilize the snow pack. When snowmelt occurs, this presents a potential for contamination of groundwater through percolation and as surface runoff. Water quality monitoring of this runoff should be performed to track any potential for contamination.

The use of recycled water is being proposed for golf course irrigation in order to preserve potable water resources. Two District wells (wells 17 and 20) are located near a golf course that intends to utilize recycled water. A concern regarding recycled water use for irrigation is the potential for nitrate-nitrogen to enter the groundwater system. A water balance estimate for reclaimed water irrigation has been developed as part of the recycled water project, which concluded that if reclaimed water is applied to the golf course at a rate equal to or less than the rate of evapotranspiration of the turfgrasses, then the nitrogen content of the recycled water will be assimilated by the grasses (ES 1996, p.2-3 to 2-10). The TDS of the recycled water averages 388 mg/L therefore salinity is not considered a problem.

Identification and Management of Wellhead Protection Areas and Recharge Areas

The federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the 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.

A key consideration in managing a groundwater resource is its vulnerability to sources of contamination that are located primarily at and near the land surface. Because of generally low groundwater velocities, once contaminants have reached the water table, their movement to deeper levels of the groundwater flow system is slow. Once parts of an aquifer are contaminated, the time required for a return to better water quality conditions can be long.

A Wellhead Protection Area (WHPA) is the surface and subsurface area surrounding a water well or a wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach groundwater. The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPA’s can vary in size and shape depending on geology, pumping rates, and well construction. By delineating WHPA’s, portions of groundwater basins can be prioritized for management.

Delineation of Wellhead Protection Area:

The EPA Office of Groundwater and Drinking Water has recommended a number of methods to delineate Wellhead Protection Areas. The State of California Drinking Water Source Assessment and Protection Program has established a method of delineating source areas and protection zones. Protection zones are delineated based on three different times-of-travel (the time for groundwater to travel from a point in an aquifer to a pumping well) representing 2, 5, and 10 years. Since it is difficult to estimate groundwater times-of-travel in the Mammoth Basin, minimum protection zone radii for fractured rock aquifers have been utilized. These radii are as follows: 900 feet for zone A (microbiological), 1,500 feet for zone B5 (chemical), and 2,250 feet for zone B10 (chemical). The 2002 District Drinking Water Source assessment contains figures showing the location of District production wells and protection zones.

Permeable deposits directly overlying an aquifer can be described as primary recharge areas. In these areas, contaminants can move directly downward to the underlying aquifer with little or no attenuation.

The primary recharge area for current District extraction wells includes the western section of the Mammoth Basin. Groundwater recharge to the basin is derived from direct percolation of precipitation, and infiltration along Mammoth Creek and other minor streams tributary to the basin. This part of the groundwater basin can potentially receive substantial subsurface recharge because of its western location where basin precipitation is greatest. The location of District production wells within the Mammoth Basin is shown on Appendix D.

Identification of potential sources of contaminants within each WHPA:

Once a Wellhead Protection Area is delineated, an analysis of past, existing, and future potential land uses is necessary to formulate an effective management strategy. In this way, the long-term viability of the water supply can be evaluated and, if necessary, changes can be made to land use regulations to further protect each well site.

- Current, Past and Future Land Uses:

Historical land uses within the WHPA involved three cities near the present community of Mammoth Lakes that were established in 1877 as a result of gold being discovered. Peak mining activity occurred in 1879 and was then followed by a consistent decline in the mines. The majority of these mines were located within the WHPA.

Between 1880 and 1900, the area was populated by the seasonal migration of cowhands who grazed cattle in the meadow areas. It is in this meadow area where District wells 6 and 10 are located. Mines were briefly reopened in 1898 but failed to prosper and were closed shortly thereafter.

Tourism began during the early 1900’s when Mammoth Camp was established in the Mammoth Meadow. During the twenties and thirties, the town prospered, providing tourists with lodgings, boat rentals and pack trips. Winter recreational activities during this period were greatly restricted due to the heavy snowfall.

With the completion of State Highway 203 in 1937, tourism continued to grow and began to include winter recreational activities. Downhill skiing became popular in the 1930's and the Mammoth Mountain Ski Area initiated operations.

A wide range of land use types, intensities, and ownership patterns characterizes the existing land use activities in the WHPA. The urbanized portion of the community consists of less than 2,500 acres of privately owned land that is surrounded entirely by land administered by the U.S. Forest Service. In the western portion of the Mammoth Basin are National Forest System lands used for active and passive recreation which include the Lakes Basin; Twin Lakes, Lake Mary, Lake Mamie, Horseshoe Lake and Lake George. There is currently a 9-hole golf course located in the Old Mammoth meadow area where District production wells 6 and 10 are located, and an 18-hole course situated centrally in town where District production wells 17 and 20 are located.

The Town of Mammoth Lakes is made up primarily of residential land uses with some commercial and light industrial uses making up the remainder. A major characteristic of the community is the seasonality of land use activities. During the seven-month winter season when the Mammoth Mountain Ski Area is available for skiing, activity is centered at the ski area and within the Town of Mammoth Lakes. During the summer months of July, August, and September, activity shifts to areas outside of the town. These activities include hiking, camping, fishing, and other outdoor recreation activities.

The Snowcreek Development project has been approved and could result in up to 2,332 condominium units and 150,000 square feet of commercial space. An existing 9-hole golf course has recently gained approval to expand to eighteen holes. This project is located within the Old Mammoth Meadow that contains District wells 6 and 10, but is down gradient from the production wells.

The Juniper Springs Project is located near the northwestern portion of the Mammoth Basin and is near District well 16 and groundwater treatment plant 2. This is a multi-use development consisting of condominium units and hotel/motel units in a resort/convention hotel. The Mammoth Mountain Ski Area utilizes water from the Dry Creek drainage for snowmaking purposes in this area.

Additional development within the Sierra Star project includes condominium units, hotel/motel units, resort/convention hotel, and an existing 18-hole golf course. It is projected that the golf course will be irrigated with recycled water. District production wells 17 and 20 are located adjacent to this development.

The North Village Development project involves the renovation of existing structures and development of a new commercial center with supporting hotel/motel units, resort/convention hotels, and residential units. This project is also located near the northwestern boundary of the Mammoth Basin and north of the District's production wells.

Land uses within the Dry Creek Basin involve the Mammoth Mountain Ski Area including maintenance and repair facilities, restaurants, cafeterias, administrative office buildings, and lodge and hotel facilities.

- Point Source Contamination:

Point sources refer to easily identifiable sources of contamination that typically concentrate waste discharges into a single point. Examples would include sewage treatment plants, large injection wells, and certain industrial discharges.

Wastewater generated by the community of Mammoth Lakes flows into a collection system and is transported to a central treatment facility where it receives secondary treatment including filtration and disinfection. The treated wastewater is currently discharged to a percolation pond known as Laurel Pond that is located in the eastern quarter of the Mammoth Basin and is southeast of the District's production wells. Some recycled water is utilized by contractors within the community for construction purposes such as dust control and grading. In addition, recycled water has been utilized for the establishment of grass at a community park and for seasonal irrigation of highway landscaping. The wastewater treatment facility operates under a permit issued by the State Water Quality Control Board-Lahontan Region.

Wastewater generated by the Mammoth Mountain Ski Area (MMSA) operations flows into a series of lagoons. This wastewater percolates into the ground and is a potential source of groundwater contamination within the Dry Creek groundwater basin. The Lahontan Regional Water Quality Control Board has placed a requirement on MMSA to complete a feasibility study to determine the most effective method to meet current waste treatment standards.

Engineering studies have been performed and preliminary design work has been completed for modifying the existing wastewater treatment facility so that it can produce Title 22 recycled water. If approvals are received, this recycled water would be available for irrigation of golf courses, parks, revegetation projects, and potentially snowmaking. This use would be regulated under waste discharge permits that would require water quality monitoring. Two District wells (17 and 20) are located adjacent to the eighteen-hole Sierra Star golf course that intends on utilizing recycled water for irrigation. The use of recycled water would be a potential source of contamination resulting in nitrogen loading and increased salinity entering the groundwater supply in this area.

There are currently no injection wells or existing discharges from industrial sites within the WHPA.

- Non-Point Source Contamination:

Non-point sources refer to the widespread sources of contamination that cumulatively present a significant threat to groundwater quality. Examples include on-site septic systems, road drainage, agricultural runoff, and fertilizers, underground fuel storage tanks and landfills.

For the most part, the entire Mammoth Basin is served by a wastewater collection system and all wastewater is treated at the treatment facility. There are very few individual septic tank systems within the area. These are necessary where access to the community wastewater collection system is not feasible. No septic tank systems are located near any District production well sites.

The community is served by a storm water drainage system that collects road drainage and delivers the drainage to two settling basins. The discharge from these two basins are located down gradient of the District's production well supplies and therefore do not present a threat as a potential source of contamination for drinking water sources. They do however represent a potential source of contamination to the aquifer system and surface waters.

Fertilizers utilized on the existing nine-hole Snowcreek golf course are a source of potential contamination to District well supplies. Two of the District's wells (6 and 10) are located within the area of the existing golf course. Water quality sampling is performed on the production wells and on nearby monitor wells to monitor potential impacts from the use of fertilizers. Expansion of the Snowcreek golf course to eighteen holes may result in the use of recycled water for irrigation of the new nine-hole expansion. The area of the expansion is located down gradient from the District's production wells and contamination is not expected to occur. The eighteen-hole Sierra Star golf course is also projected to utilize recycled water for irrigation. This course is located near two District production wells (17 and 20). Shallow monitor wells (lysimeters) have been installed in the area to determine potential impacts on the groundwater system from use of fertilizers and recycled water.

Chemicals are used by the Mammoth Mountain Ski Area to stabilize the snowpack and prolong the ski season during the spring. This chemical has the potential for groundwater contamination when the snow melts through percolation into the ground or as surface run-off into Dry Creek.

Potential sources of contamination from underground fuel storage systems include fuel storage at the Mammoth Mountain Ski Area maintenance building that is located near the northwest boundary of the watershed. This site experienced a gasoline spill of approximately 7,000 gallons on January 12, 1999. Evidence of contamination was found in the groundwater at the site and a treatment system was established. Continued monitoring of District production wells number 17 and 20 has shown no indication of contamination of District well supplies.

Other underground fuel storage systems and industrial/commercial uses are located primarily near the eastern edge of the community and down gradient of District production well locations.

<u>Contingency Plan to Provide Alternate Drinking Water Supplies In Case a Well or Wellfield Becomes Contaminated:</u>

Water is currently supplied to District customers from one surface water source and eight production wells. Wells that would be most sensitive to contamination would include those located on or near a golf course where fertilizers and pesticides are used. These include wells 6 and 10 located on the Snowcreek golf course and wells 17 and 20 located near the Sierra Star golf course.

If either well 6 or 10 showed signs of contamination, both wells should be shut down due to their close proximity to each other and similar water quality. With these two wells shut down, supplies would come from the other existing wells and from surface water. These two wells combined have contributed up to 1,500 acre-feet of water per year with production rates up to 2,100 gallons per minute. This loss of production is significant and would require increased pumping from the other District wells as well as maximum use of surface water to make up the difference. Depending on seasonal precipitation and time of year, water restrictions may be required to make up the loss from wells 6 and 10. The development of extraction wells in the Dry Creek Basin would also help provide additional water to the community in case of an emergency.

Contamination of wells 17 or 20 would require that both wells be shutdown as there may be some interconnection between the two. The shutdown of both of these wells would have similar impacts as the shutdown of wells 6 and 10 because they have similar production capabilities. Again, depending on seasonal precipitation and time of year, water restrictions may be required to make up the loss from wells 17 and 20. One potential source for a temporary alternate supply could come from wells owned and operated by the Mammoth Mountain Ski Area. The District could possibly receive water at rates up to 400 gallons per minute through a connection near Canyon Lodge.

Plan to Prevent New Well Drilling From Contaminating or Spreading the Contamination of Groundwater

In 1993, the District adopted an ordinance requiring a permit for the development of private groundwater wells within the District service boundary. This permit is dependent on compliance with the California Environmental Quality Act and findings that the location and construction of the well will not constitute a health hazard; will not result in an unreasonable drawdown in District wells; and, will not result in any overdraft of groundwater resources or cause significant adverse effects to the quantity or quality of the resources. The ordinance also requires that all construction, repair, or destruction of wells comply with the Department of Water Resources "California Well Standards." A copy of the ordinance is included in Appendix I.

Regulating Contaminant Migration in Groundwater

Groundwater contamination originates from a number of sources or activities such as leaking tanks discharging petroleum products or solvents, or the application of pesticides and fertilizers. Effective control and clean-up of contaminated groundwater requires a coordinated effort between all regulatory agencies involved, source control, understanding of the hydrogeology, and delineation of the contamination. Such coordinated efforts have been evidenced in the response to the fuel spill at the Mammoth Mountain Ski Area maintenance building site.

Regulatory Agencies

Agencies with a role to play in mitigating groundwater contamination include the Regional Water Quality Control Board-Lahontan Region (Regional Water Board), the U.S. Environmental Protection Agency, and the District. The degree to which each agency participates depends on the nature and magnitude of the problem.

The Regional Water Board conducts the identification of current and past users of hazardous materials, and verification of the proper storage and disposal of these materials. If, during the verification process, evidence of any uncontrolled discharge or spill of these materials is found, then the Regional Water Board can order investigation of the extent of contamination and its subsequent cleanup. The District should remain in close contact with the Regional Water Board during source investigations and site cleanups.

Contaminant Transport

The transport of contaminants in the subsurface is controlled by a variety of physical, chemical and biological processes involving the contaminants, the aquifer materials, and other compounds in the groundwater.

Advection is the movement of contaminants caused by the flow of groundwater. Contaminants dissolved in groundwater will be carried by the flow of groundwater in a down gradient direction, forming a contaminant plume. The most common tool for delineating the boundaries of a plume is the monitoring well.

The District has installed fifteen monitor wells within the general area of its production wells (see Appendix F). Seven of the monitoring sites involve shallow wells ranging in depth from 27 feet to 89 feet and primarily tap groundwater in the uppermost glacial till. The remaining eight sites involve deep wells ranging in depth from 357 feet to 700 feet and primarily tap water in fractured volcanic rock.

As stated previously, District production wells 6 and 10 are located within the area of the Snowcreek golf course, which presents a potential source of contamination from use of fertilizers and pesticides. Both wells are located along the southern border of the golf course and the direction of groundwater flow in this area is from south to northeast. This is beneficial in that any contaminant that may filter down in the golf course area will follow the groundwater flow that is down gradient from both production well sites. District monitor wells in this area that are important in determining potential contamination problems include two shallow wells (4M and 10M) and one deep well (14). These sites should be sampled and analyzed for organic nitrogen, phosphorus, and pesticides on an annual basis.

District production wells 17 and 20 are located adjacent to the Sierra Star golf course and will be susceptible to potential contamination from fertilizers, pesticides, and the potential use of recycled water on the golf course. Well 20 is located on the northwestern border of the course and well 17 is located near the northern border. Groundwater flow in this area flows in an easterly direction, and both wells may be susceptible to potential contamination. Currently there are no monitor wells near production wells 17 and 20. To properly monitor the water quality of the shallow groundwater it would be advisable to construct one or two shallow monitor wells in the area up gradient from the two production wells. These wells should also be sampled and analyzed for organic nitrogen, phosphorus, and pesticides on an annual basis.

Administration of a Well Abandonment and Well Destruction Program

All wells should be properly destroyed or decommissioned if they are not to be used in the future. Wells that are abandoned or improperly destroyed can pollute groundwater to the point where it is unusable or requires expensive treatment. There are three general means by which this occurs: 1) pollutants enter the well from the surface; 2) the well establishes vertical communication due to poor construction methods and allows poor quality groundwater and pollutants to move from one aquifer to another; and, 3) the well is used for illegal waste disposal.

The District has adopted a Well Standards Ordinance that addresses well destruction and establishes requirements for destroying or abandoning wells within the District's service area.

District requirements reference the Department of Water Resources Water Well Standards. A copy of the Well Standards Ordinance is included in Appendix I.

CHAPTER 5

SUSTAINABLE YIELDS

This chapter discusses the efforts that the District makes to ensure that groundwater acquired from the Mammoth Basin does not significantly deplete the supplies. Sustainable yields are a goal for groundwater management that incorporates the two other primary goals of protecting the environment and meeting the needs of the community. Sustainable groundwater yield can be defined as the groundwater extraction regime, measured over a specified planning timeframe that allows acceptable levels of stress and protects dependent economic, social, and environmental values.

Generally, groundwater levels should correspond to water year type. For instance, in multiple dry years, groundwater levels would be expected to decline while in multiple wet years, groundwater levels would be expected to rise. However, a year of above normal precipitation with no corresponding recharge would be a cause for concern. The following sections discuss the District's efforts to ensure that the groundwater yields from the Mammoth Basin are sustainable for generations to come.

Mitigation of Groundwater Overdraft

The long-term source of water for District production wells represents a change in the amount of water entering or leaving the groundwater system. How much groundwater is available for use depends upon how these changes in inflow and outflow affect the surrounding environment.

In determining the effects of pumping and the amount of water available for use, it should be recognized that not all the water pumped is necessarily consumed. For example, a portion of the water used for landscape irrigation returns to the groundwater system through infiltration, while another portion is lost to evapotranspiration processes. It is important to differentiate between the amount of water pumped and the amount of water consumed when estimating water availability and developing sustainable management strategies.

Uncontrolled long-term depletion of storage or groundwater mining in a groundwater basin can cause several problems, including subsidence, degradation of groundwater quality, ecologic impacts, and increased cost of pumping. In addition, if the storage in a groundwater basin is depleted and not replaced naturally or by an artificial recharge program, this source of supply cannot be counted upon when surface water sources are limited, as in a drought.

Long-term droughts have previously been experienced in the Eastern Sierra and are likely to continue to occur in the future. Long-term droughts stress the groundwater system and have effects similar to groundwater withdrawals such as reductions in groundwater storage and in discharge rates. Because the climate stress of drought on the hydrologic system can be added to the existing stress from groundwater pumping, droughts represent extreme hydrologic conditions that should be evaluated in any long-term management plan.

Mitigation of groundwater overdraft can occur through the cessation or regulation of extractions and/or the increase of recharge to offset over extraction. This could take the form of restrictions through strict regulations of amounts extracted. Managing groundwater overdraft may also be accomplished through conjunctive use. The establishment of a conjunctive use program would utilize surface water to recharge the basin in time of surplus, and rely more on groundwater pumping in times of shortage of surface water.

The safe yield of an aquifer is defined as the amount of water that can be withdrawn from it annually without producing an undesired result. Any withdrawal in excess of safe yield is an overdraft. To properly develop an understanding of the safe yield of an aquifer or groundwater basin, one must start by developing a hydrologic budget. Such a budget should include all significant inputs and outputs to the basin. Recharge to a hydrologic system occurs naturally from direct precipitation, stream inflow, and groundwater underflow from an up-gradient basin. Discharge occurs through evaporation, transpiration via vegetation, stream drainage, and groundwater underflow into a down-gradient basin.

Earlier in this report, in Chapter 2, it was estimated that the total useful storage in the Mammoth Basin drainage area tributary towards the outflow at the eastern end of the basin is approximately 242,600 acre-feet. Useful storage within the Mammoth groundwater basin itself amounted to approximately 135,100 acre-feet. In the immediate area of the District’s groundwater extraction wells, it is estimated that the groundwater basin contains a useful storage estimated to be about 24,300 acre-feet. Groundwater storage can, however, be a deceptive value when evaluating groundwater availability. Evaluating the hydrologic balance of the basin by comparing inflow of precipitation, surface inflow, and subsurface inflow versus consumptive use, surface outflow and subsurface outflow will provide more insight than simple groundwater storage figures.

District groundwater extractions since 1983 have averaged 936 acre-feet per year. The maximum extraction occurred in 1992 and amounted to 2,385 acre-feet. Future extractions from the Mammoth Basin available to meet planned growth in the community are projected to total 4,000 acre-feet per year under normal precipitation conditions. Future annual extractions from the Dry Creek Basin are projected to be approximately 350 acre-feet during dry water years (MCWD 1996, p.7)

Mark J. Wildermuth states in his 1996 report prepared for the Snowcreek Golf Course Expansion Project that the response of groundwater levels to pumping of District production wells over time indicate that groundwater levels recover almost completely each year, even during periods of lower than normal precipitation (Wildermuth 1996, p.17).

It has been the District’s experience that over prolonged periods of drought production rates are reduced due to lower groundwater levels. This has resulted in the District projecting lower annual groundwater extractions to be counted on during periods of drought. In the District’s Urban Water Management Plan, the projected groundwater supply from the Mammoth Basin under multiple year drought conditions amounts to 3,260 acre-feet per year. To be conservative, the District uses these figures for future planning purposes to meet the demands of community growth. Table 9 shows the estimated production capabilities of each District well under drought conditions based on wells 1, 6, 10, and 15 production during 1990 through 1992, an extended drought period.

Table 9
Estimated Annual Well Production during Multiple Year Drought

Well Number	Production (ac-ft)	Well Number	Production (ac-ft)
1	300	16	300
6	400	17	500
10	500	18	300
15	460	20	500

Facilitating Conjunctive Use Operations

Conjunctive operation of a groundwater basin is the operation of a groundwater basin in coordination with a surface water reservoir system. The basin is intentionally recharged in years of above average precipitation so groundwater can be extracted in years of below average precipitation when surface water supplies are below normal.

A standard conjunctive use program requires the following elements:

- A source of surface water in years of high precipitation
- Conveyance facilities to import or export water
- Recharge facilities
- Usable storage capacity in the aquifer
- Extraction facilities
- Distribution facilities for surface water and groundwater

The District's water system does not include conveyance facilities to import or export water, or recharge facilities. The District would still benefit in conducting a limited program of conjunctive use operations.

The State Water Resources Control Board regulates surface water use by the District. The existing surface water use permit stipulates restrictions on the drawdown of Lake Mary, a water supply reservoir, and the maintenance of minimum flows in Mammoth Creek.

In below normal precipitation years, the available supply from Lake Mary is limited due to lake drawdown restrictions and minimum flow requirements in Mammoth Creek. It is during these periods when groundwater extractions will be at their greatest. During years of normal or above normal precipitation, excess surface water is available for use. During these periods, use of surface water should be maximized to allow for replenishment of the groundwater system.

Replenishment of Groundwater Extracted by Water Producers

Replenishment of groundwater can be achieved through recharge of either natural water supplies or water acquired from outside the basin by a groundwater management agency.
Replenishment may occur in the following ways:

- Through natural percolation of surface water through the soil to the basin
- The delivery of surface water to spreading grounds or basins that are maintained to allow maximum percolation into the groundwater
- Through injection of surface water into the groundwater basin through injection wells

In the Mammoth Basin, replenishment of groundwater occurs through natural percolation of surface water through the soil. The majority of water that enters the groundwater table comes from melting snow received during the previous winter season that includes a period typically extending from October through March. Precipitation during this period averages 85% of the total precipitation received for the year.

There are several options to potentially increase percolation into the groundwater basin. The most feasible would be to divert additional water into the Bodle Ditch that flows into the Old Mammoth meadow area where District production wells 6 and 10 are located. This could be performed during years of above normal precipitation and therefore would not interfere with maintenance of required streamflows in Mammoth Creek.

An additional possibility in the future would be to introduce recycled water into the basin that would add to the groundwater recharge down gradient of District production well supplies. This would allow recharge into the basin of a large portion of the groundwater previously pumped, thereby minimizing any potential impact to users of water down gradient from District wells.

CHAPTER 6

MEETING THE NEEDS OF THE COMMUNITY

As of 2005, the Town of Mammoth Lakes is going through major revisions of its General Plan. The 1987 plan is being updated and multiple growth alternatives are being considered. While it is difficult to determine the amount of actual planned growth of the town, the District still plans for future water needs of the community. As existing supplies are allocated, the District will be looking for future groundwater sources at Dry Creek and within the Mammoth Basin itself. These sources will have to be carefully explored before development occurs to ensure that negative environmental impacts are mitigated.

The content of this Groundwater Management Plan will be revisited in the future to ensure the water needs of the growing and changing local community will be met. As new information and data is obtained, the District will incorporate necessary changes to the management plan. Regular updates will also ensure sustainable yields and the protection of the unique local environment in the future. An advisory committee and the District's hydrologist will assist in periodic review of the plan. The Board will approve any changes to the document.

Review of Land Use Plans and Coordination with Land Use Planning Agencies

An important component of a groundwater management plan is the review of land use plans for the surrounding area or basin, and coordinating efforts with regional and local land use planning agencies. Land activities and how they are managed can affect both groundwater quality and quantity. The threat that a certain land use may pose to a groundwater resource is a function of the groundwater aquifer properties, management practices associated with the individual land use, and actual use of surrounding land.

Planning agencies affecting District groundwater operations include the Town of Mammoth Lakes and the U.S. Forest Service. There is information exchange between these agencies and the District and the District is notified in advance of proposed development projects and has an opportunity to comment.

Land uses within the District's service area that have a potential to adversely impact groundwater resources include industrial development within the Mammoth Business Park and golf course irrigation utilizing recycled water. An additional potential problem area would include the increasing amount of paved surfaces that allow non-point source contaminants from surface run-off from streets and parking areas to possibly enter surface water and groundwater. An example of this would be the paving of Mill City Road, allowing surface run-off into the Bodle Ditch, which is a source of recharge to District wells 6 and 10.

The Development of Relationships with State and Federal Regulatory Agencies

The formation of a groundwater management district involves the development of relationships and communication strategies with a variety of state and federal regulatory agencies.

The State Water Resources Control Board, as the lead water agency responsible for maintaining water quality standards, provides the framework and direction for California's groundwater protection efforts. The Lahontan Regional Water Quality Control Board is the regulatory authority for water quality in the Mammoth Basin watershed area.

Other agencies that the District works with in regard to groundwater management include the U.S. Forest Service, California Department of Fish and Game, and the California Department of Health Services.

REFERENCES

Association of California Water Agencies. April 1993. *AB 3030 Groundwater Management Manual, Elements of a Groundwater Management Plan.*

Bauer Environmental Services. June 1998. *Draft Environmental Impact Report and Environmental Assessment of Proposed Reclaimed Water Project.*

Birman, J.H. Dec. 3, 1973. *Geophysical Survey for Ground Water Potential in the Vicinity of Mammoth Lakes, California.*

California Department of Water Resources. December 1973. *Mammoth Basin Water Resources Environmental Study.*

California Department of Water Resources. June 1991. California Well Standards. Bulletin 74-90.

CDEC, California Cooperative Snow Surveys. Available at http://cdec.water.ca.gov/snow/.

Cayan, D.R. 1996. *Interannual climate variability and snowpack in the western United States.* Journal of Climate, 9, 928-948.

Environmental Protection Agency. July 1994. *Groundwater Management Programs: Strategies For Local Government Environmental Protection Agency.*

Enviroscientists. *Town of Mammoth Lakes 2005 General Plan Update, Administrative Draft Program Environmental Impact Report.* February 2005.

ES Environmental Services. February 1996. Basis of Design Report Mammoth Lakes Wastewater Treatment Plant Tertiary Treatment Project.

Groundwater Resources Association of California, Hydrovisions, Vol. 14, no. 1, 2005

Lipshie, Steven Ross. 1974. *Surficial and Engineering Geology of the Mammoth Creek Area, Mono County, California.*

Los Angeles Department of Water and Power Snow Surveys. Available at http://www.ladwp.com/ladwp/cms/ladwp000865.jsp

Mammoth Community Water District. Urban Water Management Plan. 2000.

McDonald, M. G. and A. W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U. S. Geological Survey Techniques of Water-Resources Investigations, Book 6, Chapter A1.

Schmidt, Kenneth D., Unpublished letter to Mr. James Kuykendall, General Manager, MCWD, Potential Impacts of Pumpage of New Wells, August 5, 1992.

Schmidt, Kenneth D., and Associates. 1993-2004. *Annual Report on Results of Mammoth Community Water District Groundwater Monitoring Program for October – September.* Prepared for the Mammoth Community Water District, Mammoth Lakes, California.

Schmidt, Kenneth D and Associates. October 1996. *Groundwater Conditions and Potential Reuse of Reclaimed Water at Mammoth Lakes.*

SWA Group, The. 1977. *Water Management Plan, Final Environmental Report.*

U.S. Forest Service. April 1994. *Environment Assessment for Dry Creek Well and Pipeline Project.*

Vorster, P. 1985. *A Water Balance Forecast Model for Mono Lake, California*. Thesis. California State University, Hayward.

Wildermuth, Mark J. November 2003. *Investigation of Groundwater Production Impacts On Surface Water Discharge and Spring Flow*.

Wildermuth, Mark J. September 1996. *Hydrologic Impacts of the Snowcreek Golf Course Expansion on the AB and CD Headwater Springs.* Prepared for Dempsey Construction Corporation.