Long-Range Water Supply Plan
Los Alamos County

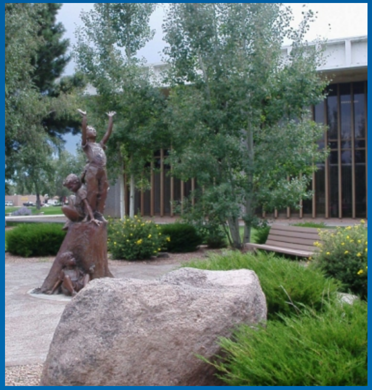

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Table of Contents

Section **Page**

Executive Summary ES-1

1. Introduction 1

2. Overview of Los Alamos County Water System 3

3. Hydrogeologic Overview and Risks to Water Supply 7
   - 3.1 Hydrogeology 7
     - 3.1.1 Recharge 9
     - 3.1.2 Aquifer Properties 10
     - 3.1.3 Water Levels 16
   - 3.2 Risks to Water Supply 27
     - 3.2.1 Aquifer Depletion Risk 27
     - 3.2.2 Contamination Risk 29
     - 3.2.3 Sources of Contamination 51
     - 3.2.4 Treatment Options 54

4. Water Rights 64
   - 4.1 Los Alamos County Water Rights 65
     - 4.1.1 Rio Grande Surface Water and Groundwater Rights 65
     - 4.1.2 San Juan-Chama Surface Water Rights 66
     - 4.1.3 Water Rights Appurtenant to Land Purchase 67
   - 4.2 Water Rights Administration 67
     - 4.2.1 Rio Grande Compact 67
     - 4.2.2 Protection of Senior Water Rights 68
     - 4.2.3 Active Water Resource Management 69
     - 4.2.4 Rio Grande Offset Requirements 69
     - 4.2.5 Rio Grande Declared Groundwater Basin 70
   - 4.3 Risks to Los Alamos County Water Rights 70
     - 4.3.1 Protection of Senior Water Rights 71
     - 4.3.2 Rio Grande Offset Requirements 71
     - 4.3.3 Navajo Water Rights Settlement Provisions 72
   - 4.4 Acquisition of New Water Rights to Meet Future Demand 72

5. Water Demand 73
   - 5.1 Historical Use 73
   - 5.2 Current Water Use 81
   - 5.3 Population Projections 88
     - 5.3.1 Historical Growth in the Region 88
     - 5.3.2 Factors That Could Impact Future Growth 90
     - 5.3.3 Previous Population Projections for the Region 91
   - 5.4 Future Water Demand 92

6. Reconciliation of Supply with Demand 102

Table of Contents (Continued)

Section **Page**

7. Timeline for Incorporation of San Juan-Chama Project Water into Los Alamos County Water Supply 106

8. Water Conservation Plan 107
   - 8.1 Existing Conservation Practices 110
     - 8.1.1 Prohibition of Water Waste 110
     - 8.1.2 Limitations to Outdoor Watering 111
     - 8.1.3 Improvements to Park Irrigation 111
     - 8.1.4 Water Rates 111
     - 8.1.5 Automated Billing System 112
     - 8.1.6 Meter Maintenance and Replacement 113
     - 8.1.7 Leak Detection Program 113
     - 8.1.8 Water Pressure Maintenance 113
     - 8.1.9 Standards for Water Line Construction 113
     - 8.1.10 Wastewater Reuse 114
     - 8.1.11 County-Provided Mulch 114
     - 8.1.12 Subdivision Regulations 114
     - 8.1.13 Education 114
   - 8.2 Water Conservation Goals 116
   - 8.3 Conservation Measures 117
     - 8.3.1 Public Education Program for Residential and Commercial Users 117
     - 8.3.2 Efficient Utility Management 118
     - 8.3.3 Reducing Water Waste 119
     - 8.3.4 Promotion of Xeriscaping 120
     - 8.3.5 Graywater Use 121
     - 8.3.6 Rainwater Harvesting 123
     - 8.3.7 Indoor Conservation Incentives 125
     - 8.3.8 New Construction Standards 125
     - 8.3.9 LANL Conservation 125
     - 8.3.10 Inclining Block Rate Structure 126
   - 8.4 Water Conservation Potential 126
   - 8.5 Funding and Implementation of Los Alamos County's Water Conservation Plan 131
   - 8.6 Drought Management 131

9. Facilities Assessment 139

10. Recommendations 141

References 144

List of Figures

Figure		Page
2-1	Water Supply	4
3-1	Conceptual Hydrogeologic Model of the Los Alamos County Area	8
3-2	Regional Aquifer Potentiometric Surface	17
3-3	Well Locations	19
3-4	Average Annual Non-Pumping Water Levels, Guaje Well Field	20
3-5	Average Annual Non-Pumping Water Levels, Pajarito Well Field	21
3-6	Average Annual Non-Pumping Water Levels, Otowi Well Field	22
3-7	Major Liquid Release Sources	30
3-8	Locations of Groundwater Contamination by Plutonium-238, Plutonium-239,-240, and Americium-241 Above the DOE Derived Concentration Guide for Drinking Water	32
3-9	Detections of Chromium Above EPA MCL in Well R-28	41
3-10	Detections of Chromium in Filtered Samples from Single-Screen Regional Aquifer Wells	42
3-11	Chromium Concentrations (average) in Regional Groundwater	43
3-12	Detections of Chromium in Filtered Samples from Intermediate-Depth Perched Aquifer Wells	44
3-13	Chromium Concentrations (average) in Intermediate-Depth Perched Aquifers	45
3-14	Perchlorate Concentrations (average) in Regional Groundwater	48
3-15	Perchlorate Concentrations (average) in Intermediate-Depth Perched Aquifers	49
3-16	Locations of Inferred Past Extent of Groundwater Contamination by Tritium Above the EPA MCL	52
3-17	Locations of Inferred Past Extent of Groundwater Contamination by Nitrate (as nitrogen) Above the EPA MCL	53
5-1	Historical Los Alamos County Water Diversions	74
5-2	Per Capita Residential Demand and Precipitation in Los Alamos County, 1999-2004	79
5-3	Monthly Water Use by Los Alamos County and Los Alamos National Laboratory in 2005	80
5-4	Residential and Net Per Capita Demand in 2004	84
5-5	Water Demand by Customer Class in 2004	85
5-6	Distribution of Wastewater Effluent in 2003	89

List of Figures (Continued)

Figure **Page**

5-7 Projected Water Demands Under the Full Build-Out Scenario 93
5-8 Projected Water Demand Under Low Water Use Projection 96
5-9 Projected Water Demand Under High-Water-Use Projection 99
5-10 Sustainable Population Under Different Conservation Levels 100

6-1 Supply and Projected Water Demand under Low-Water-Use Projection 104
6-2 Supply and Projected Water Demand under High Water Use Projection with Diminished Water Rights 105

7-1 San Juan-Chama Drinking Water Project Timeline, Overview 108

8-1 Projected Water Demand with Conservation Under Low Water Use Projection......... 132

List of Tables

Table **Page**

2-1 Active Wells in the Los Alamos Water Supply System. 5

3-1 Regional Aquifer Recharge Estimates 10
3-2 Aquifer Test Results, Regional Aquifer Wells 12
3-3 Aquifer Test Results, Supply Well PM-2 15
3-4 Average Supply Well Water Level Declines... 23
3-5 Average Test Well Water Level Declines.. 24
3-6 Regional Aquifer Well Screen Information 25
3-7 Average Regional Aquifer Monitor Well Water Level Declines 27
3-8 Susceptibility of Los Alamos County Supply Wells to Contamination According to NMED Preliminary Source Water Assessment 55
3-9 Summary of Treatment Options 56
3-10 Arsenic Concentrations Detected in Los Alamos Public Supply Wells and Booster Stations 61
3-11 Concentrations of Radon in Los Alamos Public Supply Wells. 63
4-1 Summary of Los Alamos County Water Rights.. 66

List of Tables (Continued)

Table **Page**

5-1 Annual Diversions from Groundwater and Surface Water, Los Alamos County, 1947-2005 75

5-2 Historical Diversions and Population for Los Alamos County, 1950-2000 78

5-3 Monthly and Annual Water Supply and Potential Return Flow Data 82

5-4 Water Demand by Customer Class, Los Alamos County Water Utility 83

5-5 Residential Water Use in 2003 and 2004 in Los Alamos County 87

5-6 Per Capita Demand Rates in 2004 for Single and Multi-Family Residential, Commercial, and LANL Uses 87

5-7 Historical Population, Los Alamos County 90

5-8 Population Projections for Los Alamos County 2000 through 2060 92

5-9 Low Projected Water Use Under Full Build-Out Scenario (Projection 1), Los Alamos County 95

5-10 High Projected Water Use Under Full Build-Out Scenario (Projection 2), Los Alamos County 98

8-1 Water Rates in New Mexico Communities 112

8-2 Single Family Residential Water Use in 2003 in Los Alamos County 127

8-3 Potential Demand Reduction for Indoor Water Fixtures 128

8-4 Potential Savings, Outdoor Use 129

8-5 State and Federal Funding Sources 133

8-6 Summary of Recommended Conservation Measures and Drought Stages 138

List of Appendices

Appendix

A Water Supply Information

B San Juan-Chama Timeline

C Facilities Assessment

Executive Summary

Los Alamos County is developing this long-range water supply plan to provide a sustainable supply for the future needs of the community. The objective of the plan is to evaluate projected demands in relation to available supply, while considering water quality and water rights risks to the supply, to ultimately ensure that both a viable physical supply and associated water rights are in place as needed to meet future demands.

In addition to providing a plan for a sustainable future water supply, a long-range water plan that covers at least 40 years allows the County to set aside water for use in the future. Section 72 1 9(B) of the New Mexico Water Code allows covered entities such as Los Alamos County to legally appropriate and preserve water that they cannot currently use but will need in the future to meet projected water requirements for the service area based on projected growth and other factors. This Los Alamos County water plan also includes a conservation plan, which addresses New Mexico Office of the State Engineer (OSE) requirements for conservation planning.

The Los Alamos County Water Utility (LACWU) provides water service to the residents of Los Alamos and White Rock, Los Alamos National Laboratory (LANL), and Bandelier National Monument. The water system was originally operated by the U.S. Department of Energy; LACWU began operating the water system in September 1998. Los Alamos is currently supplied by 12 wells in three well fields: the Guaje, Pajarito, and Otowi well fields.

Los Alamos County is situated on the Pajarito Plateau within the western margin of the Española Basin. The hydrogeologic framework within Los Alamos County consists of three distinct aquifer systems:

- Shallow perched groundwater in alluvial deposits along canyon bottoms
- Intermediate-depth perched groundwater
- Deeper, regional aquifer

All of the LACWU wells, which have depths up to 3,000 feet below ground surface (bgs) and water levels ranging from 250 to 1,200 feet bgs, draw on the regional aquifer.

Recharge to groundwater in the area originates primarily in the Sierra de los Valles west of Los Alamos. A number of studies have calculated recharge to the regional aquifer for the Española Basin and for the Pajarito Plateau, with estimates ranging from about 4,300 acre-feet per year (ac-ft/yr) to about 8,100 ac-ft/yr.

Long-term data from the Pajarito and Guaje well fields indicate an average water level decline of about 1.2 feet per year (ft/yr); the average decline in the Otowi well field is about 1.3 ft/yr. Substantial declines have occurred in the Guaje replacement wells, which were constructed between November 1997 and July 1998 but have only been in service since 1999. The average annual water level declines for these wells vary from about 5 to 37 feet, and the average decline for the entire Guaje replacement well field is about 21.7 ft/yr for the period from 1998 to 2001.

Water levels have also been monitored by LANL since 1992 in several regional aquifer test wells using pressure transducers and periodic manual measurements. The average water level decline observed in these wells is about 0.5 foot per year.

Considering a demonstrated saturated thickness of at least 1,900 feet penetrated in supply well PM-5 and potentially greater thicknesses of Santa Fe Group sediments underlying the plateau, a continuation of the observed rates of decline does not represent a substantial imminent or foreseeable risk to the water supply. However, poorer water quality is expected as wells begin to draw from greater depths.

Water quality data from numerous water supply and monitoring wells were evaluated to determine if any of the detected concentrations exceed water quality standards. The water quality in wells currently supplying drinking water does not exceed regulatory limits, and the concentrations of most of the contaminants present in groundwater in Los Alamos County are largely below regulatory standards. However, some of the constituents detected in Los Alamos groundwater represent a potential risk to the Los Alamos water supply. In particular, chromium has been detected at levels approaching the regulatory standard in the regional aquifer and intermediate perched aquifer upgradient of well PM-3.

The source of the chromium groundwater contamination is uncertain and is the subject of current investigations by LANL. However, it is thought likely to be from historical discharges from cooling towers, where potassium dichromate was used as a descaler.

All of the chromium concentrations presented in this report represent total chromium, which includes both Cr^{+3} (trivalent chromium) and Cr^{+6} (hexavalent chromium) species. Whereas Cr^{+3} is an essential nutrient for humans and occurs naturally in many foods, Cr^{+6} is known to cause various health effects. The results of recent testing by LANL indicate that the chromium in groundwater samples from regional aquifer monitor well R-28 exists predominantly in the hexavalent form; thus the risk to the water supply is serious.

Another constituent of concern is perchlorate. All of the supply wells exhibit perchlorate concentrations below 0.4 ppb except for Otowi-1, in which perchlorate has been consistently detected at concentrations between 1 ppb and 5 ppb since 2000. The Otowi-1 well is currently not being used. Recent results show levels slightly more than 2 ppb. While there is no current regulatory limit for perchlorate, a regulatory limit is being considered and is likely to be adopted in the future. Perchlorate in high concentrations has been detected primarily in intermediate-depth perched aquifers in Mortandad Canyon.

An evaluation of water rights was conducted to assess potential risks to the legal ability to provide sufficient water supplies for future growth. Los Alamos County's groundwater rights under a 1975 combined permit are 5,541.3 ac-ft/yr. Los Alamos County also has a service contract for 1,200 acre-feet of San Juan-Chama Project surface water, which flows into the Rio Grande through a series of tunnels, conveyance channels, and reservoirs.

In 2004, the County of Los Alamos signed an agreement with several federal agencies and San Ildefonso Pueblo as part of the negotiation and settlement of the Pueblo's land claims. The "Los Alamos Agreement," signed January 22, 2004, will allow the County to purchase 400 acres of land from the U.S. Forest Service and secure water rights on several hundred more acres. Final water right amounts will be determined by the OSE once the County applies for a change of ownership of the existing water rights appurtenant to those lands.

The State of New Mexico adheres to the prior appropriation system for water rights administration. This approach is based on a "first in time, first in right" concept, whereby the water right holder with a priority date senior to other rights can exercise that right to the detriment of a right with a junior priority date (referred to as a priority call). To date, priority call-based administration has not occurred in the Rio Grande basin; however, with additional growth and other pressures, such as endangered species requirements, active administrative protection of senior water rights in groundwater basins and rivers is likely to become more frequent over the 40-year planning horizon.

The OSE recognizes the groundwater-surface water connection and conditions permits so that new groundwater appropriations will not increase surface water depletions and thereby affect senior water right holders. Specifically, the OSE requires applicants for groundwater rights to purchase and retire valid water rights in an amount equivalent to the effect that the groundwater withdrawals will have on the river. While the Los Alamos County permits do not currently require such an offset, it is possible that the OSE could require offsets if the County applies to transfer the point of diversion (as would occur if wells need to be relocated due to contamination) or the place or type of use.

The OSE has further clarified this policy in recently issued policy stating that offset rights may only be valid for pre-1907 rights, a pre-1907 surface water right previously transferred into a well, or a valid existing groundwater right with a priority date older than May 31, 1939, the date of the Rio Grande Compact (NM OSE, 2006). This policy limits the number of water rights that could be considered for fulfillment of offset requirements.

Another potential risk to Los Alamos County water rights is that drought impacts could reduce the quantity of San Juan-Chama water available to contractors in some years.

To project water use into the future, historical diversions as well as population and economic growth projections were considered. Diversions have increased over the past almost 60 years due to increased population, though they have dropped in recent years due to conservation measures. Diversions also fluctuate significantly from year to year due in part to fluctuating levels of precipitation. For instance, in 2002 and 2003 precipitation was 12 and 10 inches, respectively, and demand was about 4,800 ac-ft/yr, while in 2004 and 2005, when precipitation was 19 and 21 inches, respectively, demand was less than 4,300 ac-ft/yr.

The per capita demand rate for residential customers in 2004 was 105 gpcd. If unaccounted-for losses, commercial, and municipal uses are included, the demand was 151 gpcd. If water use by LANL is factored in, the demand rate was 201 gpcd.

In a New Mexico First Town Hall workshop in August 2004, the County identified several goals for creating a sustainable Los Alamos County that may impact future growth and water demand, including:

- Increase the availability of housing in the county
- Increase retail opportunities
- Diversify the economy to become less dependent on LANL

Based on these goals, the County is pursuing three growth actions that they hope to complete by 2020:

- Constructing approximately 2,800 new housing units on about 979 acres of land (which would cause the population to grow from about 18,500 to 25,000 people)

- Increasing retail sales by constructing approximately 365,000 square feet of new retail space on 45 acres of land

- Creating 2,500 new high-wage primary industry jobs, which will require the construction of approximately 875,000 square feet of office, laboratory, and industrial space on 67 acres of land

Assuming that these growth actions are implemented, DBS&A developed both a low- and high-water-use projection of the amount of water needed to fulfill demand over the 45-year planning horizon. Two scenarios for comparison of projected water use to available water supply were then considered:

- *Scenario 1: Low-water-use projection and supply available to fulfill water rights.* The total projected water demand under the low-water-use projection is estimated to increase from about 4,300 ac-ft/yr in 2005 to about 6,700 ac-ft/yr in 2020 without any additional conservation efforts. This amount is almost equal to the total water rights held by the County of 6,741.3 ac-ft/yr, including the County's allotment of San Juan-Chama water. By 2050, the water use would increase to about 7,600 ac-ft/yr, or over 800 ac-ft more than the combined water rights and San Juan-Chama water. For this scenario, it was assumed that the County can continue to produce water for which it has a water right, recognizing that either treatment or moving of wells to alternate uncontaminated locations may be required to fulfill those water rights.

- *Scenario 2: High-water-use projection and loss of water rights.* The total projected water demand under the high-water-use projection is estimated to increase to about 8,000 ac-ft/yr by the year 2020, or about 1,300 ac-ft/yr more than the total water rights including San Juan-Chama water. After 2020, residential and commercial water use would increase at 1 percent per year so that by the year 2050, water demand under this projection would be about 9,400 ac-ft/yr or 2,600 ac-ft more than the combined water rights and San Juan-Chama water. This scenario further envisions a situation in which a portion of the groundwater supply is contaminated, necessitating the relocation of 2,000 ac-ft of supply well diversions, and purchase of native Rio Grande water rights or use of San Juan-Chama water is needed to fulfill OSE-required offsets. In this case, groundwater rights would be diminished, resulting in a gap between secured water rights and projected demand of about 4,000 ac-ft/yr.

In both scenarios, there is a gap between supply and projected demand that will need to be addressed through both water supply initiatives and demand reductions (water conservation).

One option for increasing supply is diversion and use of the County's San Juan-Chama Project water. The County will be need to take several steps in order to site, design, permit, and construct facilities necessary to divert and treat San Juan-Chama water for distribution to Los Alamos County water users. Assuming active pursuit of these steps beginning in 2008, the timeline for implementation would be about 8 years. If implementation is pursued at a more moderate pace, the time frame for implementation would be 10 to 15 years.

Another option for addressing the gap between supply and demand is to reduce demand through conservation measures. Los Alamos County has an active conservation program that includes prohibition of water waste, limitations to outdoor watering, improvements to park irrigation, relatively high water rates, automated billing systems, meter maintenance and replacement, a leak detection program, maintenance of pressure zones, standards for water line construction, wastewater reuse, county-provided mulch, subdivision guidance for native landscaping, and an extensive public education program.

The LACWU water conservation plan recommends expanding these conservation measures through a variety of measures that can be easily implemented by the County and its residents in a phased approach. The water conservation program objectives are to:

- Ensure careful management of the program by hiring or designating an existing staff person as a water conservation coordinator to oversee the program.
- Reduce water waste.
- Promote public awareness of conservation programs and public participation in voluntary conservation measures.
- As water conservation measures are implemented, carefully monitor changes in water use, taking into account climatic variations, to evaluate the effectiveness of water conservation measures.
- Periodically update the water conservation plan to focus on the programs that result in the highest measured use reductions.

In order to achieve these goals, the LACWU water conservation plan focuses on the following

- A continuing public education program focusing on minimizing water waste and reducing indoor and outdoor water use through voluntary measures for both residential and commercial users
- Good management of the water system, including meter replacement, leak detection, and record-keeping
- Continued implementation of the LACWU existing conservation programs such as wastewater reuse

- Promotion of xeriscaping and landscape requirements for new development

- Encouraging voluntary conservation through xeriscape rebate programs, supplying mulch, and supplying indoor plumbing retrofit kits

- Working with LANL to promote conservation

The water conservation plan will be implemented over time as resources and funding become available. A phased approach will allow for careful evaluation of the effectiveness of individual conservation measures in reducing demand.

An inspection was conducted to assess the processes and working condition of LACWU facilities, including 12 wells, 22 tanks, 17 pump stations, 14 pressure reducing valves, and 6 maintenance storage buildings. The inspection recommended minor repairs, replacements and upgrades for all facilities, and concluded that LACWU maintenance facilities are inadequate. A central maintenance office, shop, and storage building for 10 personnel is needed for the Water Production Department.

In summary, Los Alamos County is anticipating future growth and increased demands that are projected to exceed existing water rights unless demand is reduced through conservation. While the water supply will likely produce at current rates for well beyond the 45-year planning period, issues regarding water rights and potential water quality concerns indicate that the County needs to proactively plan for future use. A summary of recommendations for addressing the future water supply needs of the County follows.

Water Supply (Quantity)

- Initiate steps toward implementation of the San Juan-Chama diversion project.

- Monitor water levels in the vicinity of the water supply wells and evaluate declines on a regular basis.

- Implement recommendations for maintenance and infrastructure improvements described in the facilities assessment.

Water Quality/Contaminant Risk Recommendations

- Work closely with LANL and the New Mexico Environment Department regarding ongoing monitoring of contaminants.

- Plot and evaluate contaminant data on a quarterly basis to be sure that any trends or changes are identified quickly.

- Begin contingency planning for moving wells affected by contaminants to alternate well locations. Identify possible locations for new wells that are upgradient from or off-gradient of key source areas, and begin to resolve infrastructure, land access, and water rights transfer issues so that alternative wells can be developed in a timely manner.

Water Rights

- Secure services of water rights attorney to advise and plan for water rights acquisition (availability of pre-1907 water rights, return flow credits, costs, time to secure, potential litigation).

- Finalize acquisition of water rights from newly acquired lands.

- Evaluate and quantify pumping effects on the river from current water production regime and potential changes in pumping amounts and locations.

- Meet with the OSE to discuss priority administration and the number and amount of water rights that are senior to those of Los Alamos County.

- Consider conducting a hydrogeologic evaluation of pumping impacts on the Rio Grande to be prepared to address OSE concerns for future water rights transactions.

Water Conservation

- Hire or designate an existing staff person as a water conservation coordinator so that the program can be carefully managed.

- Continue existing water conservation initiatives, including public education, automated billing, meter replacement, leak detection, and others.

- Monitor the effectiveness of voluntary compliance in reducing water waste, and if necessary, pass an enforceable ordinance so that penalties can be assessed.

- Update subdivision regulations to include requirements for graywater reuse, water harvesting, xeriscaping, and low-water-use indoor plumbing for all new commercial and residential development.

- Establish rebate programs for xeriscaping and toilet and washing machine replacement.

- Distribute indoor plumbing leak detection and retrofit kits.

- Monitor the effectiveness of existing and new conservation measures and refine the conservation program appropriately.

Implementation of these recommendations will help the County to be prepared to meet its future water supply needs.

1. Introduction

Los Alamos County supplies water for Los Alamos, White Rock, Los Alamos National Laboratory, and Bandelier National Monument. To prepare for the future water supply needs of these communities, the County is developing this long-range water supply plan. The objective of this plan is to evaluate projected demands in relation to available supply, while considering water quality and water rights risks to the supply, to ultimately ensure that both a viable physical supply and associated water rights are in place as needed to meet future demands.

In addition to providing a plan for a sustainable future water supply, a long-range water plan that covers at least 40 years addresses several regulatory requirements regarding water rights and water conservation. In particular, a water plan allows certain organizations, including Counties, to set aside water for use in the future. Section 72-1-9(B) of the New Mexico Water Code allows covered entities such as Los Alamos County to legally appropriate and preserve water that they cannot currently use but will need in the future to meet projected water requirements for the service area based on projected growth and other factors. Counties are specifically exempt from forfeiture of unused water rights if those rights have been appropriated for the implementation of a water development plan or for preservation of water supplies (NMSA 72-12-8 (F)). These provisions are the same for both surface water and groundwater (NMSA 72-5-28(C)).

This Los Alamos County water plan also includes a conservation plan, which addresses New Mexico Office of the State Engineer (OSE) requirements set out in a new statute (NMSA 1978 Section 72-14-3.2) that calls for conservation planning by any public supply system with diversions of at least 500 acre-feet annually for domestic, commercial, industrial, or government customers for other than agricultural purposes. Covered entities must develop, adopt, and submit to the OSE a comprehensive water conservation plan, including a drought management plan, as a prerequisite for applying for funding from key state funding agencies. After December 31, 2005, neither the Water Trust Board nor the New Mexico Finance Authority shall accept an application from a covered entity for financial assistance in the construction of any water diversion, storage, conveyance, water treatment, or wastewater treatment facility unless the covered entity includes a copy of its water conservation plan. The U.S. Bureau of Reclamation (USBR) also requires a conservation plan for diversion of San Juan-Chama Project water.

To develop this long-range sustainable water supply plan, Los Alamos County retained Daniel B. Stephens & Associates, Inc. (DBS&A). Specific tasks that DBS&A was requested to perform include:

- Task 1: Analyze existing water supply, demand, and compare supply to demand, including evaluating risks to the supply
- Task 2: Evaluate the age, condition, and effectiveness of existing water production facilities and recommend alterations, replacements, and improvements
- Task 3: Develop a timeline for constructing facilities to begin using San Juan-Chama water to supplement the County's water supply
- Task 4: Develop a water conservation plan
- Task 5: Develop recommendations for long-term regional water supply
- Task 6: Support public involvement in the development of the plan.

The facilities analysis portion of the plan (Task 2) was conducted by Molzen-Corbin & Associates; Rosemary Romero facilitated the public involvement process (Task 6). Amy C. Lewis, hydrologist, supported portions of Tasks 1 and 4.

The remainder of this water plan presents the results of the analyses and evaluations and provides recommendations for measures the County may undertake to plan for a sustainable future water supply.

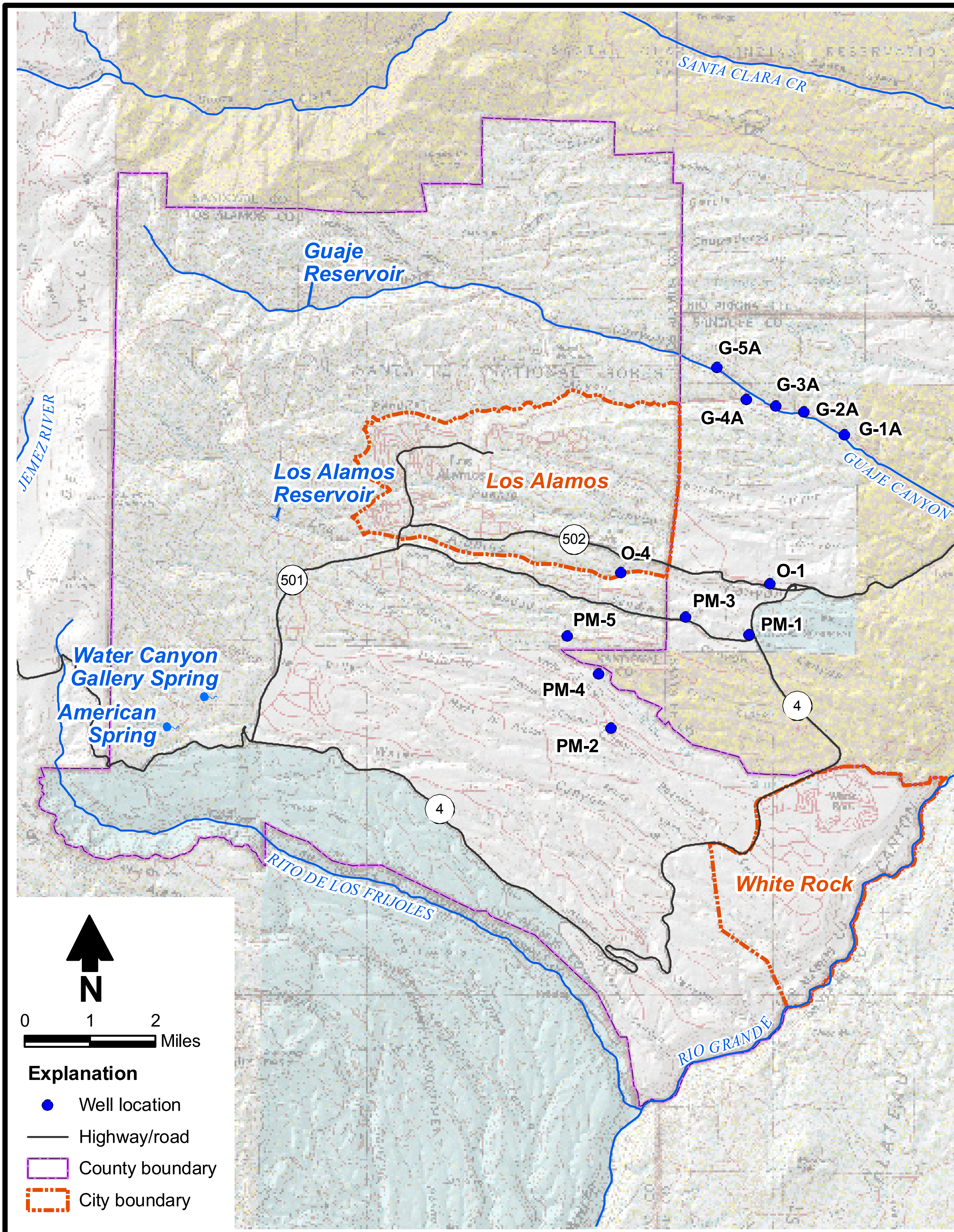
2. Overview of Los Alamos County Water System

The Los Alamos Boys Ranch, a year-long school for teenage boys started in 1918, was the original settlement in the area that is now Los Alamos County. The sole source of water for the school was surface water from Los Alamos Reservoir in Los Alamos Canyon (Figure 2-1). The water was piped from the reservoir and stored in a redwood water tank near the school. During World War II, Los Alamos was selected as the site for the secret Project Y, because the steep canyons and mesa tops provided a secure location for the project. The Los Alamos Laboratory (as it was then called) came into existence in early 1943 for the single purpose of Project Y: to design and build an atomic bomb (LANL, 2006a). Los Alamos Boys Ranch closed in early 1943 and the Laboratory became the only establishment. In 1949 Los Alamos County was created from parts of Sandoval and Santa Fe Counties.

When the Laboratory took over in 1943, they continued to use Los Alamos Reservoir, but also piped in water from a spring gallery in Guaje Canyon. In 1947, a dam was built in Guaje Canyon and water from the resulting Guaje Reservoir was used for water supply (Figure 2-1). In addition, American Spring and several springs in Water Canyon were tapped and piped into the water system. The Los Alamos well field was drilled in 1946, thereby increasing the supply to meet the growing demands of the Laboratory and its residents. By 1989, groundwater from the Los Alamos, Guaje, Pajarito and Otowi well fields supplied all of the potable demands for Los Alamos.

The Los Alamos well field was abandoned and plugged in 1992 because the wells had reached the end of their useful life. Also in the 1990s, six of the seven wells in the Guaje well field were retired and four replacement wells drilled and tapped into the existing piping and booster stations. Los Alamos Reservoir continued to be used to water parks, but the Cerro Grande fire in 2000 damaged the reservoir and the diversion system (the County is planning to repair the system in 2007 and resume using it for watering parks).

The Los Alamos County Water Utility (LACWU) began operating the water system in September 1998; however, ownership of the water system and associated water rights were not transferred from the Department of Energy (DOE) to the water utility until September 2001. LACWU currently provides water service to the residents of Los Alamos and White Rock, Los Alamos



LOS ALAMOS COUNTY WATER PLAN

Water Supply

Figure 2-1

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National Laboratory (LANL), and Bandelier National Monument. The utility has a contract to supply to DOE the water required by LANL with no limitations.

In addition to the former laboratory water sources, Los Alamos County has a contract with the Bureau of Reclamation for water from the San Juan-Chama Project, which brings water from the San Juan Basin to Heron Reservoir on the Chama River. Releases from Heron flow from the Chama to the Rio Grande. To use the San Juan-Chama Project water, diversion directly from the Rio Grande will be required. However, the diversion rights of San Juan-Chama water could also be used to offset impacts of pumping (as the City of Santa Fe has done since 1972), as further discussed in Sections 4.3.2 and 6.

Los Alamos is currently supplied by the 12 wells shown in Figure 2-1 and listed in Table 2-1. These wells, with depths up to 3,000 feet below ground surface (bgs) and water levels ranging from 250 to 1,200 feet bgs, all draw on the regional aquifer beneath the Pajarito Plateau. The Los Alamos well field located on San Ildefonso Pueblo property was used until 1992. Six original wells in the Guaje well field were plugged and abandoned in 1999. The only active wells are shown on Table 2-1.

Table 2-1. Active Wells in the Los Alamos Water Supply System.

Well Field	Well Name	Date Completed	Completion Depth (ft)	Coordinates (ft) x	Coordinates (ft) y	Initial Depth to Water
Guaje	G-1A	Oct-54	1,519	1,655,241	1,784,353	250
	G-2A	Mar-98	1,980	1,651,974	1,786,166	318
	G-3A	May-98	1,980	1,649,662	1,786,585	408
	G-4A	Apr-98	1,980	1,647,318	1,787,113	452
	G-5A	Jun-98	1,980	1,644,877	1,789,636	551
Otowi	O-1 [a]	Aug-90	2,497	1,649,396	1,772,232	673
	O-4	Mar-90	2,595	1,637,337	1,772,995	780
Pajarito	PM-1	Feb-65	2,499	1,647,734	1,768,112	722
	PM-2	Jul-65	2,300	1,636,698	1,760,406	823
	PM-3	Nov-66	2,552	1,642,590	1,769,530	740
	PM-4	Aug-81	2,874	1,635,623	1,764,740	1,060
	PM-5	Sep-82	3,092	1,632,110	1,767,790	1,208

Source: Koch and Rogers, 2003

[a] Well is currently not being used to supply drinking water.

The pump in one well has been lowered 60 feet. Line shaft turbine pumps work only with a certain water level above the pump (that creates pressure or hydraulic head), and the water level in several other wells has decreased to close to the required level, threatening the pumps in those wells.

Wastewater is currently treated at two facilities: the White Rock wastewater treatment plant (WWTP) and the Bayo WWTP. Both of these WWTPs have treated effluent reuse lines that are used for irrigation of turf. Two former WWTPs—the East Road, abandoned and demolished in the mid-1960s, and the Pueblo, abandoned in 1993—also had effluent reuse systems, both of which supplied the golf course.

3. Hydrogeologic Overview and Risks to Water Supply

This section describes the hydrogeologic conditions pertinent to the Los Alamos water supply (Section 3.1) and includes an assessment of potential risks to the supply due to depletion or contamination of the aquifer (Section 3.2).

3.1 Hydrogeology

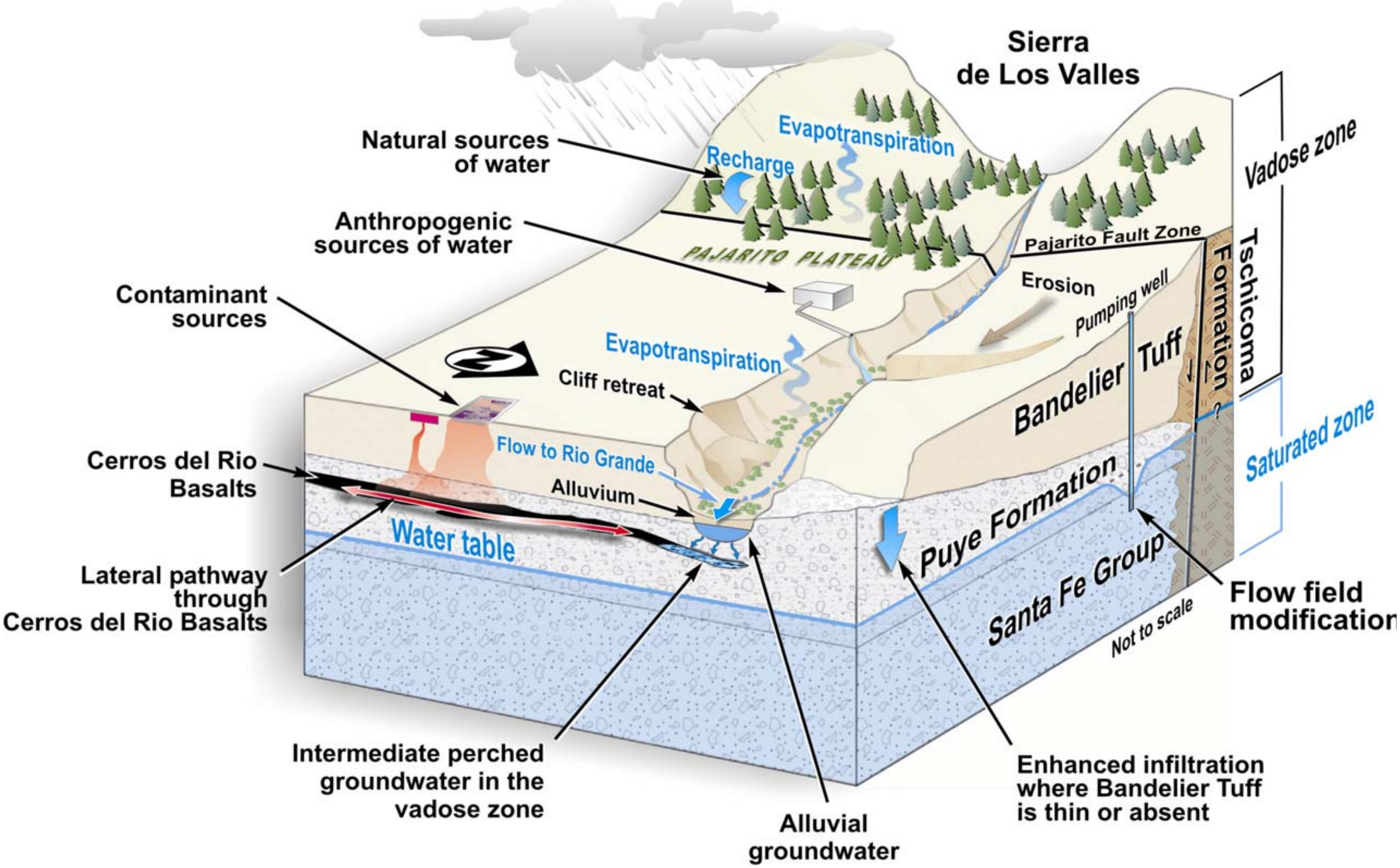
Los Alamos County is situated on the Pajarito Plateau within the western margin of the Española Basin. The hydrogeologic framework within Los Alamos County consists of three distinct aquifer systems:

- Shallow perched groundwater in alluvial deposits along canyon bottoms
- Intermediate-depth perched groundwater
- Deeper, regional aquifer

A block diagram depicting a conceptual model of the hydrogeology of the Los Alamos area that illustrates the general configuration of these aquifer systems is shown in Figure 3-1.

Alluvial aquifers occur within axial fluvial deposits located along canyon bottoms and have a limited saturated thickness and variable lateral extent depending on the presence of intermittent surface flow or anthropogenic discharges from water treatment outfalls. Hydrologic investigations of alluvial aquifers have been conducted in Los Alamos Canyon, Pueblo Canyon, Pajarito Canyon, Sandia Canyon, and Cañon de Valle. Though their limited extent precludes any utility for beneficial use, these aquifers provide an important pathway for contaminant migration.

Observed occurrences of intermediate-depth perched aquifers are widely distributed across the northern and central parts of the Pajarito Plateau at depths ranging from 118 to 894 feet beneath Los Alamos Canyon, Pueblo Canyon, Sandia Canyon, Mortandad Canyon, and Cañon de Valle. These perched zones usually occur in the Puye Formation fanglomerates, the Cerros del Rio Basalt, and units of the Bandelier Tuff, and are typically associated with low-permeability



Source: LANL, 2005a

LOS ALAMOS COUNTY WATER PLAN

Conceptual Hydrogeologic Model of the Los Alamos County Area

Figure 3-1

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5/26/06

layers such as unfractured basalt flows and clay-rich zones. Saturated thicknesses range from about 3 to 420 feet, but lateral extents are poorly defined (LANL, 2005a). Again, the generally small extent of these aquifers limits their potential for beneficial use, but they provide an important pathway for contaminant migration through the vadose zone.

The regional aquifer occurs at depths up to approximately 1,150 feet beneath the plateau and is the primary source of water supply for Los Alamos County. This aquifer occurs primarily within the poorly to semi-consolidated basin-fill sediments of the Santa Fe Group. The total thickness of the Santa Fe Group beneath the Pajarito Plateau is poorly defined. The deepest well on the plateau (PM-5), with a depth of 3,110 feet, does not fully penetrate the base of the basin-fill sediments. Estimates of the total thickness of these sediments range from 6,650 feet in the central basin to as much as 9,000 to 10,000 feet in the central and western parts of the basin (Broxton and Vaniman, 2005).

The regional aquifer extends into the overlying Puye Formation fanglomerate beneath parts of the Pajarito Plateau. Other geologic units encompassed by the regional aquifer beneath parts of the county include fractured volcanic rocks of the Tschicoma Formation (western part) and the Cerros del Rio Basalt (eastern part) as well as localized occurrences of older basalts.

3.1.1 Recharge

The major source of recharge to the regional aquifer is precipitation within the Sierra de los Valles. Alluvial groundwater is also a source of recharge to the regional aquifer, as well as to the intermediate perched saturated zones (thereby providing potential downward pathways for contaminants released at the surface to eventually reach the regional aquifer). Precipitation in Los Alamos County is elevation-dependent and ranges between about 13 and 20 inches annually (Newman and Robinson, 2005).

A number of studies have estimated recharge to the regional aquifer for the Española Basin and for the Pajarito Plateau (Table 3-1). Keating et al. (2005) determined that significant recharge occurs primarily above the 2195-meter (7200-foot) elevation. At lower elevations, recharge occurs primarily in canyons and arroyos; recharge on mesas is minimal to non-existent

(Anderholm, 1994; Birdsell et al., 2005). Kwicklis et al. (2005) estimated that 23 percent of total recharge to the regional aquifer beneath the plateau is from streamflow loss. In addition to the recharge estimates, Table 3-1 includes an estimate of discharge to the Rio Grande (determined from inverse modeling using streamflow data and transient head data), which approximates aquifer recharge before significant pumping began.

Table 3-1. Regional Aquifer Recharge Estimates

Category	Rate (ac-ft/yr)	Source
Pajarito Plateau recharge	8,596	Kwicklis et al., 2005
	4,912	McLin et al., 1996
	4,298 to 5,526	Griggs and Hem, 1964
	8,084	Hearne, 1985
Lateral inflow from Jemez Mountains	7,445	McAda and Wasiolek, 1988
Discharge to Rio Grande from Pajarito Plateau and Sierra de los Valles	6,473	Keating et al., 2003

In terms of a linear rate, Keating et al. (2003) applied recharge rates for the LANL basin-scale model that vary from 2 to 6 millimeters (0.08 to 0.24 inches) per year for areas above 7200 feet elevation. The LANL site scale model also incorporates focused recharge along canyons with magnitudes up to a few hundred millimeters per year (mm/yr) (3.9 inches per year) (LANL, 2005a). Studies of infiltration from perched alluvial systems in wet canyons have determined recharge rates of 100 to 1000 mm/yr (3.9 to 39.4 inches per year) (Gray, 1997; Kwicklis et al., 2005).

3.1.2 Aquifer Properties

Aquifer permeability estimates for the Santa Fe Group have been determined from pump tests of supply wells and several monitor wells screened in the regional aquifer. Permeability estimates from supply well pump tests range from 10^{-11} to $10^{-12.8}$ meters squared (m^2) (Keating et al., 2005), which represents a very productive aquifer. These wells are screened over large intervals of several hundred feet and thus these values represent average conditions for the deep aquifer. Pump tests of monitor wells with shorter screens completed near the top of the aquifer in the Puye Formation yield permeabilities ranging from $10^{-11.2}$ to $10^{-13.8}$ m^2 (Nylander et al., 2003). Specific storage estimates range from $10^{-5.5}$ per meter (/m) to $10^{-3.8}$/m in the Otowi well field and $10^{-4.8}$/m in the abandoned Los Alamos well field (LANL, 2005a).

The results of pump tests performed in several regional aquifer monitor wells (often referred to as *R-wells*) installed as part of LANL's Hydrogeologic Work Plan (1998) implementation are shown in Table 3-2. Table 3-3 summarizes aquifer properties determined from a multiple well pump test conducted by LANL on supply well PM-2 during February 2003, using supply wells PM-4 and PM-5 (which were not pumped during the 25-day test) and monitor wells R-15, R-20, R-21, R-22, and R-32 as observation wells (McLin, 2005).

Anisotropy, the ratio of vertical to horizontal hydraulic conductivity, is important for predicting contaminant movement in the vadose and saturated zones. Pumping test analyses have indicated that a strong degree of anisotropy is present in the regional aquifer beneath the Pajarito Plateau. The magnitude of this anisotropy is uncertain and difficult to constrain, however, and estimates range from 0.00005 to 0.01 (LANL, 2005a). Nevertheless, these estimates indicate that the potential for water and contamination to move horizontally is 100 to 20,000 times greater than the potential to move vertically within the regional aquifer. Hydrologic modeling suggests that vertical permeability is 100 to 1,000 times lower than horizontal permeability in the Santa Fe Group silts and sands (Hearne, 1985; McAda and Wasiolek, 1988; Keating et al. 2003, as cited by LANL, 2005a).

Analysis of the PM-2 pump test indicated that the aquifer behaves as a confined system during the early test stages, but transitions to a leaky-confined behavior during the later stages of the test. Whereas specific confining layers have not been identified in the regional aquifer, the pumping test responses attributable to high anisotropy ratios were assumed to result from layered heterogeneity apparent in the Santa Fe Group sediments (McLin, 2005).

Most of the recent drilling conducted by LANL has demonstrated the existence of water table (unconfined) conditions at the top of the regional aquifer, and multiple-screened wells generally show a pattern of decreasing heads with greater depth except where confined conditions are present near the Rio Grande. However, data from R-31 in the southern part of the county show

Table 3-2. Aquifer Test Results
Regional Aquifer Wells
Page 1 of 3

Well	Screened Interval (ft bgs)	Stratigraphic Unit [a]	Test Type [b]	Analytical Method [c]	Hydraulic Conductivity (ft/d)	Transmissivity (ft^2/d)
R-13	NA	Puye (f, p)	PT [d]	HJ	1293.3	21.4
	NA	Puye	PT [e]	HJ	829.7	13.7
R-14	1200.6-1233.1	Puye (f)	IT	NA	NA	NA
	1286.5-1293.1	upd	IT	Theis (I)	0.5	72.4
	1286.5-1293.1	upd	IT	Theis (R)	0.4	68.9
	1286.5-1293.1	upd	IT	Theis (RR)	0.9	142.5
	1286.5-1293.1	upd	IT	SC	1.1	177.2
R-15	958.6-1020.3	upd	PT	Theis (c)	1.7	232
	958.6-1020.3	upd	PT	Theis (u)	2	277
	958.6-1020.3	upd	PT	Moench (u)	2.2	306
	958.6-1020.3	upd	PT	Neuman (u)	2.2	299
	958.6-1020.3	upd	PT	SC (c)	2	271
	958.6-1020.3	upd	PT	SC (u)	2.3	318
	958.6-1020.3	upd	PT	AV	2.2	300
	958.6-1020.3	upd	PT	R- M/N	2.2	302
R-16	863.4-870.9	SFG	IT	Theis (R) [f]	1.6	879
	863.4-870.9	SFG	IT	sc	NA	849
	1014.8-1022.4	SFG	IT	Theis (R) [f]	2	1092
	1014.8-1022.4	SFG	IT	sc	NA	1058
	1237.0-1244.6	SFG	IT	Theis (R) [f]	1.6	916
	1237.0-1244.6	SFG	IT	sc	NA	900
R-19	1726.8-1733.9	Puye (p)	IT	BR	4.87	NM
	1726.8-1733.9	Puye (p)	IT	C-B-P	3.71	NM
	1726.8-1733.9	Puye (p)	IT	H	4.57	NM
	1832.4-1839.5	Puye (p)	IT	BR	0.11	NM
	1832.4-1839.5	Puye (p)	IT	C-B-P	0.18	NM
	1832.4-1839.5	Puye (p)	IT	H	0.12	NM
R-20	904.6-912.2	cd	IT	BR	0.17	18.1
	904.6-912.2	cd	IT	BR	0.15	16
	904.6-912.2	cd	IT	sc	0.13	14.2
	1147.1-1154.7	upd	IT	Theis (I)	0.6	68.1

[a] Explanations of these abbreviations are provided at the end of the table
[b] Explanations of these abbreviations are provided at the end of the table
[c] Explanations of these abbreviations are provided at the end of the table
[d] Pumping
[e] Recovery
[f] Assumes 1:1000 Kv/Kh anisotropy

ft bgs = feet below ground surface
ft/d = feet per day
f^2/d = feet squared per day
NA = Not applicable
NM = Not measured

Table 3-2. Aquifer Test Results
Regional Aquifer Wells
Page 2 of 3

Well	Screened Interval (ft bgs)	Stratigraphic Unit [a]	Test Type [b]	Analytical Method [c]	Hydraulic Conductivity (ft/d)	Transmissivity (ft^2/d)
R-20 (cont.)	1147.1-1154.7	upd	IT	Theis (R)	0.6	68.6
	1147.1-1154.7	upd	IT	Theis (RR)	1.6	187.8
	1147.1-1154.7	upd	IT	sc	1.6	180
	1328.8-1336.5	SFG	IT	Theis (c)	0.6	70.9
	1328.8-1336.5	SFG	IT	sc	1.5	180
R-22	947.0-988.9	CRB	IT	BR	0.04	NM
	947.0-988.9	CRB	IT	C-B-P	0.06	NM
	947.0-988.9	CRB	IT	H	0.05	NM
	1272.2-1278.9	Puye (f)	IT	BR	0.21	NM
	1272.2-1278.9	Puye (f)	IT	C-B-P	0.53	NM
	1272.2-1278.9	Puye (f)	IT	H	0.25	NM
	1378.2-1384.9	ob	IT	BR	0.54	NM
	1378.2-1384.9	ob	IT	C-B-P	0.66	NM
	1378.2-1384.9	ob	IT	H	0.61	NM
	1378.2-1384.9	ob	IT	BR	0.72	NM
	1378.2-1384.9	ob	IT	C-B-P	0.66	NM
	1378.2-1384.9	ob	IT	H	0.76	NM
	1447.3-1452.3	Puye (of)	IT	BR	0.27	NM
	1447.3-1452.3	Puye (of)	IT	C-B-P	0.64	NM
	1447.3-1452.3	Puye (of)	IT	H	0.39	NM
R-31	666.3-676.3	CRB	IT	BR	0.41	NM
	666.3-676.3	CRB	IT	C-B-P	0.48	NM
	666.3-676.3	CRB	IT	H	0.53	NM
	826.6-836.6	TL	IT	BR	1.23	NM
	826.6-836.6	TL	IT	C-B-P	1.4	NM
	826.6-836.6	TL	IT	H	1.48	NM
	1007.1-1017.1	TL (?)	IT	BR	0.75	NM
	1007.1-1017.1	TL (?)	IT	C-B-P	1.35	NM
	1007.1-1017.1	TL (?)	IT	H	0.88	NM
R-32	867.5-875.2	Trg	IT	Theis (I)	1.9	13.5
	867.5-875.2	Trg	IT	Theis (R)	4.1	29

[a] Explanations of these abbreviations are provided at the end of the table
[b] Explanations of these abbreviations are provided at the end of the table
[c] Explanations of these abbreviations are provided at the end of the table
[d] Pumping
[e] Recovery
[f] Assumes 1:1000 Kv/Kh anisotropy

ft bgs = feet below ground surface
ft/d = feet per day
f^2/d = feet squared per day
NA = Not applicable
NM = Not measured

Table 3-2. Aquifer Test Results
Regional Aquifer Wells

Well	Screened Interval (ft bgs)	Stratigraphic Unit [a]	Test Type [b]	Analytical Method [c]	Hydraulic Conductivity (ft/d)	Transmissivity (ft^2/d)
R-32 (cont.)	867.5-875.2	Trg	IT	Theis (RR)	4.2	29.4
	867.5-875.2	Trg	IT	SC	4.2	29.5
	972.9-980.6	Puye (f)	IT	Theis (I)	0.2	16.7
	972.9-980.6	Puye (f)	IT	Theis (R)	0.2	16.7
	972.9-980.6	Puye (f)	IT	Theis (RR)	>1.2	>105.2
	972.9-980.6	Puye (f)	IT	SC	>1.2	>104

[a] cd = Cinder deposits
CRB = Cerros del Rio basalt
f = Fanglomerate
ob = Older basalt
of = Older fanglomerate
p = Pumiceous
SFG = Santa Fe Group
TL = Totavi Lentil
Trg = Tertiary river gravels
upd = Unassigned pumiceous deposits

[b] IT = Injection testing
PT = Pumping test

[c] AV = Average value (all tests)
BR = Bouwer-Rice
c = Confined
C-B-P = Cooper-Bredehoeft-Papadopulos
H = Hvorslev
HJ = Hantush-Jacob
I = Injection
R = Recovery
R- M/N = Recommended: Moench or Neuman
RR = Residual-recovery
sc = Determined from specific capacity
SC = Specific capacity
u = Unconfined

[d] Pumping
[e] Recovery
[f] Assumes 1:1000 Kv/Kh anisotropy

ft bgs = feet below ground surface
ft/d = feet per day
f^2/d = feet squared per day
NA = Not applicable
NM = Not measured

Table 3-3. Aquifer Test Results
Supply Well PM-2

Well ID	Well Type	Analytical Method [a]	Aquifer Description: Type	Aquifer Description: Radial Distance (ft)	Aquifer Description: Thickness (ft)	Transmissivity (ft^2/d)	Hydraulic Conductivity (ft/d)
PM-2	Pumped	Theis (P)	Confined	1	850	4,507	5.3
		Theis (SR)	Confined	1	850	4,068	4.8
		Theis (RR)	Confined	1	850	3,834	4.5
		SC	Confined	1	850	4,214	5.0
		HJ	Leaky	1	850	4,542	5.3
		NW	Leaky	1	850	4,235	5.0
		Moench (case 1)	Leaky	1	850	4,235	5.0
PM-4	Observation	Theis (P)	Confined	1	850	3,999	4.7
		Theis (SR)	Confined	4,478	850	4,390	5.2
		Theis (RR)	Confined	4,478	850	4,965	5.8
		HJ	Leaky	4,478	850	4,235	5.0
		NW	Leaky	4,478	850	4,235	5.0
		Moench (case 1)	Leaky	4,478	850	4,235	5.0
PM-5	Observation	Theis (P)	Confined	8,808	850	12,980	15.3
		Theis (SR)	Confined	8,808	850	14,740	17.3
		Theis (RR)	Confined	8,808	850	16,340	19.2
		Hwa	Confined	8,808	490	6,246	12.7
		HJ	Leaky	8,808	850	4,235	5.0
		NW	Leaky	8,808	850	4,235	5.0
		Moench (case 1)	Leaky	8,808	850	4,235	5.0
R20-3	Observation	Theis (P)	Confined	1,225	850	4,312	5.1
		Theis (SR)	Confined	1,225	850	4,334	5.1
		Theis (RR)	Confined	1,225	850	4,645	5.5
		HJ	Leaky	1,225	850	4,235	5.0
		NW	Leaky	1,225	850	4,235	5.0
		Moench (case 1)	Leaky	1,225	850	4,235	5.0

[a] HJ = Hantush-Jacob
Hwa = Hantush wedge aquifer
NW = Neuman-Witherspoon
P = pumping
RR = residual recovery
SC = specific capacity
SR = simple recovery

ft = feet
ft/d = feet per day
ft^2/d = feet squared per day

small head decreases with depth in the upper screens, but head increases with greater depths in the lower screens. These results suggest that the higher heads at depth are from a zone that is hydrologically separated from the upper zone and comprises a zone of deep confined flow beneath the plateau, hydraulically distinct from the upper zone (LANL, 2005a). The PM-2 pump test results (pumping from the deep aquifer zone) also showed muted responses from observation wells screened near the top of the aquifer. These results are also consistent with a compartmentalized system.

Two possible conceptual models of the regional aquifer would conform to these recent drilling and aquifer testing results (LANL, 2005a):

- A strongly anisotropic aquifer with unconfined conditions at the top of the aquifer but with increasingly leaky-confined behavior at depth that limits vertical movement of groundwater

- A compartmentalized aquifer with a laterally extensive low-permeability zone that separates the upper unconfined zone from a deeper confined aquifer

The existence of an extensive low-permeability zone has not been recognized in the drilling performed thus far, so the former model seems more likely. Both models support a mechanism of predominantly lateral flow paths near the water table and impeded vertical movement of groundwater further into the deep aquifer.

3.1.3 Water Levels

Potentiometric surface contours and extrapolated flow directions in the regional aquifer are shown in Figure 3-2. Flow is generally eastward toward the Rio Grande.

The apparent anomaly in the Figure 3-2 data at the northeastern edge of the county is due to the inclusion of water level data from wells R-9 and R-12 to construct the potentiometric surface contours. These wells are completed in zones where Miocene-age basalts are intercalated with Santa Fe Group sediments, and it is questionable whether they are representative of the regional aquifer water table. Therefore the accuracy of implied flow paths toward the depicted

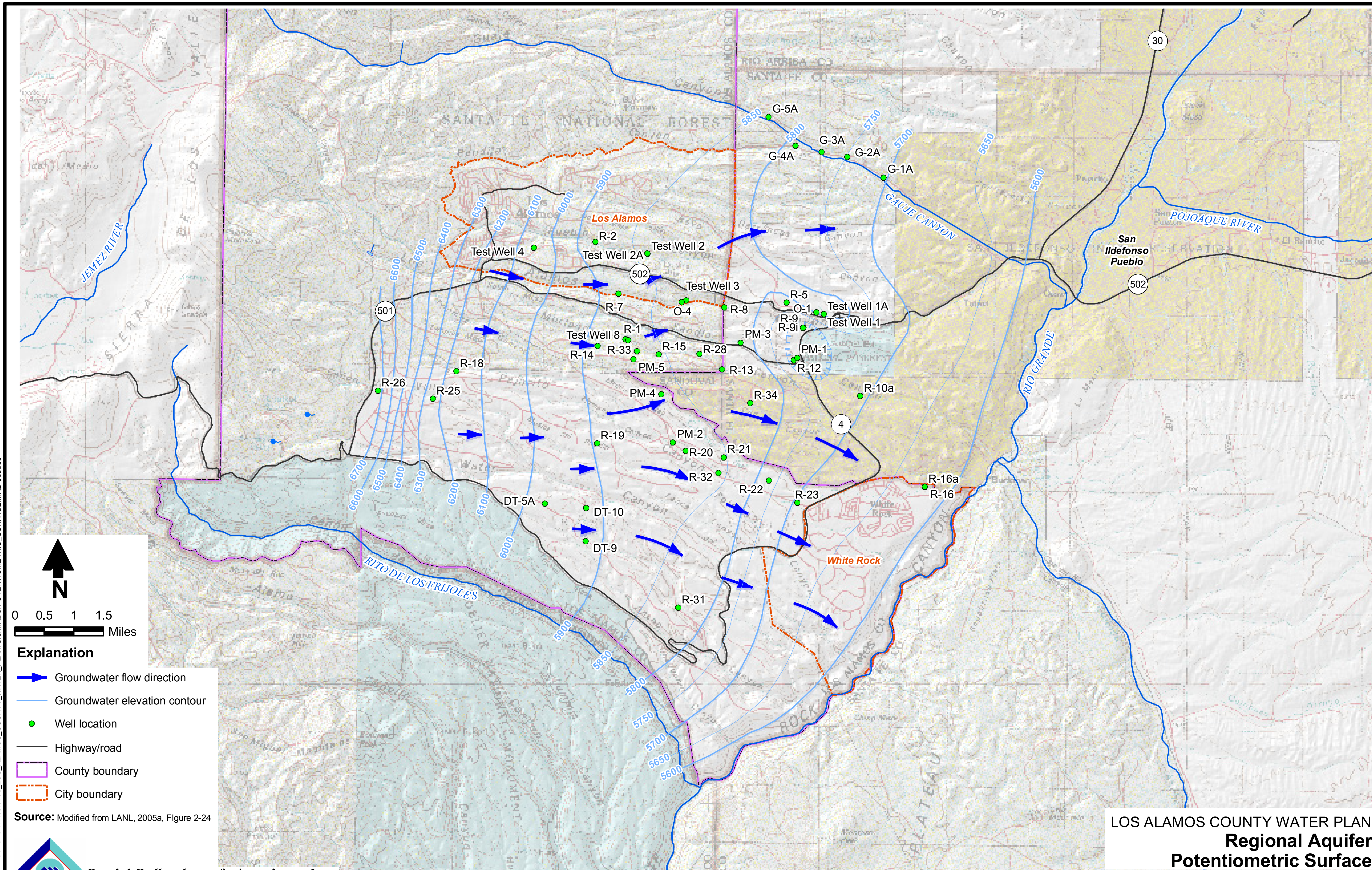

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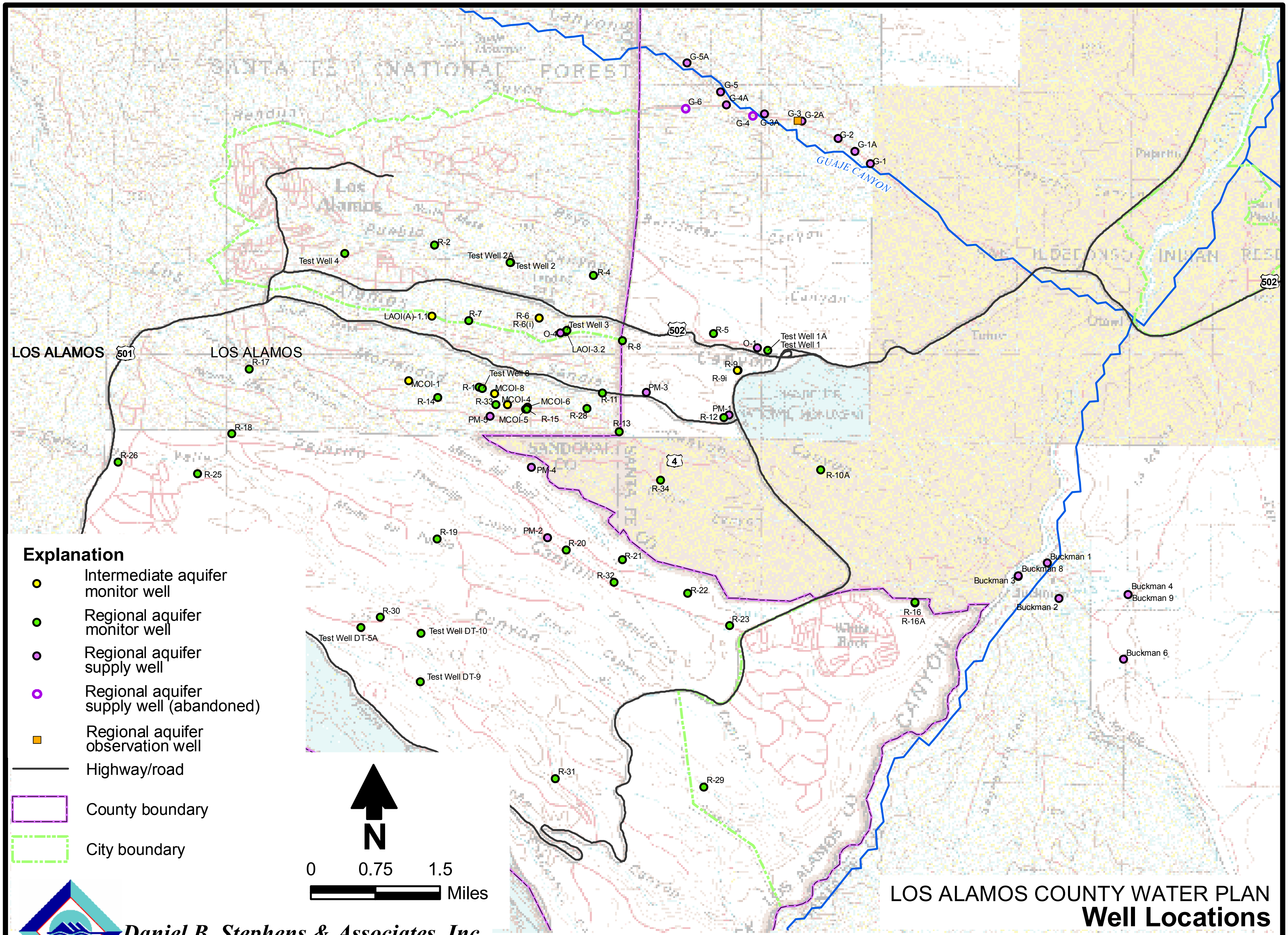
Figure 3-2

depression in the water table is doubtful, and they are thus not shown on the map. Water table gradients in the central and eastern portions of the county vary between 0.0026 (TW-3 to R-5) and 0.04 (CDV-R-37 to CDV-R-15), while steeper gradients up to 0.162 (R-26 to R-25) exist in the western portions of the county (LANL, 2005a).

Available water level data from numerous wells screened in the regional aquifer were used to plot hydrographs illustrating historical water level behavior in the regional aquifer. Locations of these wells are shown in Figure 3-3. Long-term supply well data, consisting of annual average non-pumping water levels for the Guaje well field (since 1950) and the Pajarito well field (since 1965), are shown in Figures 3-4 and 3-5 respectively. More recent (since 1990) but sporadic data are available for the Otowi well field (Figure 3-6).

Table 3-4 summarizes the net changes and average water level declines for these data. Long-term data from the Pajarito and Guaje well fields indicate an average water level decline of about 1.2 feet per year (ft/yr); the average decline in the Otowi well field is about 1.3 ft/yr. Substantial declines have occurred in the Guaje replacement wells, which were constructed between November 1997 and July 1998 but have only been in service since 1999 (Koch and Rogers, 2003). The average annual water level declines for these wells vary from about 5 to 37 feet and the average decline for the entire Guaje replacement well field is about 21.7 ft/yr for the period from 1998 to 2001.

Water levels have also been monitored by LANL since 1992 in several regional aquifer test wells using pressure transducers and periodic manual measurements. Hydrographs for these wells are provided in Appendix A1. All of these wells show an overall gradual decline in water levels during the period of record except for test well 1 (TW-1). This well is located in lower Pueblo Canyon and exhibits the influence of enhanced recharge by discharges from the Bayo WWTP. As a result of this recharge, the water level in test well TW-1 has risen by more than 20 feet since 1992. The remaining wells demonstrate the amount of decline in the regional water table at locations distant from the effects of the county production wells. The average water level decline observed in the regional aquifer test wells excluding TW-1 is about 0.5 foot per year (Table 3-5).



LOS ALAMOS COUNTY WATER PLAN
Well Locations

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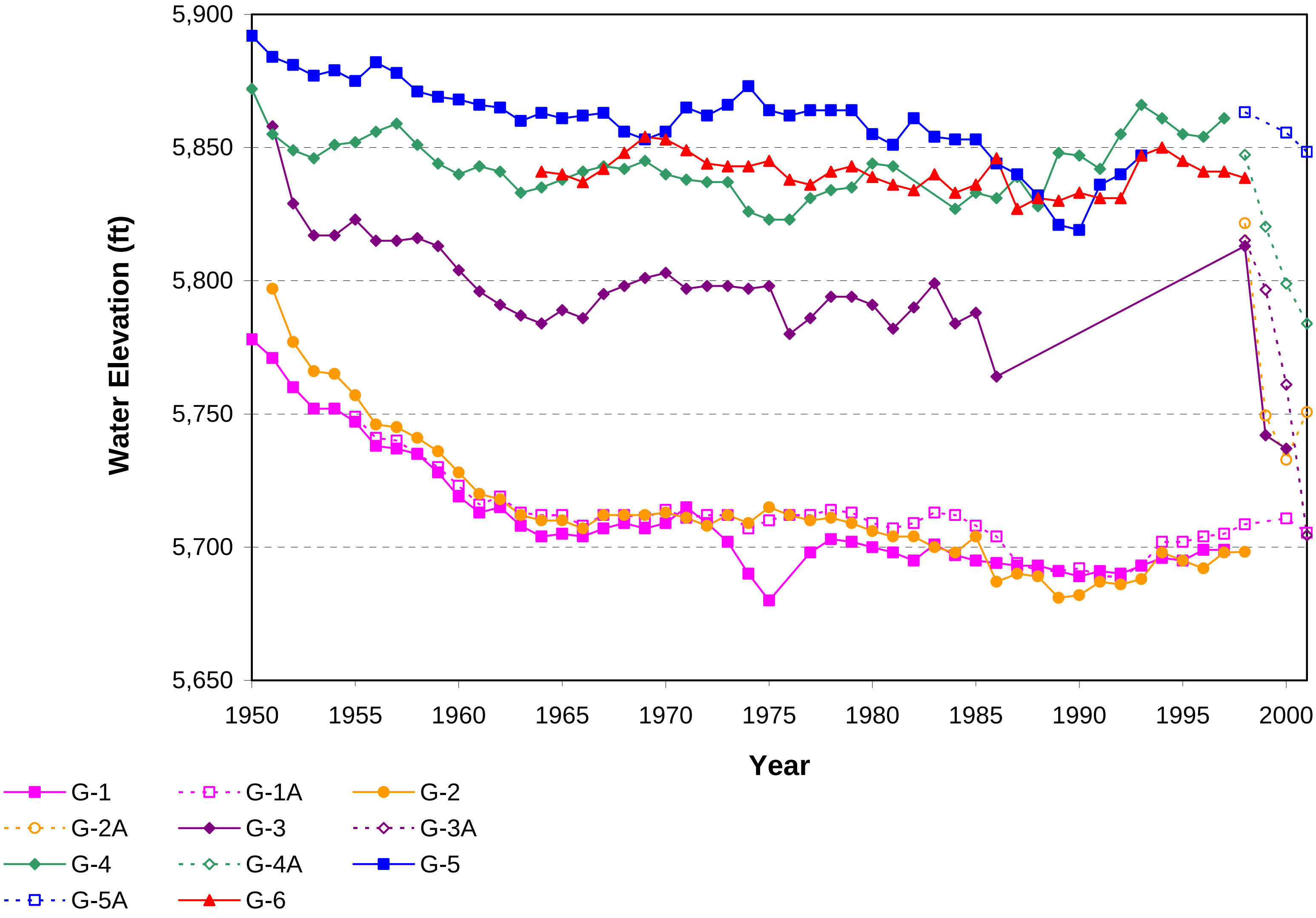
Figure 3-3



LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Guaje Well Field

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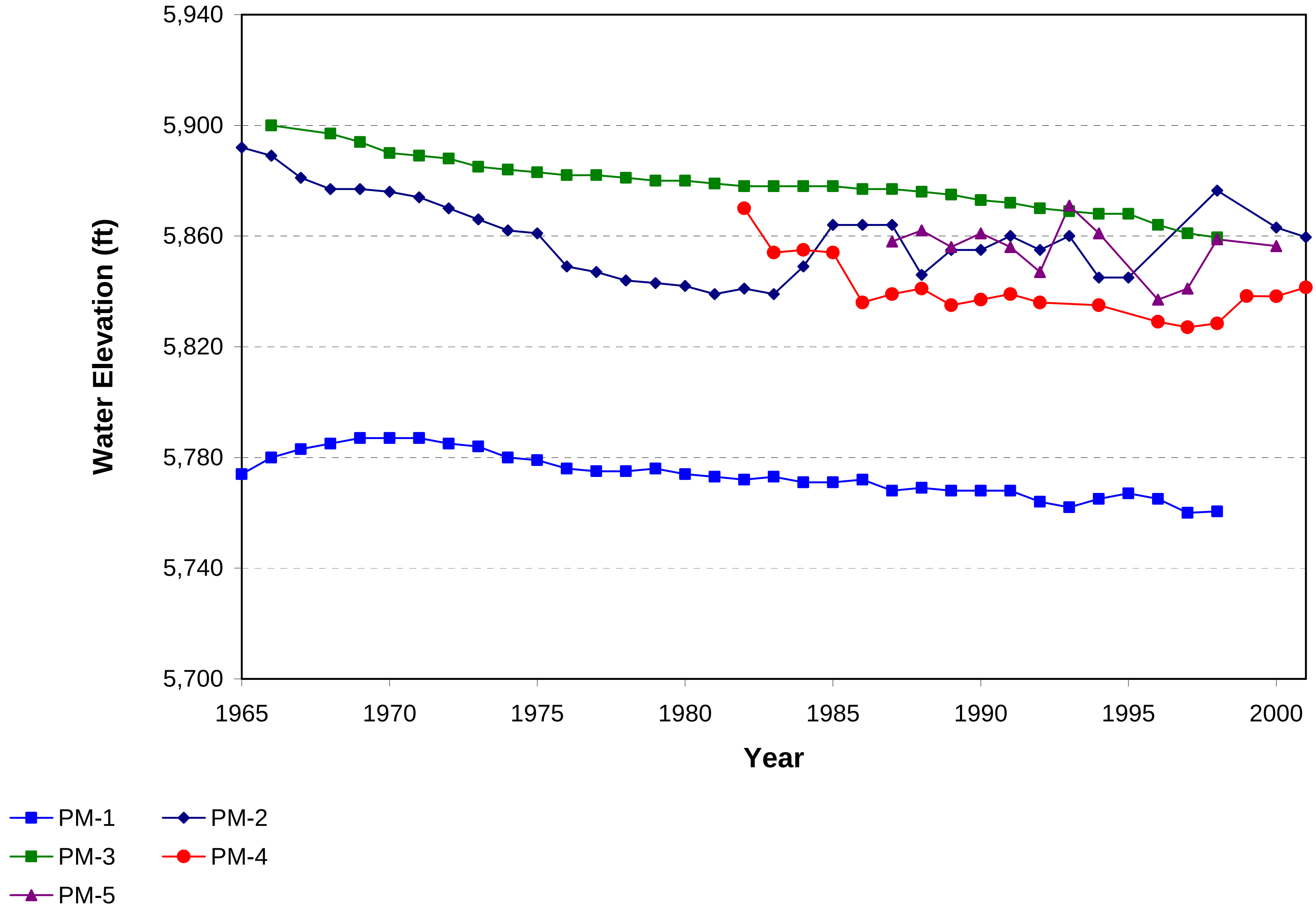
5/26/06

Figure 3-4



LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Pajarito Well Field

Figure 3-5

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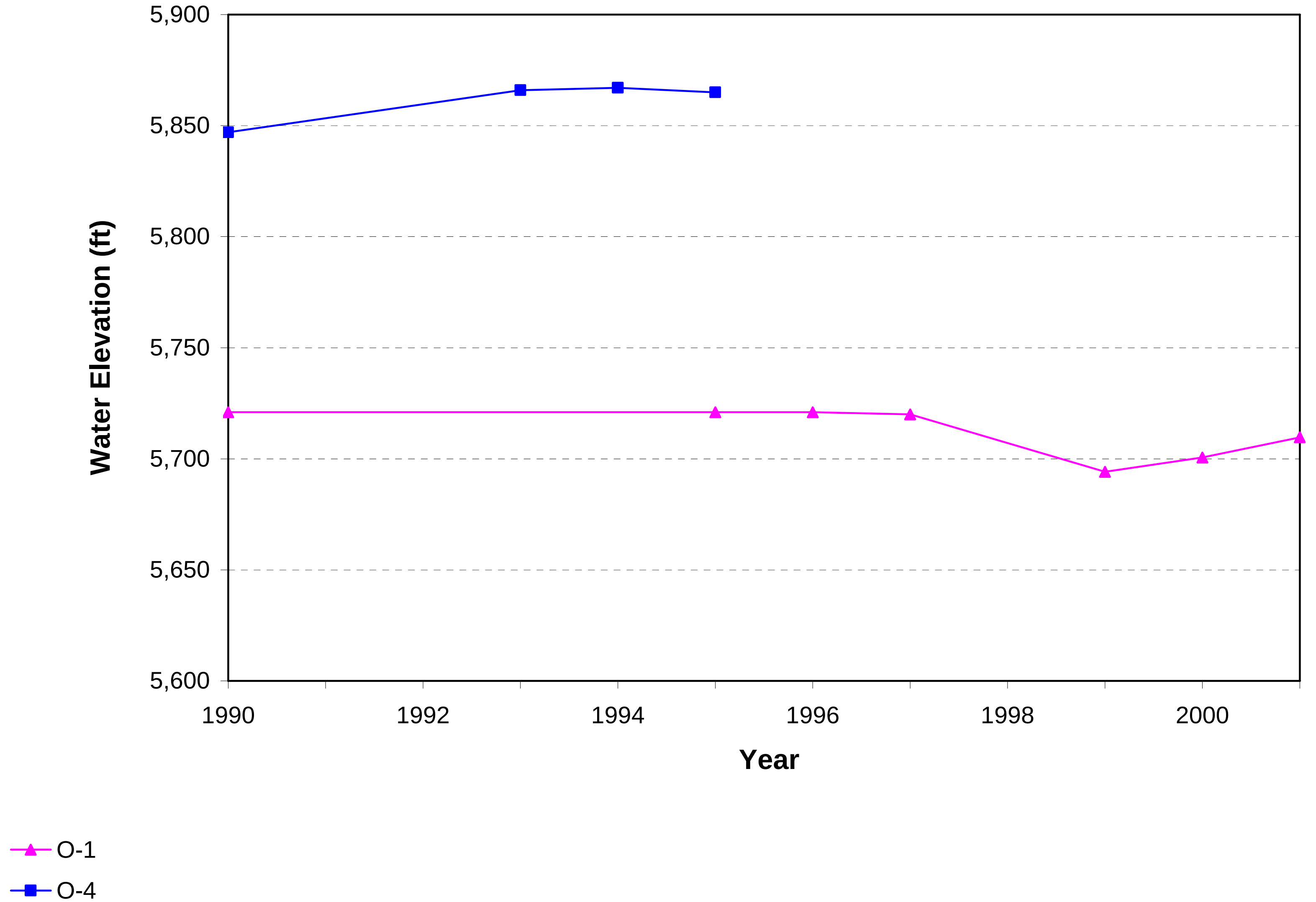

LOS ALAMOS COUNTY WATER PLAN

Average Annual Non-Pumping Water Levels
Otowi Well Field

Figure 3-6

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Table 3-4. Average Supply Well Water Level Declines

Well	Well Depth (ft)	Year	Average Water Level (ft msl)	Water Level Change (ft)	Years of Record	Average Decline (ft/yr)
PM-1	2499	1970	5774.0	–13.5	28	–0.48
		1998	5760.5			
PM-2	2300	1965	5892.0	–32.4	36	–0.90
		2001	5859.6			
PM-3	2552	1966	5900.0	–40.5	32	–1.26
		1998	5760.5			
PM-4	2874	1982	5870.0	–28.5	19	–1.50
		2001	5841.5			
PM-5	3092	1982	5887.0	–30.6	18	–1.70
		2000	5856.4			
Pajarito Well Field Average						**–1.17**
G-1	2000	1950	5778.0	–79.0	47	–1.68
		1997	5699.0			
G-1A	1519	1955	5749.0	–43.6	46	–0.95
		2001	5705.4			
G-2	1980	1951	5797.0	–98.8	47	–2.10
		1998	5698.2			
G-3	1800	1951	5858.0	–121.0	49	–2.47
		2000	5737.0			
G-4	1940	1951	5872.0	–11.0	47	–0.23
		1998	5861.0			
G-5	1850	1951	5892.0	–45.0	43	–1.05
		1994	5847.0			
G-6	1530	1964	5841.0	–2.4	34	–0.07
		1998	5838.6			
Guaje Well Field Average						**–1.22**
O-1	2497	1990	5721.0	–11.3	11	–1.03
		2001	5709.7			
O-4	2595	1990	5847.0	18.0	5	3.60
		1995	5865.0			
Otowi Well Field Average						**1.29**
G-2A	1980	1998	5821.6	–70.9	3	–23.63
		2001	5750.7			
G-3A	1980	1998	5815.2	–110.7	3	–36.90
		2001	5704.5			
G-4A	1980	1998	5847.3	–63.3	3	–21.10
		2001	5784.0			
G-5A	1980	1998	5863.3	–14.9	3	–4.96
		2001	5848.4			
Guaje Well Field Replacement Wells Average						**–21.65**

ft = Feet ft msl = Feet above mean sea level ft/yr = Feet per year

Table 3-5. Average Test Well Water Level Declines

Well	Well Depth (ft)	Date	Water Level (ft msl)	Water Level Change (ft)	Years of Record	Average Change (ft/yr)
TW-1	642	11/02/1992	5834.39	+20.41	13.3	+1.54
		02/06/2006	5854.80			
TW-2	834	11/09/1992	5856.52	–11.01	8.0	–1.38
		10/30/2000	5845.51			
TW-3	815	08/04/1992	5851.73	–11.42	13.5	–0.85
		02/01/2006	5840.31			
TW-4	1205	07/20/1992	6072.56	–0.82	13.5	–0.06
		02/01/2006	6071.74			
TW-8	1065	10/23/1992	5881.89	–6.77	13.3	–0.51
		02/03/2006	5875.12			
DT-5A	1821	04/23/1993	5961.51	–3.46	12.4	–0.28
		09/21/2005	5958.05			
DT-9	1501	11/20/1992	5920.89	–5.02	13.1	–0.38
		12/22/2005	5915.87			
DT-10	1409	04/09/1993	5923.61	–3.98	12.9	–0.31
		02/14/2006	5919.63			
Test Wells Average Change (excluding TW-1)						**–0.54**

ft msl = Feet above mean sea level ft/yr = Feet per year

Water level data from pressure transducers operated in numerous regional aquifer monitor wells installed as part of LANL's Hydrogeologic Work Plan (1998) implementation were used to plot hydrographs for these wells. The locations of the R-wells are shown in Figure 3-3, and the R-well hydrographs are provided in Appendix A2. Data are provided for 25 R-wells, 12 of which are single-screen completions and 13 are multiple-screen completions. The hydrographs in Appendix A2 show water level data from a total of 35 separate screens in the multiple-screen R-wells. Although most of the screens in these wells are completed in the regional aquifer, some of the upper screens intercept overlying intermediate-depth perched groundwater horizons. Screen information for the multiple-screen R-wells is shown in Table 3-6

While most of the R-well hydrographs show relatively steady water levels over time, a few—notably R-19, R-20, and R-32, all multiple-screen wells—exhibit fluctuating water levels to varying degrees. At these locations, the regional aquifer appears to be more responsive to aquifer stresses and recharge conditions than is apparent in the other R-wells.

Table 3-6. Regional Aquifer Monitor Well Screen Information
Page 1 of 2

Well	Screen Number	Screen Depth (ft)	Aquifer Type	Status
R-5	1	326.4	Intermediate	Dry
	2	372.8	Intermediate	Functional
	3	676.9	Regional	Functional
	4	858.7	Regional	Functional
R-7	1	363.2	Intermediate	Dry
	2	730.4	Intermediate	Dry
	3	895.5	Regional	Functional
R-8	1	705.3	Regional	Functional
	2	821.3	Regional	Functional
R-12	1	459	Intermediate	Functional
	2	504.5	Intermediate	Dry
	3	801	Regional	Functional
R-14	1	1,201	Regional	Functional
	2	1,287	Regional	Functional
R-16	1	641	Intermediate	Cased off
	2	863.4	Regional	Functional
	3	1,015	Regional	Functional
	4	1,237	Regional	Functional
R-19	1	827.2	Intermediate	Dry
	2	893.3	Intermediate	Functional
	3	1,171	Regional	Functional
	4	1,410	Regional	Functional
	5	1,583	Regional	Functional
	6	1,727	Regional	Functional
	7	1,832	Regional	Functional
R-20	1	904.6	Regional	Functional
	2	1,147	Regional	Functional
	3	1,329	Regional	Functional
R-22	1	872.3	Regional	Functional
	2	947	Regional	Functional
	3	1,272	Regional	Functional
	4	1,378	Regional	Functional
	5	1,447	Regional	Functional
R-25	1	737.6	Intermediate	Functional
	2	882.6	Intermediate	Functional
	3	1,055	Intermediate	Dry

Table 3-6. Regional Aquifer Monitor Well Screen Information
Page 2 of 2

Well	Screen Number	Screen Depth (ft)	Aquifer Type	Status
R-25 (cont.)	4	1,185	Intermediate	Functional
	5	1,295	Regional	Functional
	6	1,405	Regional	Functional
	7	1,605	Regional	Functional
	8	1,795	Regional	Functional
	9	1,895	Regional	Functional
R-26	1	651.8	Intermediate	Functional
	2	1,422	Regional	Clogged screen
R-31	1	439.1	Intermediate	Dry
	2	515	Regional	Functional
	3	666.3	Regional	Unreliable pressure
	4	826.6	Regional	Unreliable pressure
	5	1,007	Regional	Unreliable pressure
R-32	1	867.5	Regional	Functional
	2	931.8	Regional	Functional
	3	927.9	Regional	Functional

An analysis of the single-screen R-well water levels for wells with more than 1 year of data is provided in Table 3-7. These data show a pattern of water level decline in the regional aquifer generally similar to that seen in the test well data, with an average decline of about 0.4 ft/yr.

Table 3-7. Average Regional Aquifer Monitor Well Water Level Declines

Well [a]	Well Depth (ft)	Date	Water Level (ft msl)	Water Level Change (ft)	Years of Record	Average Change (ft/yr)
R-9	758	02/28/2000	5694.80	–2.92	5.85	–0.50
		01/04/2006	5691.88			
R-13	1018	02/25/2002	5839.05	–2.64	3.71	–0.71
		11/10/2005	5836.41			
R-15	1031	09/06/1999	5856.20	–5.78	6.18	–0.94
		11/10/2005	5850.42			
R-21	907	03/31/2004	5854.30	–0.13	1.63	–0.08
		11/17/2005	5854.17			
R-23	873	10/08/2002	5699.45	–1.45	3.19	–0.46
		12/15/2005	5698.00			
R-28	958	12/09/2003	5839.61	+0.04	1.15	+0.03
		02/01/2005	5839.65			
Single Screen Regional Aquifer Monitor Wells Average Change						**–0.44**

[a] Wells with more than 1 year of water level data

3.2 Risks to Water Supply

Potential risks to the groundwater resource for Los Alamos County fall into two main categories: aquifer depletion and groundwater contamination. Sections 3.2.1 and 3.2.2 provide an analysis of these risks. Risks related to the legal ability to use the water supply are discussed in Section 4.

3.2.1 Aquifer Depletion Risk

Long-term water level data from supply wells indicate a rate of decline of about 1.2 to 1.3 ft/yr, though the replacement wells in the Guaje well field have shown somewhat more substantial declines during their short-term record (Table 3-4). Beyond the immediate influence of pumping wells, data from the test wells and regional aquifer monitor wells indicate a lower average rate of decline of about 0.5 ft/yr (Tables 3-5 and 3-7). Though the average rate of decline appears modest on an annual basis, some supply wells have experienced total water level declines in excess of a hundred feet since the inception of nearly 50 years of pumping (Table 3-4).

Using water level data, Rogers et al. (1996) estimated the volume of groundwater depletion from supply well production between 1949 and 1993 to be between 4.0×10^{10} and 6.0×10^{10} gallons (123,000 and 184,000 acre-feet), compared to total pumping withdrawals of 5.7×10^{10} gallons (175,000 acre-feet) during the same period. This analysis implies that recharge to the regional aquifer during this period was negligible and that production well pumping was essentially mining the aquifer. However, the recovery of water levels in wells that were not pumped for extended periods was cited by McLin et al. (1996) as evidence that recharge has occurred. Water levels can recover without recharge as the cone of depression that develops during pumping re-equilibrates, however, and it should be noted that the recharge estimates presented in Table 3-1 are on the same order as pumping withdrawals.

Even if net recharge is negligible, considering a demonstrated saturated thickness of at least 1900 feet penetrated in supply well PM-5 and potentially as much as 10,000 feet of Santa Fe Group sediments underlying the plateau (Section 3.1), a continuation of the observed rates of decline does not represent a substantial imminent or foreseeable risk to the water supply. Barring potential water quality issues, continued pumping of the regional aquifer at current rates is likely to be sustainable for hundreds of years. LANL's Española Basin and Pajarito Plateau Regional Flow Model predicts that water levels will continue to decline at the same rate (with the same production level) and can be sustained for hundreds of years (Keating, 2006). However, poorer quality of water is expected as wells begin to draw from greater depths.

Vesselinov and Keating (2002) determined that the regional aquifer beneath the plateau is also impacted by pumping from the Buckman well field by the City of Santa Fe. They used LANL's groundwater model of the Española Basin to determine the three-dimensional capture zone of the Buckman well field under steady-state conditions. The results of the study indicated that the well field capture zone extends beneath the Pajarito Plateau and that, of the water produced from the Buckman wells, 39 percent was from the regional aquifer east of the Rio Grande, 27 percent was from captured river recharge, and 34 percent was from the regional aquifer west of the river. Based on the average annual total pumping rate from the Buckman well field during the period 1997 through 2001 of 4,889 acre-feet per year (ac-ft/yr), this distribution results in an annual depletion of approximately 1,662 acre-feet from the regional aquifer beneath the Pajarito Plateau due to Buckman groundwater withdrawals.

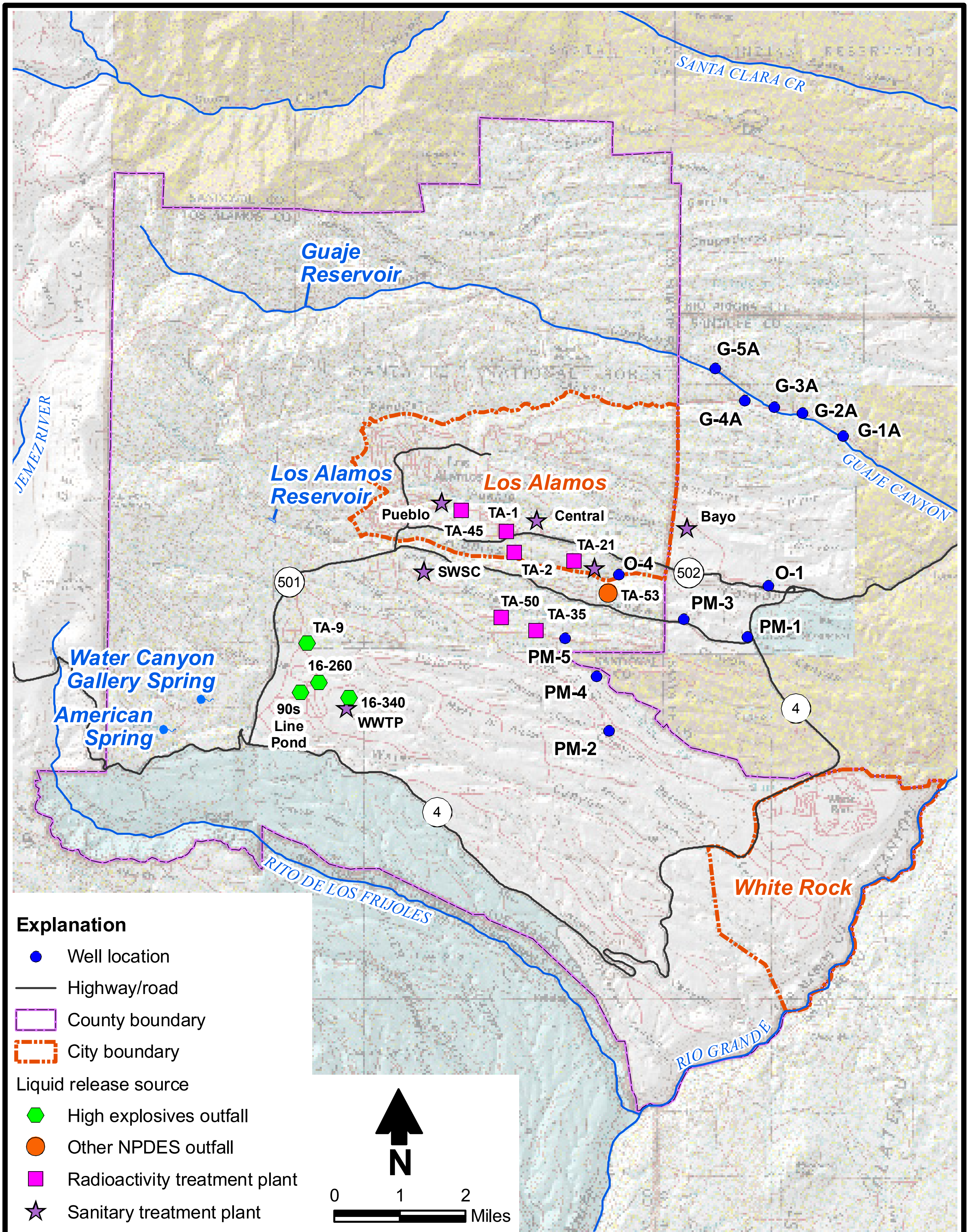
Whereas pumping withdrawals from the Los Alamos supply wells averaged about 3,975 ac-ft/yr from 1949 through 1993, the additional impact of the Buckman withdrawals at their current rate is unlikely to significantly impact the rate of decline of the regional aquifer water table beneath the county. If users other than Los Alamos County and the City of Santa Fe begin pumping in the area, the cumulative impacts in relation to water levels and saturated thickness will need to be evaluated.

3.2.2 Contamination Risk

Since the early 1940s a wide array of chemicals have been released into the canyons of the Pajarito Plateau from various LANL operations. These releases have occurred through effluent discharges from water treatment facilities and other miscellaneous sources such as sanitary septic systems, and cooling towers, and runoff from firing sites and other laboratory facilities. Figure 3-7 shows the locations of liquid waste disposal sites at LANL.

The presence of contaminants in groundwater in Los Alamos County is primarily associated with areas where effluent discharges have led to enhanced infiltration. The chemical properties of each contaminant control the degree to which they move into the subsurface. Reactive chemicals have a tendency for adsorption (adhesion of dissolved molecules to the surfaces of solids), limiting their movement in groundwater, while conservative or non-reactive chemicals tend to move readily in groundwater. Examples of contaminants released from LANL facilities are:

- Reactive contaminants include strontium-90, americium-241, cesium-137, plutonium-238, and plutonium-239,-240 (LANL, 2005a). These contaminants persist at elevated levels in the alluvial system but are not observed in the intermediate and



Source: LANL, 2005a, Figure 3-12

LOS ALAMOS COUNTY WATER PLAN

Major Liquid Release Sources

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Figure 3-7

regional aquifers due to their adsorptive behavior, which limits their mobility in groundwater. Figure 3-8 shows the locations of plutonium detected in perched groundwater. Because plutonium is very absorptive, the risk of it migrating to public supply wells is low.

- Non-reactive contaminants include chromium, tritium, nitrate, perchlorate (an oxidizer), and RDX (a component of explosives, also known as cyclotrimethylenetrinitramine, cyclonite, hexogen, and T4). These chemicals are highly mobile and are observed in groundwater within perched intermediate zones and the regional aquifer beneath several canyons including Cañon de Valle, Los Alamos Canyon, Mortandad Canyon, Pueblo Canyon, and Sandia Canyon (LANL, 2005a).

Most contaminants present in groundwater in Los Alamos County have concentrations largely below regulatory standards.

3.2.2.1 Transport Velocities and Travel Times

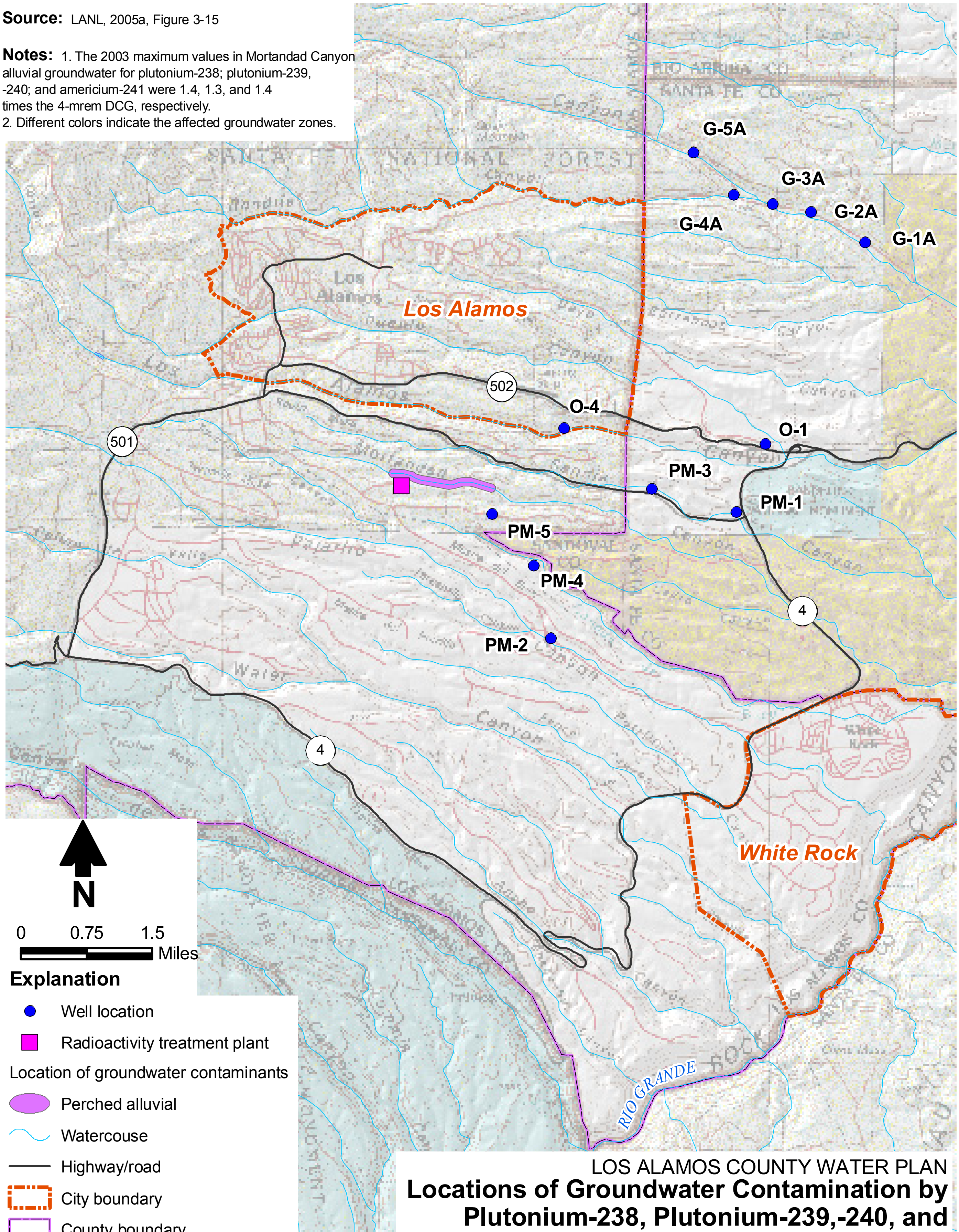
Numerous pathways for potential contaminant transport are present throughout the Pajarito Plateau. Transport modes for contaminants from the surface to the regional aquifer vary according to the hydrogeologic setting and include:

- Matrix flow through nonwelded and poorly welded tuffs (mesa tops and dry canyons)
- Fracture flow through welded tuffs (mountain front and Pajarito Fault zone)
- Fracture flow through dense basalts (Cerros del Rio basalt outcrop at low-head weir)
- Matrix flow through brecciated basalts (perched intermediate aquifers)
- Infiltration from wet canyons (Los Alamos Canyon, Pueblo Canyon, Mortandad Canyon, Sandia Canyon, Cañon de Valle)

Transport velocities are also highly variable throughout the plateau. Infiltration beneath dry canyons and mesa tops is estimated at about 1 millimeter per year (mm/yr) to a few mm/yr, resulting in travel times to the regional aquifer of several hundreds to thousands of years (Birdsell et al., 2005). On the other hand, fracture flow through fractured tuffs or basalts is likely to be comparatively rapid. For example:

Source: LANL, 2005a, Figure 3-15

Notes: 1. The 2003 maximum values in Mortandad Canyon alluvial groundwater for plutonium-238; plutonium-239, -240; and americium-241 were 1.4, 1.3, and 1.4 times the 4-mrem DCG, respectively.
2. Different colors indicate the affected groundwater zones.



LOS ALAMOS COUNTY WATER PLAN

Locations of Groundwater Contamination by Plutonium-238, Plutonium-239,-240, and Americium-241 Above DOE Derived Concentration Guide for Drinking Water

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05/09/2006

JN WR05.0168

Figure 3-8

M:/PROJECTS/WR05.0168_LOS_ALAMOS_COUNTY_WATER_PLAN/GIS/MXDS/PLUTONIUM_ABOVEDOE.MXD 609050

- Perched groundwater occurring in a brecciated basalt at 180 to 230 feet deep in well R-9 in lower Los Alamos Canyon exhibits tritium concentrations that indicate a travel time of no more than a few decades (Broxton et al., 2001).

- An example of relatively rapid vertical transport from a wet canyon is seen in Mortandad Canyon, where core samples from the R-15 and MCOBT-8.5 boreholes indicate that nitrate has moved to a depth of at least 328 feet in the vadose zone in approximately 40 years (Birdsell et al., 2005).

- Elevated nitrate (approximately 1.5 mg/L nitrate as nitrogen) was also detected at a depth of 1,007 feet in the regional aquifer in a sample collected from R-15 in August 1999. Assuming that the source of nitrate is discharge from the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) that began operation in 1963, these data suggest a minimum vertical transport velocity of approximately 30 ft/yr.

- An example of elevated transport velocities possible in fracture-dominated flow through tuff was shown by a tracer test conducted from a discontinued outfall pond at TA-16 in 1997. After only 4 months, the tracer was detected in a spring located 984 feet laterally and 108 feet vertically downgradient from the outfall pond (LANL, 1998). These data indicate that transport velocities for lateral and vertical transport exceeding 2,900 ft/yr and 300 ft/yr, respectively, are possible for fracture flow through welded tuffs.

As discussed in Sections 3.1.2 and 3.1.3, hydrogeologic conditions for transport of contaminants that may reach the regional aquifer favor lateral movement, generally eastward toward the Rio Grande. Localized influences from production wells are likely to perturb this pattern somewhat. As noted in Section 3.1.3, water table gradients in the central and eastern portions of the county vary between 0.0026 and 0.04. Hydraulic conductivities determined from aquifer tests in wells screened in the Santa Fe Group or Puye Formation generally range between 0.25 and 5.0 feet per day (ft/d) (Tables 3-2 and 3-3). Assuming an average porosity of 0.1 and applying Darcy’s Law, a plausible range of pore-water velocity (the speed at which a conservative or non-sorbing solute travels) may be obtained by applying the equation:

$$v = \frac{K}{n_e} \frac{dh}{dl}$$

where v = pore water velocity

K = hydraulic conductivity

n_e = effective porosity

dh/dl = the hydraulic gradient

Applying the minimum gradient and hydraulic conductivity yields a pore water velocity of 2.4 ft/yr, while applying the maximum gradient and hydraulic conductivity yields a pore water velocity of 730 ft/yr. Thus the range of uncertainty for contaminant transport travel times through the regional aquifer is potentially large.

Vesselinov (2005) evaluated potential fast contaminant flow paths in the regional aquifer from the vicinity of well TW-1 to Spring 2B in White Rock Canyon. The aquifer units present in this vicinity include the Puye Formation and the Totavi Lentil, both highly permeable units. Using a hydraulic gradient of 0.02, a hydraulic conductivity of 27.9 ft/d, and an effective porosity of 0.1 resulted in a pore water velocity of 2,024 ft/yr. Based on this analysis, the mean advective travel time over the approximately 19,700-foot distance from TW-1 to Spring 2B is approximately 10 years.

Compounding the overall uncertainty of transport velocity analyses for the regional aquifer is the fact that the effective porosity of the regional aquifer is uncertain. It is therefore difficult to constrain regional aquifer transport velocity and contaminant travel times beyond the extrapolation of a fairly large range of values as described above.

Activities conducted under the hydrogeologic work plan (LANL, 2005a) confirm the conundrum of estimating flow velocities and travel times because any model is very dependent on the conceptualization of the hydrogeology. The LANL researchers state that if the conceptual model as currently understood is correct, then “contaminants would travel laterally in the phreatic zone and arrive at springs discharging at the Rio Grande.” They further suggest that this conceptual model of flow paths is influenced by the pumping wells and that the Pajarito Mesa wells could capture contaminants that reach the regional aquifer.

The LANL (2005a) report summarizes vadose zone modeling that shows the highest infiltration rates along canyon bottoms. Rapid travel times (less than 100 years) to the water table are present in Pajarito Canyon near White Rock, Canon de Valle, Mortandad Canyon at the TA-50 RLWTF, middle and lower Los Alamos Canyon, and Pueblo and Guaje Canyons (LANL, 2005a, p. 4-6). The report (LANL, 2005a, p. 4-50) further indicates that travel times to PM-4 could be less than 100 years as simulated by the most current hydrologic models of the Pajarito Plateau. Using a simple Darcy's Law analysis of an isotropic, uniform gradient, Purtymun (1984) estimated that the travel time from west to east across LANL would be 134 years.

3.2.2.2 Potential for Cross Contamination Between Aquifers

The possibility of cross contamination between perched aquifers and the regional aquifer during well drilling exists primarily when open borehole conditions are maintained over an extended period of time. Recent characterization well drilling by LANL has incorporated procedures to minimize this risk. When a perched zone of saturation is encountered above the regional aquifer, that zone is sealed off by setting well casing with bentonite and/or cement prior to advancing the borehole to the regional aquifer. This procedure ensures that the borehole does not provide a pathway for migration of potentially contaminated perched groundwater to the regional aquifer. In some cases, the productivity of a perched aquifer encountered during drilling was so low that the water that drained from the perched aquifer was imbibed into the borehole wall a short distance below the perched saturation zone. In these cases, the potential for cross contamination was considered to be negligible and the perched zone was not sealed off.

Cross contamination between aquifers during well drilling by LANL has been verified in only one case, in well R-25 where numerous well construction problems and the Cerro Grande fire led to open hole conditions from July 1998 to October 2000. It is possible that cross communication between aquifers may also be an issue with older test wells and supply wells, but further study will be necessary to determine whether this is the case.

3.2.2.3 Comparison to EPA Standards

An initial assessment of potential contaminants of concern for the regional aquifer was made by querying LANL's water quality database (WQDB) for all detected constituents exceeding the Environmental Protection Agency (EPA) primary drinking water standards in wells screened in the regional aquifer. Those results for the regional aquifer monitor wells, supply wells, and test wells are shown in Appendix A3. Although the regional aquifer results include data from several multiple-screen wells that also have screens in intermediate-depth perched aquifers, it is appropriate to consider these data, as the presence of contaminants in the intermediate perched aquifers presents an imminent risk to the underlying regional aquifer.

The WQDB contains an immense quantity of data that have undergone varying degrees of evaluation, have a variety of provenances, and oftentimes have various qualifying conditions. Consequently, a significant amount of interpretation is sometimes necessary to determine the validity of the reported results. The following discussion provides such an interpretation.

Table A3-1 shows a substantial number of EPA drinking water standard exceedances for several metals, including antimony, arsenic, beryllium, chromium, copper, lead, mercury, nickel, selenium, thallium, and uranium. The reported concentrations of these constituents appear suspiciously high within the context of historical data from groundwater sampling at LANL. Many of the exceedance sampling dates also appear to indicate early samples collected either during or shortly after the drilling of the respective well, and these early detections are not followed by similar levels in subsequent sampling events.

Table A3-2 also shows numerous exceedances for the same suite of metals in several supply wells, and likewise, many of those exceedances, primarily from the Guaje replacement wells, are early samples collected either during or shortly after drilling. A notable exception is arsenic in supply well G-1A, which exhibits a consistent record of exceedances over a 10-year period. Occasional exceedances of cadmium, thallium, and lead in the Pajarito well field, mostly in 1998, all of which are anomalous values that are not consistent with prior or subsequent data. These trace metal exceedances are all from unfiltered samples, so the metals results likely include suspended solids that may be present in the samples and are not necessarily representative of dissolved constituents.

Table A3-3 also shows numerous exceedances for the same suite of metals in several of the LANL test wells. All of these exceedances are also from unfiltered samples, so they again are not necessarily representative of dissolved constituents.

The elevated trace metals detections in the Pajarito supply wells and test wells may likely be related to elevated levels of iron oxide in these wells due to oxidation of their carbon steel well casings. Because iron oxide is an excellent sorbent, naturally occurring trace metals will become preferentially attached to the iron oxide particles and would appear to be abnormally elevated in unfiltered samples.

In order to further evaluate these data, time series plots for several metals detected in well R-9 samples were made (Appendix A3, Table A3-1). Both filtered and unfiltered sample results are plotted, along with non-detects (instances where the minimum detection level for the analysis was not exceeded). Filtered samples are most representative of dissolved constituents, whereas unfiltered samples include metals that are adsorbed onto suspended solids. This graph illustrates that the initially high levels for these metals in the samples collected in late 1997 and early 1998 dropped significantly in the subsequent sampling, and no detectable concentrations were found in most of these samples in 2004 and 2005.

Well R-9 was drilled during the period from September 1997 to February 1998 but was not completed as a well until October 1999. The early samples from 1997 and 1998 were thus collected from an uncompleted borehole rather than a developed well. These samples undoubtedly had high turbidity levels and were likely influenced by residual drilling mud. After the well was completed and developed, it appears that these influences were eliminated and the anomalous metal values then declined to minimal values or below detection as the well cleared up. This pattern suggests that a similar mechanism is responsible for the anomalously high metals detected in several other regional aquifer monitor wells and supply wells. A detailed discussion of a likely mechanism for drilling fluid impacts to water quality is provided in Section 3.2.2.3.

A time series plot of iron detections in test well samples was made to evaluate the likelihood that apparent elevated trace metals in unfiltered samples from wells with carbon steel casings can be associated with elevated iron oxide (Appendix A3, Figure A3-2). This graph clearly shows numerous detections of iron in these wells at levels as high as 57,000 parts per billion (ppb). These data support the premise that apparent trace metals exceedances in unfiltered samples from test wells and Pajarito supply wells are related to elevated levels of iron oxide in these wells due to oxidation of their carbon steel well casings and are not representative of dissolved constituents or groundwater quality.

Besides the anomalous metals detections, other questionable exceedances include:

- A few instances of organic chemical detections seen in the R-well data are also associated with either early sampling rounds conducted prior to well completion and development or are from screens that are likely to have drilling fluid impacts. Because of this association, these data may also be suspicious. At a minimum, the transitory nature of these detections does not suggest a significant contamination issue.

- Several instances of elevated phthalate levels are also present in the R-well data. Phthalate is a plasticizer and there is no known source for this contaminant from LANL operations. Therefore, these data are somewhat suspicious. One possible explanation for these detections is that they could be from plastic sample bottles with residual off-gassing that were not adequately rinsed prior to sample collection, or there may be some type of laboratory quality control issue involved. Several of the phthalate detections have lab qualifier J flags indicating analytical uncertainty for these values.

- High barium values detected in wells R-5 and R-9 are likely associated with the presence of drilling mud, in which barium sulfate is a major component.

- Occasional exceedances of gross alpha in well R-9 and the Buckman wells are not easily explained, but the R-9 detections may be related to abnormal concentrations of beryllium in some samples.

- Elevated nitrate in TW-1 is likely due to impacts of releases from the Bayo WWTP.

- Occasional strontium-90 exceedances in the test well data may be related to sorption onto iron oxide particles.

- Occasional tritium exceedances in the test well data are all from the 1970s or early 1980s and represent vestiges of historical LANL releases that have since been eliminated or substantially reduced.

The data include several detections of chromium in well R-28, located in Mortandad Canyon. This single-screen well is verified to be free of drilling fluid influences, and these detections are valid exceedances of the EPA drinking water standard of 100 ppb chromium. The issue of chromium contamination is discussed in more detail in Section 3.2.2.4.

3.2.2.4 Impact of Drilling Fluids

Recent concerns regarding the effect of residual drilling fluids on well chemistry at LANL have prompted close attention to this subject. A conceptual model for the chemistry of groundwater impacted by residual drilling fluids has been developed by LANL (Longmire, 2006). Organic-based drilling fluids provide a source of carbon that is consumed by microbes, creating reducing conditions in the well. These conditions increase the solubility of iron oxide, which provides an excellent sorbent for trace elements. As a result, metals that are naturally present in trace amounts appear to be highly concentrated by their association with iron oxide.

In order to test the applicability of this conceptual model to the R-well data, a time series plot of iron levels in well R-9 was produced (Appendix A3, Table A3-3). This graph clearly shows extraordinarily high iron levels in the early data, with some unfiltered samples exceeding 1 million ppb (the normal background level for iron in the regional aquifer is generally between 10 and 40 ppb [LANL, 2005b]). A similar pattern to that seen in other trace metals data (Figure A3-1) is present in the iron data as well (Figure A3-3), where levels have dropped off significantly in subsequent sampling rounds. These data support the conceptual model for abnormal metals values detected in wells impacted by drilling fluids.

LANL recently completed an assessment of the degree of impact by drilling fluids on the regional aquifer monitor wells using data from the three most recent sampling rounds (LANL, 2005c). This study demonstrated that most of the screens in the multiple-screen R-wells have been inadequately developed, leaving residual drilling fluids in the aquifer formation. Conversely, all of the 15 single-screen R-wells that were evaluated in this study have no detectable residual drilling fluids. The information in the LANL report was used to classify each of the detected exceedances in Table A3-1 with respect to drilling fluid influence. Where the data in Table A3-1 predate the data in the LANL report, an assessment was made as to the likelihood of drilling fluid influence based on patterns of declining concentrations similar to those seen in the R-9 data. As shown in Table A3-1, nearly all of the exceedances found in the EPA drinking water standard screen of the R-wells can be attributed to drilling fluid influences.

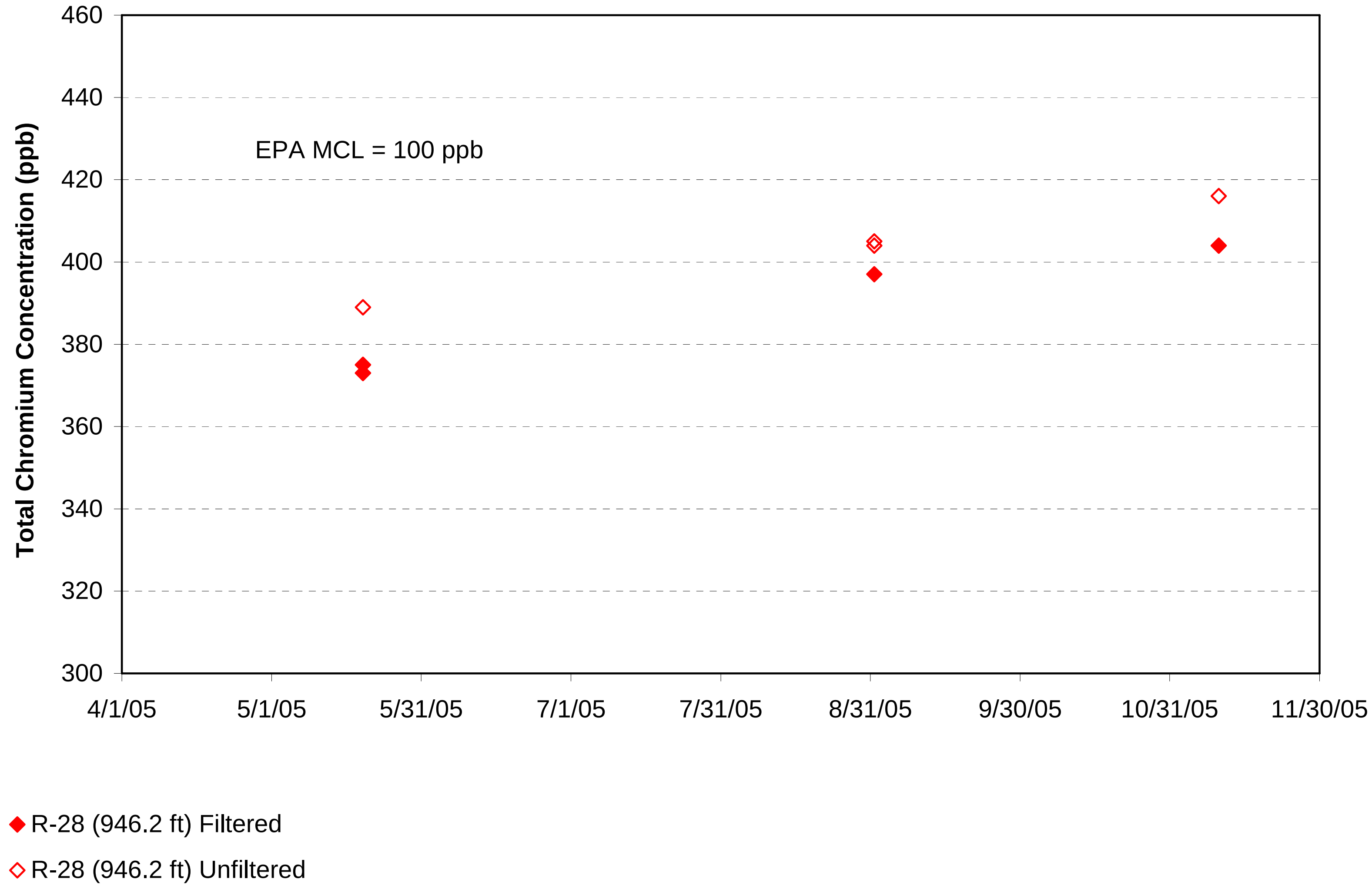
3.2.2.5 Chromium Contamination

As discussed in Section 3.2.2.2, several exceedances of EPA's chromium standard for drinking water (100 ppb) were observed in samples collected in 2005 from well-R-28. These data are plotted in Figure 3-9. This graph shows close agreement between the levels detected in both filtered and unfiltered samples, indicating that the detected chromium levels are predominantly dissolved concentrations. A consistent rising trend is also seen in these data, which suggests the presence of an advancing plume.

The results of a query of the LANL WQDB for chromium detections in regional aquifer wells are shown in Figure 3-10. This plot shows chromium detections in filtered samples from single-screen R-wells, which are known to be free of drilling fluid impacts. All these data fall below the EPA standard, and most detections are less than 5 ppb except for R-15 and R-11, where recent levels are about 7.5 ppb and 22 ppb, respectively. R-15 is located in Mortandad Canyon about 0.7 mile upgradient of R-28, while R-11 is located in Sandia Canyon about 0.25 mile northeast of R-28. The R-11 data show an increasing trend similar to the R-28 data.

The areal distribution of chromium detections in the regional aquifer is shown in Figure 3-11, which depicts averages of all chromium detections in regional aquifer wells. Discs plotted at each well location illustrate the relative differences in average chromium concentrations. It is apparent from this map that the primary location of chromium contamination in the regional aquifer, as defined by existing data, is near R-11 and R-28; all other locations exhibit average concentrations generally between 2 and 6 ppb, well below the drinking water standard.

Because contaminants present in intermediate-depth perched aquifers represent an imminent threat to the regional aquifer, the chromium results from intermediate wells were also queried for exceedances; the results of this query are shown in Figure 3-12, and the areal distribution of those detections is shown in Figure 3-13. The highest levels are observed in wells MCOI-4 and MCOI-6, located near well R-15 in Mortandad Canyon (Figure 3-3), with recent levels of about 29 ppb and 58 ppb, respectively. Similar increasing trends to those seen in the R-11 and R-28 data are also apparent in wells MCOI-4 and MCOI-6.



LOS ALAMOS COUNTY WATER PLAN

Detections of Chromium Above EPA MCL in Well R-28

Figure 3-9

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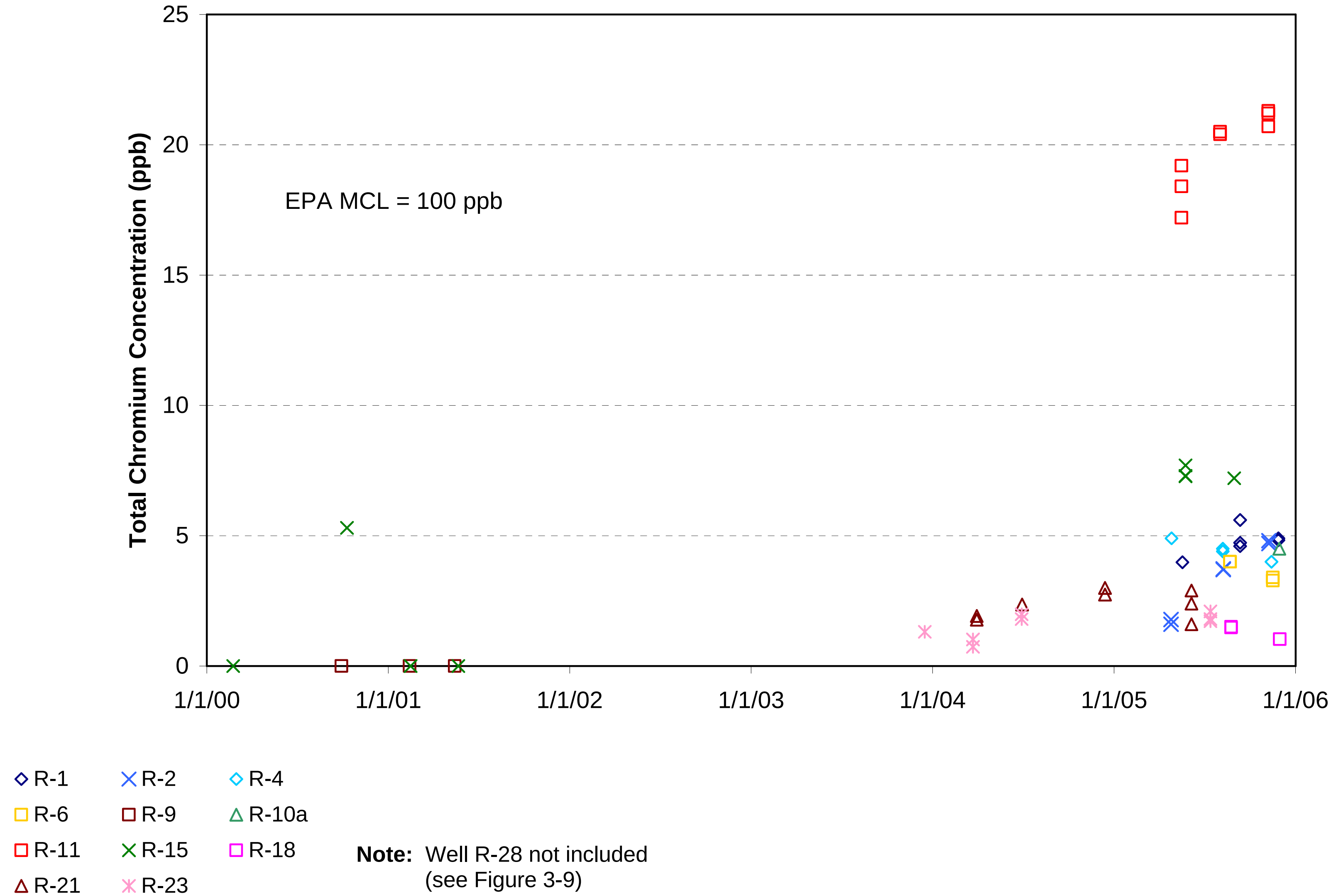

Note: Well R-28 not included (see Figure 3-9)

LOS ALAMOS COUNTY WATER PLAN

Detections of Chromium in Filtered Samples from Single-Screen Regional Aquifer Wells

Figure 3-10

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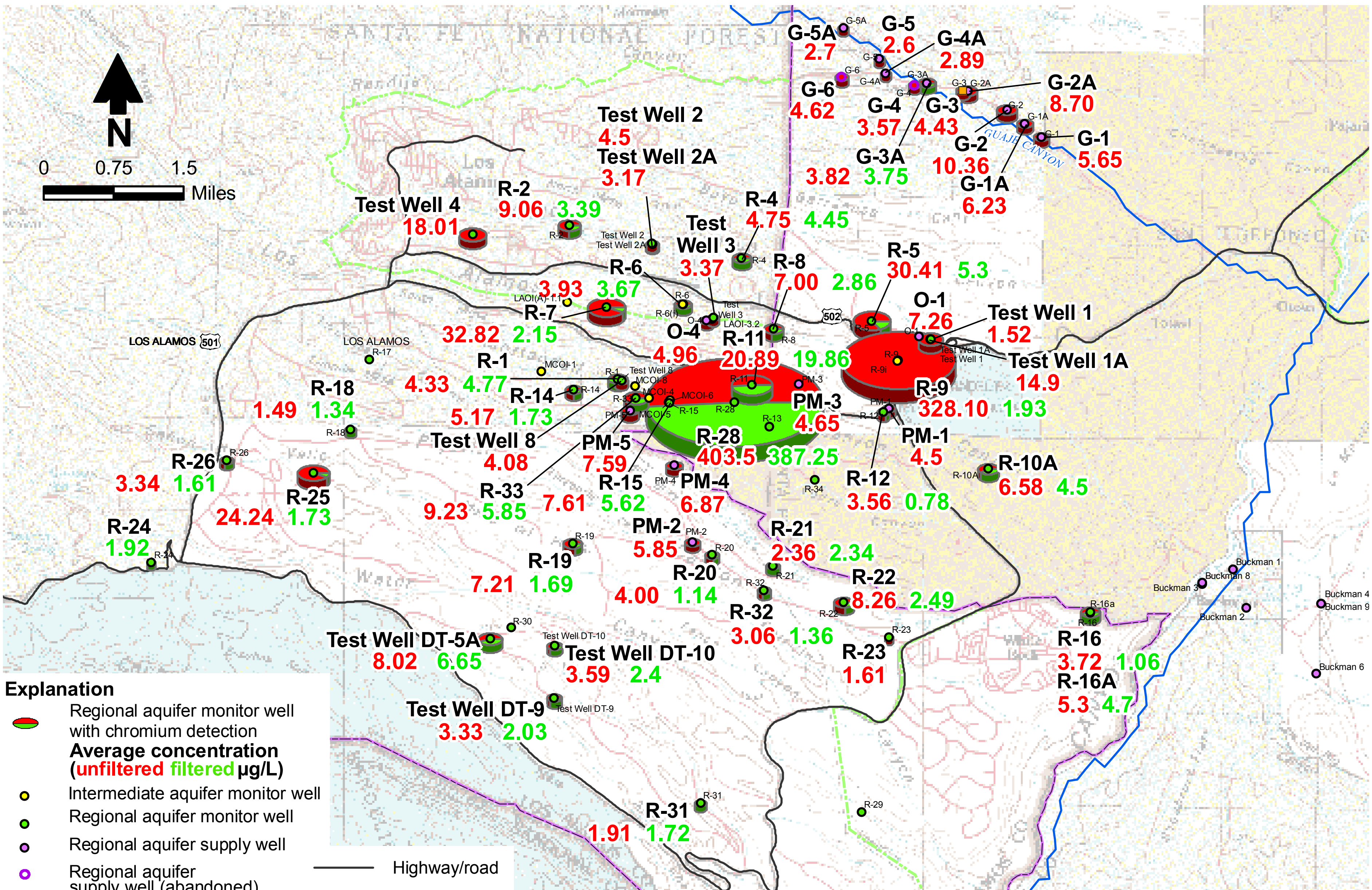

Explanation

- Regional aquifer monitor well with chromium detection
  Average concentration (unfiltered filtered µg/L)
- Intermediate aquifer monitor well
- Regional aquifer monitor well
- Regional aquifer supply well
- Regional aquifer supply well (abandoned)
- Regional aquifer observation well
- Highway/road
- County boundary
- City boundary

Note: Concentrations are an average of values from all port depths and sampling dates.

LOS ALAMOS COUNTY WATER PLAN

Chromium Concentrations (average) in Regional Groundwater

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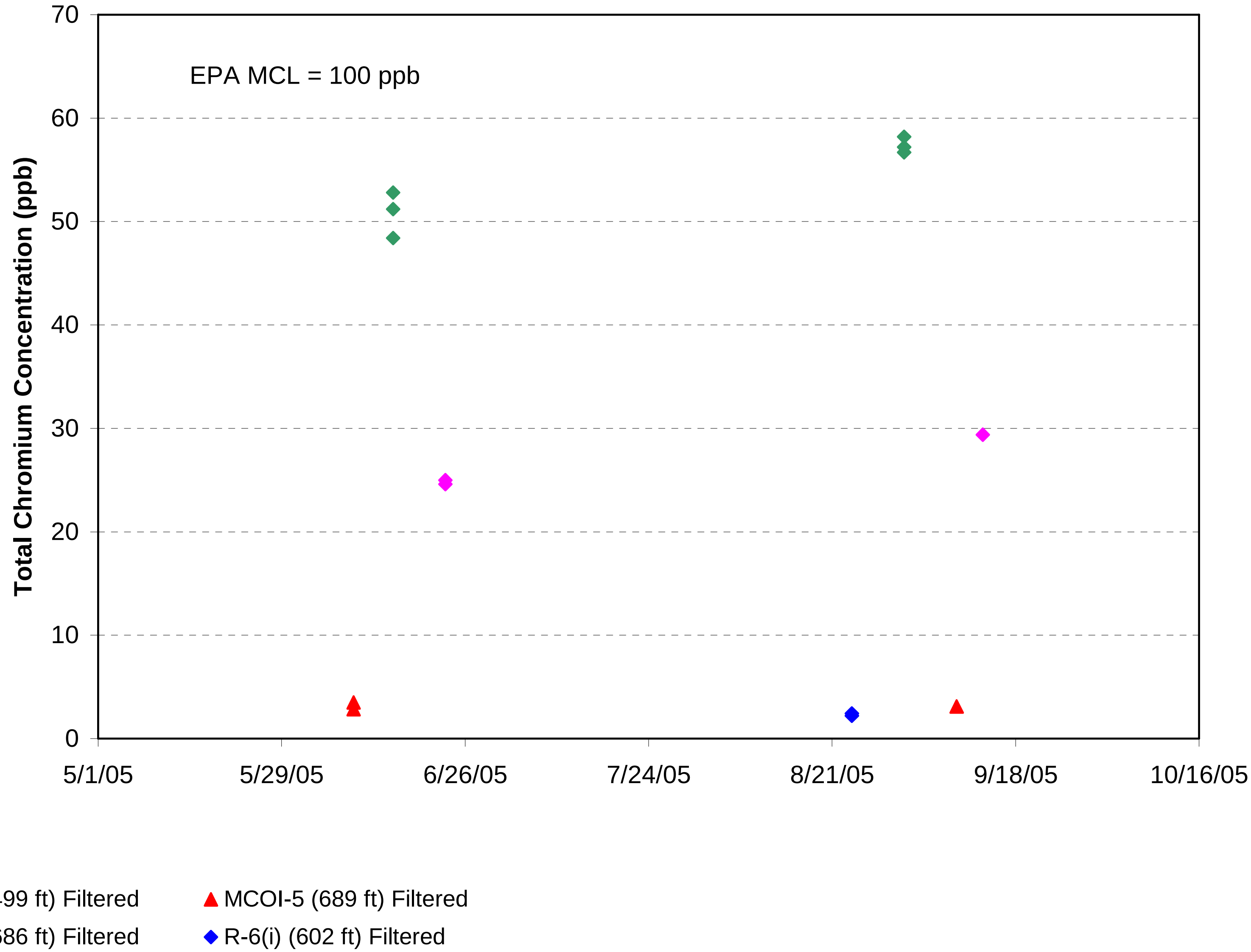
Figure 3-11



LOS ALAMOS COUNTY WATER PLAN

Detections of Chromium in Filtered Samples from Intermediate-Depth Perched Aquifer Wells

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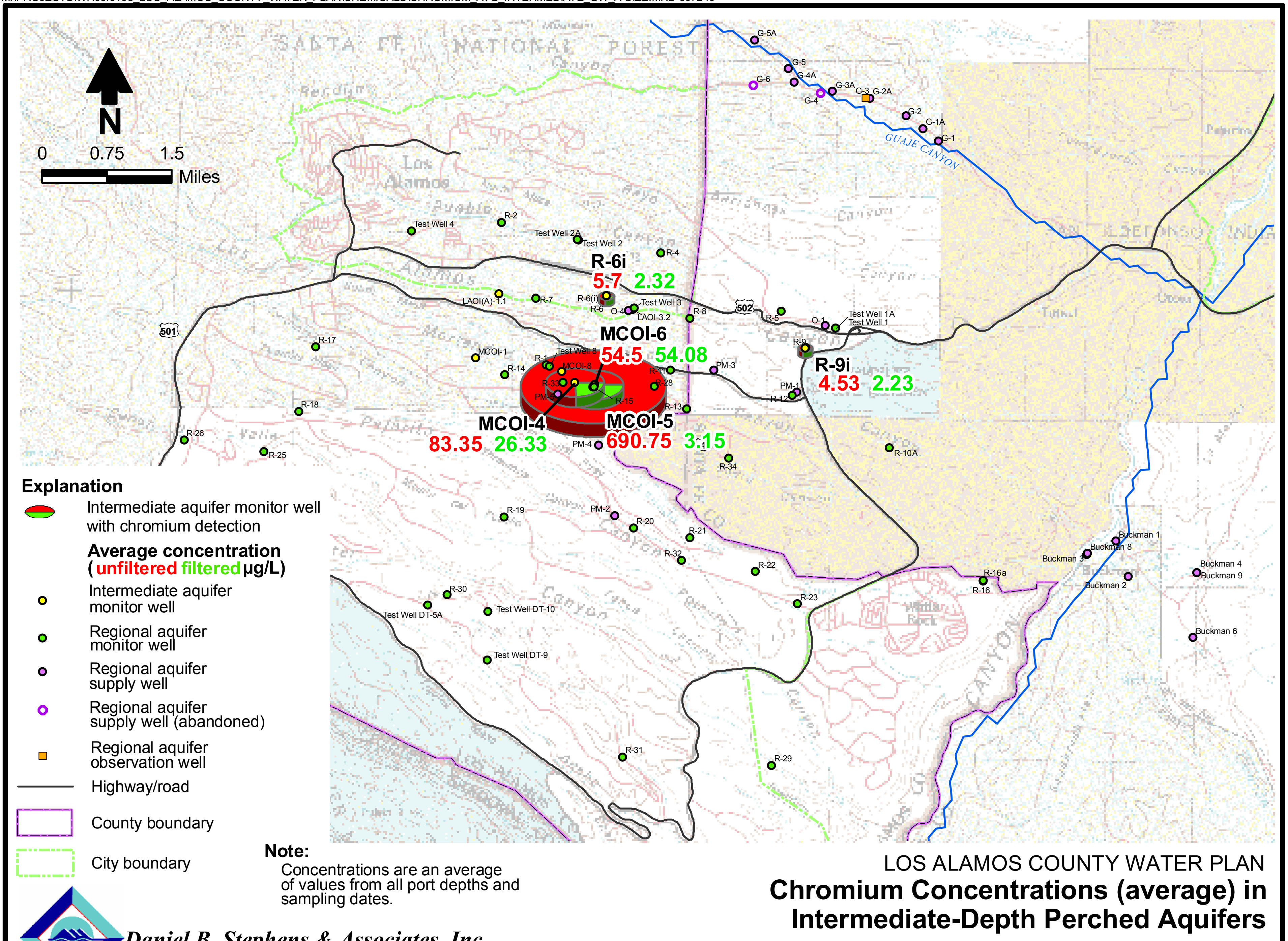
5/26/06

Figure 3-12



Note:
Concentrations are an average of values from all port depths and sampling dates.

LOS ALAMOS COUNTY WATER PLAN

Chromium Concentrations (average) in Intermediate-Depth Perched Aquifers

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04/27/2006
JN WR05.0168

Figure 3-13

The source of the chromium groundwater contamination is uncertain and is the subject of current investigations by LANL. However, it is thought likely to be from historical discharges from cooling towers where potassium dichromate was used as a descaler.

All of the plotted chromium concentrations presented in this report represent total chromium, which includes both Cr^{+3} (trivalent chromium) and Cr^{+6} (hexavalent chromium) species. Whereas Cr^{+3} is an essential nutrient for humans and occurs naturally in many foods, Cr^{+6} is known to cause various health effects including skin rashes, upset stomachs and ulcers, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material, and lung cancer. The results of recent testing by LANL indicate that the chromium in the R-28 groundwater samples exists predominantly in the hexavalent form (LANL, 2006b); thus the risk to the water supply is serious.

The most immediate risk with respect to chromium contamination to the County's water supply would appear to be supply well PM-3, which is located about ½ mile downgradient from R-28 (Figure 3-3). Because PM-3 supplies 80 percent of White Rock's water, potential contamination of this well is a concern. With possible travel times of several hundred feet per year (Section 3.2.2.1), it might appear that impacts at PM-3 are imminent if not already present. However, the screened interval in R-28 is from 934 to 958 feet deep, extending only 69 feet into the top of the regional aquifer, while PM-3 is screened at much greater depths (from 956 to 2532 feet) and therefore produces water from a much larger section of the aquifer. If the chromium plume were to reach PM-3 yet be confined to a shallow segment near the top of the aquifer, the concentration is likely to be highly diluted in the water produced from PM-3 because of the dilution effects of pumping a screened interval of more than 1500 feet. Zonal sampling using packers to seal off discrete depth zones would be required to ascertain with certainty whether the chromium plume has reached PM-3. Because of the current uncertainty in defining the vertical extent of the chromium plume, the potential impact on PM-3 is also uncertain. Nonetheless, the presence of chromium near the well represents a risk that should be carefully monitored.

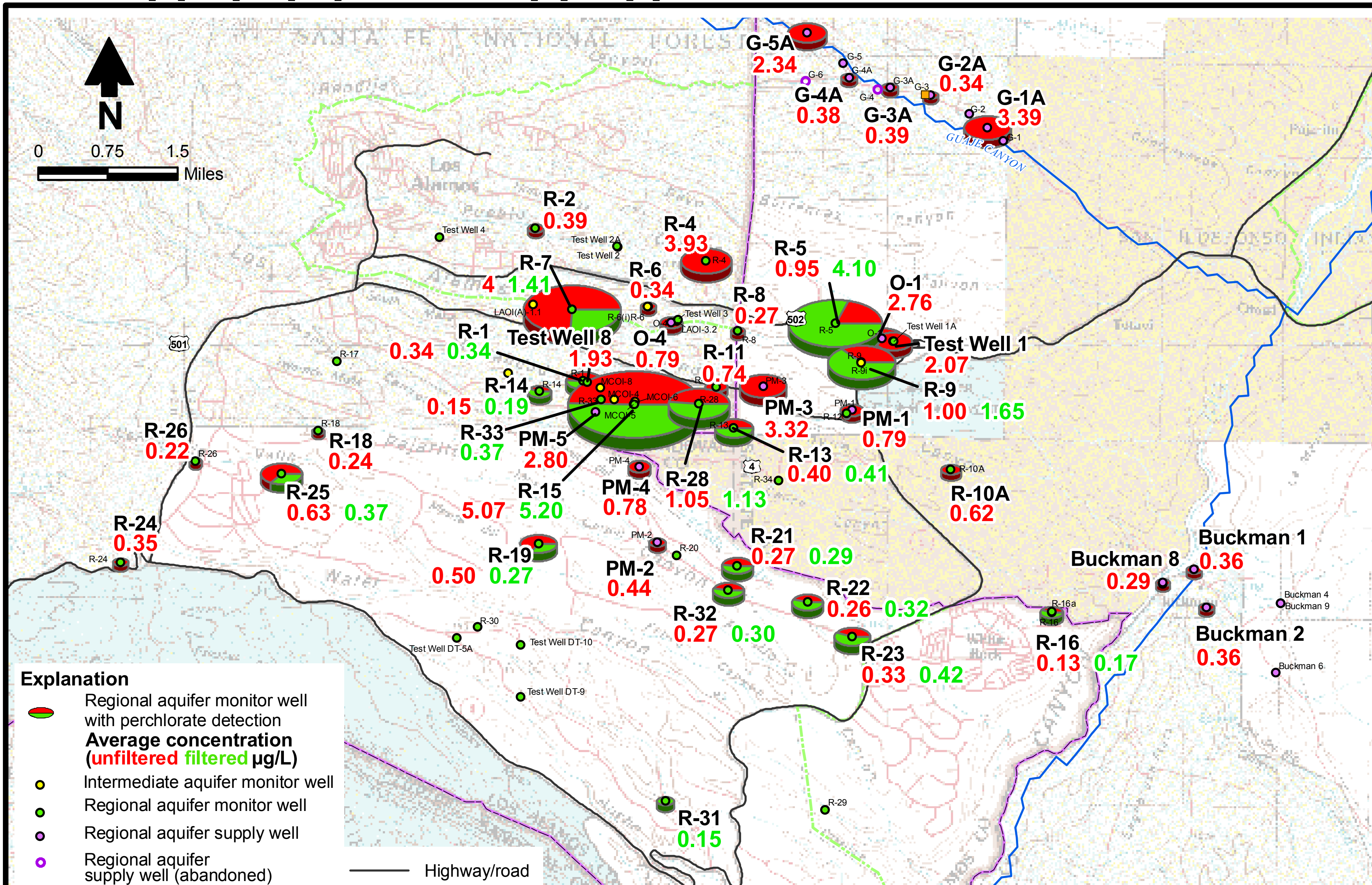
3.2.2.6 Perchlorate Contamination

Perchlorate is used as an energetics booster or oxidant in solid propellant for rockets and missiles. Perchlorate did not show up in the EPA drinking water standards screen because an official standard for this chemical has not been established. However, EPA has established an official reference dose (RfD) of 0.0007 milligrams per kilogram per day (mg/kg/day) of perchlorate (U.S. EPA, 2005), which translates to a drinking water equivalent (DWEL) of 24.5 ppb. The RfD is a scientific estimate of the maximum daily exposure level that is not expected to cause adverse health effects in humans and includes a ten-fold uncertainty factor. A DWEL assumes that all of a contaminant comes from drinking water and is therefore the concentration of a contaminant in drinking water that will have no adverse effect. Because a margin of safety is built into the RfD and the DWEL, exposures above the DWEL are not necessarily considered unsafe. However, other pathways for exposure are possible, such as food products, and therefore, the final MCL may be much lower than the DWEL. Because EPA has not set an MCL for perchlorate, the DWEL was used for this analysis as an indication of the potential order of magnitude for health risks. An action level of 4 ppb was set in the New Mexico Environment Department's (NMED's) Compliance Order on Consent issued March 1, 2005, which was based on an EPA Health Advisory that has since been withdrawn.

The results of a query of the LANL WQDB for perchlorate detections in regional aquifer wells are shown in Appendix A3 (Figure A3-4). Because perchlorate is a conservative (non-reactive) chemical, no distinction between filtered or unfiltered samples is made in the plotted data. As shown in this plot, most perchlorate detections in regional aquifer wells were below 1 ppb. The highest levels were observed in R-15 and R-4, where recent concentrations are about 7 ppb and 5 ppb, respectively. The areal distribution of average values for perchlorate detections in the regional aquifer is shown in Figure 3-14.

The results of a query of the LANL WQDB for perchlorate detections in supply wells are shown in Appendix A3 (Figure A3-5). All of the supply wells exhibit perchlorate concentrations below 0.4 ppb except for Otowi-1 which has had persistent detections between 1 ppb and 5 ppb since 2000. Recent results show levels slightly more than 2 ppb.

The results of a query of the LANL WQDB for perchlorate detections in intermediate-depth wells are shown in Appendix A3 (Figure A3-6). The highest levels are observed in MCOI-6, MCOI-4, and MCOI-5 for which recent levels are about 250 ppb, 150 ppb, and 100 ppb, respectively. A rising trend is apparent in MCOI-6. The areal distribution of average values for perchlorate detections in intermediate-depth perched aquifers is shown in Figure 3-15. Perchlorate



Note:
Concentrations are an average of values from all port depths and sampling dates.

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Perchlorate Concentrations (average) in Regional Groundwater

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Figure 3-14

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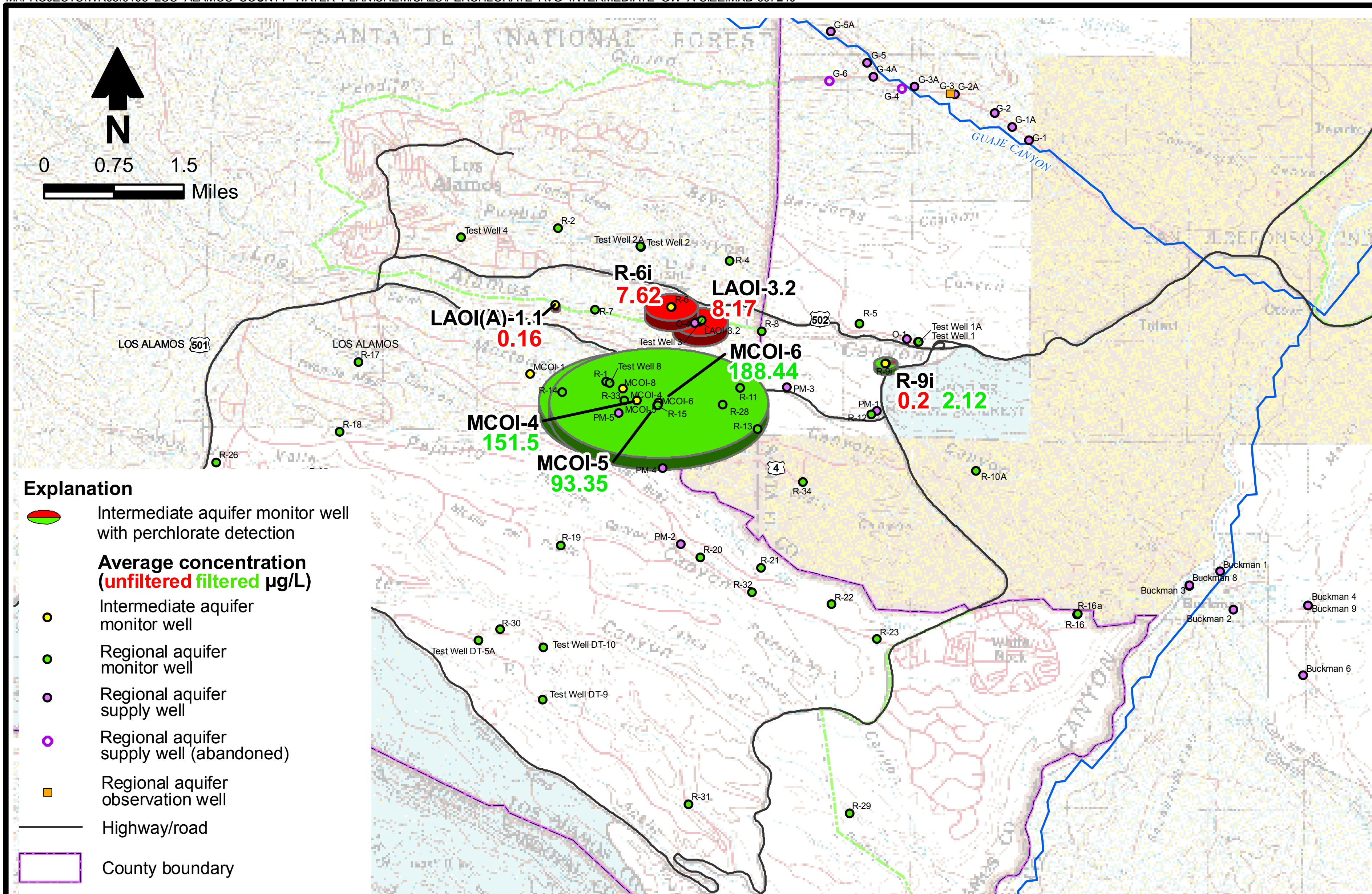

Note:

Concentrations are an average of values from all port depths and sampling dates.

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LOS ALAMOS COUNTY WATER PLAN

Perchlorate Concentrations (average) in Intermediate-Depth Perched Aquifers

Figure 3-15

occurrences in the intermediate-depth perched aquifers are primarily located in Mortandad Canyon, where the levels significantly exceed the EPA DWEL of 24.5 ppb. The perchlorate contamination present in the intermediate-depth aquifers in Mortandad Canyon thus poses a future risk to the regional aquifer in that area.

3.2.2.7 RDX Contamination

RDX, a component of explosives, is often used at LANL. RDX did not show up in the EPA drinking water standards screen because again, an official standard for this chemical has not been established. However, EPA has established a lifetime health advisory of 2 ppb. The lifetime health advisory is the maximum concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. To ascertain whether RDX might pose a health risk in Los Alamos County drinking water, RDX detections in groundwater were examined for this report.

The results of a query of the LANL WQDB for RDX detections in regional aquifer wells (Appendix A3, Figure A3-7) indicate that significant concentrations of RDX occur only in well R-25, where recent levels of about 50 ppb were detected in samples from an upper screen in an intermediate perched zone. The lower screen in the regional aquifer in this well shows a level of less than 1 ppb. Recent results from R-11 showed a level of 1.9 ppb RDX in the regional aquifer, just slightly under the EPA lifetime health advisory. Though RDX is apparently not a widespread current threat, these detections nonetheless indicate a potential future risk of contamination of the regional aquifer by this chemical.

3.2.2.8 Tritium Contamination

Though no recent detections of tritium in the regional aquifer have exceeded the EPA drinking water standard of 20,000 picoCuries per liter (pCi/L), the history of past substantial releases from LANL facilities prompted inclusion of this contaminant in DBS&A's analysis.

The results of a query of the LANL WQDB for tritium detections in regional aquifer wells (supply wells, single-screen monitor wells and test wells) are shown in Appendix A3. The supply well data (Figure A3-8) show that tritium levels peaked in the early 1980s at less than 10,000 pCi/L and have since declined to less than 100 pCi/L. The test well and regional aquifer monitor well data (Figures A3-9 and A3-10, respectively) show similar results, with most recent detections capped at about 200 pCi/L.

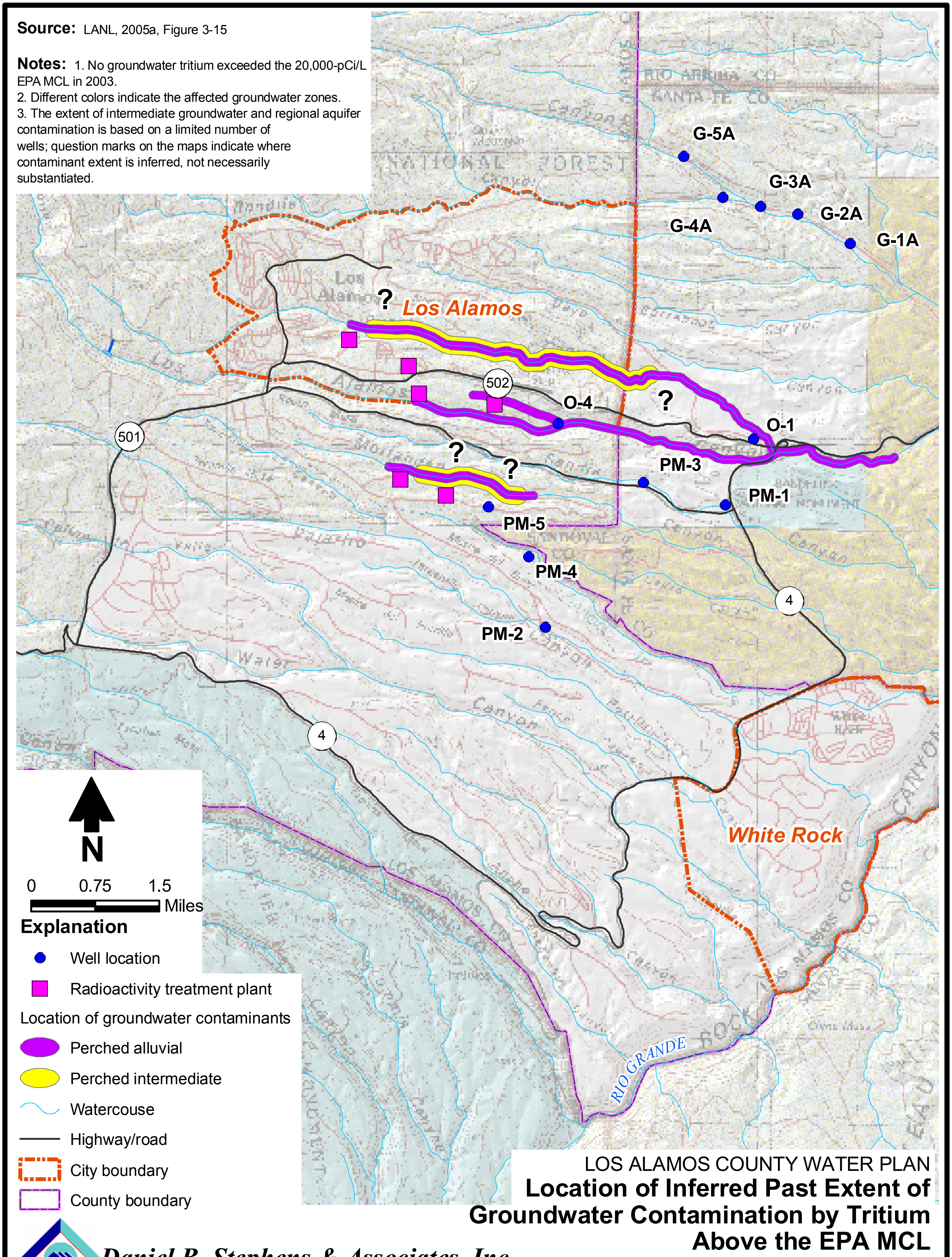
A plot showing tritium results for the intermediate-depth zones (Appendix A3, Figure A3-11) show that substantially higher levels, albeit mostly below the EPA drinking water standard, persist in the intermediate depth zones. The highest level and the only concentration that exceeds the standard was 23,500 pCi/L detected in 2005 in MCOBT-4.4, which is located in Mortandad Canyon. A pronounced increasing trend is seen in the MCOBT-4.4 data. Tritium contamination in Mortandad Canyon is from effluent discharges from the TA-50 RLWTF. Tritium levels in these discharges have recently been substantially reduced after the RLWTF adopted effluent limits in 2001. Observed tritium levels in alluvial groundwater in Mortandad Canyon in prior years have been as high as 2,000,000 pCi/L. However, tritium activity in RLWTF effluent averaged 10,400 pCi/L in 2003 (LANL, 2005a). With a reduced source term and a relatively short half-life (12.3 years), the tritium levels observed in MCOBT-4.4 should decline in the future. Thus, the future risk of tritium exceedances of the EPA drinking water standard in regional aquifer wells is considered to be low. Figure 3-16 shows the locations where elevated levels of tritium have been detected (LANL, 2005a).

3.2.2.9 Nitrate Contamination

Exceedances of the nitrate drinking water standard of 10 milligrams per liter (mg/L) nitrate as nitrogen have occurred in TW-1 as recently as 1995. The results of a query of the LANL WQDB for nitrate detections indicate that the highest recent nitrate levels observed in the regional aquifer monitor well data occur in well R-28 in Mortandad Canyon, but they are well below the standard (Appendix A3, Figure A3-12). Substantially higher levels occur in the intermediate-depth well data (Appendix A3, Figure A3-13), with recent levels exceeding the standard detected in MCOI-6, MCOI-4, and MCOBT-4.4, all located in Mortandad Canyon. These data suggest a potential future risk of impact to the regional aquifer from nitrate in this area. Figure 3-17 shows the locations of nitrate concentrations in groundwater (LANL, 2005a).

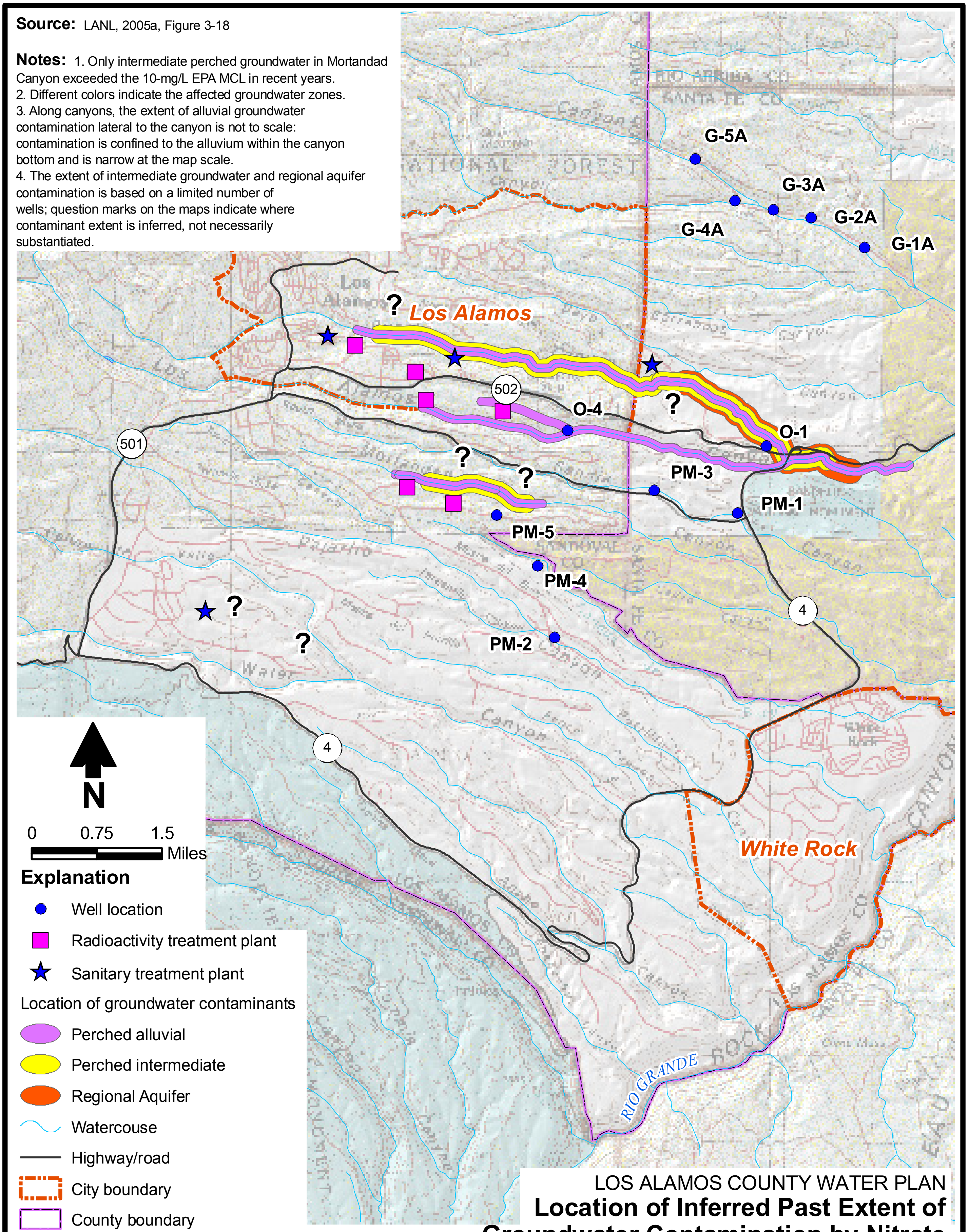
3.2.3 Sources of Contamination

In a December 2003 report, *Source Water Assessment & Protection Program, Report of Los Alamos County Water System Water Utility,* NMED identified potential threats to public supply



LOS ALAMOS COUNTY WATER PLAN

Location of Inferred Past Extent of Groundwater Contamination by Tritium Above the EPA MCL



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LOS ALAMOS COUNTY WATER PLAN

Location of Inferred Past Extent of Groundwater Contamination by Nitrate (as nitrogen) Above the EPA MCL

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05/08/2006

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Figure 3-17

wells in Los Alamos. As summarized in Table 3-8, the findings of the source water assessment indicate that the susceptibility to contamination varies from moderately low (Guaje well 2A and Pajarito Mesa 1 and 5) to moderately high (at Guaje well 1A, Otowi 1 and 4, and Pajarito Mesa 2 and 4). The susceptibility ranking is based on an assessment of the number of potential sources of contamination within a radius of the well, the depth to water, the presence of contaminants already observed in each well, and other factors that contribute to the vulnerability to the public supply.

The NMED findings are preliminary, and Los Alamos County is working with NMED to correct some significant problems in the report (as indicated in Table 3-8). In particular, it appears that the moderately high susceptibility at Guaje 1A, which is in a relatively pristine area, is due to erroneous identification of a transformer bank as an electric power generating facility.

3.2.4 Treatment Options

The contaminants that have been detected in groundwater include strontium-90, americium-241, cesium-137, plutonium-238, and plutonium-239,-240 (LANL, 2005a), tritium, chromium, nitrate, perchlorate, and RDX. While the risk of migrating to public supply wells varies depending on the reactivity of the contaminant (Section 3.2.2), this section discusses options for removing these constituents.

Table 3-9 lists the contaminants, EPA standard, and the highest detected concentrations in monitor wells along with the method to remove the contaminant from groundwater. Most of the constituents can be removed either through the reverse osmosis (RO) or ion exchange (IE) treatment processes, although disposal of the waste stream from RO and the resins from IE may pose a problem. RDX requires either carbon absorption or ultraviolet radiation; ultraviolet radiation is the preferred method of treatment because no waste is generated in the treatment process. Tritium cannot be removed from drinking water, except through long-term storage until the half-life reduces the concentration or through evaporation, which may be appropriate for a waste stream but not a public water supply. Perchlorate can also be removed with biological treatments; however, this process is more suitable for treating waste streams or for in-situ treatment of contaminated groundwater.

Table 3-8. Susceptibility of Los Alamos County Supply Wells to Contamination According to NMED Preliminary Source Water Assessment

Well Field	Well	Source Susceptibility Ranking [a]	Source Type Within 1,000 feet of Well [a]
Guaje	G-1A	Moderately high [b]	Polluted surface water sources [c]
	G-2A	Moderately low	Polluted surface water sources [c]
	G-3A	Moderate	Polluted surface water sources [c]
	G-4A	Moderate	Polluted surface water sources [c]
	G-5A	Moderate	Polluted surface water sources [c]
Otowi	O-1	Moderately high	Highway/road maintenance yards
			Secondary highway
			New Mexico impaired water
			Single family residences-unsewered
	O-4	Moderately high	Historical dumps/landfills
			Polluted surface water sources
			Other wells (provide conduit for contaminant migration)
Pajarito	PM-1	Moderately low	Polluted surface water sources
			Secondary highway
	PM-2	Moderately high	Historical dumps/landfills
			Polluted surface water sources
			Sewer lines
			Wastewater seepage/retention ponds
			Research laboratories
			Commercial septic tanks
			RCRA waste generators
			Unlined storm drainage collection areas
	PM-3	Moderate	Polluted surface water sources
	PM-4	Moderately high	Polluted surface water sources
			Research laboratories
			Historical dumps/landfills
	PM-5	Moderately low	Historical dumps/landfills
			Polluted surface water sources
			Research laboratories
			Commercial septic tanks
			Other wells (provide conduit for contaminant migration)
			Power generating stations

[a] Preliminary findings (NMED, 2003), some of which are erroneous (see footnotes b and c)

[b] Moderately high susceptibility ranking based on mistaking a transformer bank as an electric power generating facility. The transformer bank supplies secondary voltage to the well pump and is no different than any other transformer bank on any other electrically driven well.

[c] Guaje Canyon streambed is not known to be contaminated or impacted by any LANL activity

Table 3-9. Summary of Treatment Options

Contaminant	EPA MCL (µg/L [a])	Recent Maximum Concentration [b] (µg/L [a])	Source of Contaminant	Health Effects	Treatment Options at Wellhead [c]	Half-Life (years [a])	Comments
Monitor Wells							
Perchlorate	4 [d]	246 [e]	Used as an energetics booster or oxidant in solid propellant for rockets and missiles	Can interfere with iodide uptake by the thyroid gland, which can result in decreased production of thyroid hormones, which are needed for prenatal and postnatal growth and development, as well as for normal metabolism and mental function in the adult.	Ion exchange Strong base anion	None	Biological treatment can be used for waste streams or in situ treatment
Chromium	100	416 [f]	Metal found in natural deposits; used in cooling towers	Short-term health effects from short-term exposure above the MCL include skin irritation or ulceration. Long-term effects from a lifetime exposure at levels above the MCL include skin irritation and damage to liver, kidney, circulatory system, and nerve tissues	RO Ion exchange	None	
Nitrate	10,000	20,200	NA	Can cause serious illness and sometimes death in infants due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. Long-term exposure at levels above the MCL can cause diuresis, increased starchy deposits, and hemorrhaging of the spleen.	RO Ion exchange	None	

[a] Unless otherwise noted
[b] Maximum recent concentration detected in wells, from Appendix A of draft water plan except where otherwise noted
[c] Personal communication from Steve Hanson, July 2006
[d] No MCL has been established for perchlorate; the DWEL is 24.5 ppb and NMED has set an action level of 4 ppb
[e] Intermediate depth aquifer data
[f] Regional aquifer monitor well R-28, May 20, 2005
[g] Alluvial aquifer data from 2005
[h] No MCL has been established for RDX, but EPA has set a maximum lifetime health advisory of 2 ppb
[i] Guaje #2 in 1994, NMED Drinking Water Bureau data
[j] EPA proposed MCL
[k] PM #3 in 2000, NMED Drinking Water Bureau data

EPA MCL = U.S. Environmental Protection Agency maximum contaminant level
µg/L = Micrograms per liter
NA = Information not available
pCi/L = PicoCuries per liter
mrem/yr = Millirems per year

Table 3-9. Summary of Treatment Options

Contaminant	EPA MCL (µg/L [a])	Recent Maximum Concentration [b] (µg/L [a])	Source of Contaminant	Health Effects	Treatment Options at Wellhead [c]	Half-Life (years [a])	Comments
Strontium-90	8 pCi/L	35 pCi/L	Byproduct of the fission of uranium and plutonium in nuclear reactors, and in nuclear weapons.	Bone cancer, cancer of the soft tissue near the bone, and leukemia.	Ion exchange Strong base cation	29.1	
Americium-241	15 pCi/L	2.44 pCi/L [g]	Man-made metal produced when plutonium atoms absorb neutrons in nuclear reactors and in nuclear weapons detonations	Poses a significant risk if ingested (swallowed) or inhaled. It can stay in the body for decades and continue to expose the surrounding tissues to both alpha and gamma radiation, increasing the risk of developing cancer. Also poses a cancer risk to all organs of the body from direct external exposure to its gamma radiation.	Reverse osmosis	432.7	
Cesium-137	4 mrem/yr	9.39 pCi/L [g]	Produced when uranium and plutonium absorb neutrons and undergo fission	Increased risk of cancer	Ion exchange Strong base anion	30.17	
Plutonium-238	15 pCi/L	1.75 pCi/L [g]	Created from uranium in nuclear reactors	Internal exposure is an extremely serious health hazard. Generally stays in the body for decades, exposing organs and tissues to radiation and increasing the risk of cancer. Also a toxic metal that may cause damage to the kidneys.	Reverse osmosis	87	

[a] Unless otherwise noted
[b] Maximum recent concentration detected in wells, from Appendix A of draft water plan except where otherwise noted
[c] Personal communication from Steve Hanson, July 2006
[d] No MCL has been established for perchlorate; the DWEL is 24.5 ppb and NMED has set an action level of 4 ppb
[e] Intermediate depth aquifer data
[f] Regional aquifer monitor well R-28, May 20, 2005
[g] Alluvial aquifer data from 2005
[h] No MCL has been established for RDX, but EPA has set a maximum lifetime health advisory of 2 ppb
[i] Guaje #2 in 1994, NMED Drinking Water Bureau data
[j] EPA proposed MCL
[k] PM #3 in 2000, NMED Drinking Water Bureau data

EPA MCL = U.S. Environmental Protection Agency maximum contaminant level
µg/L = Micrograms per liter
NA = Information not available
pCi/L = PicoCuries per liter
mrem/yr = Millirems per year

Table 3-9. Summary of Treatment Options
Page 3 of 4

Contaminant	EPA MCL (µg/L [a])	Recent Maximum Concentration [b] (µg/L [a])	Source of Contaminant	Health Effects	Treatment Options at Wellhead [c]	Half-Life (years [a])	Comments
Tritium	20,000 pCi/L	23,500	Produced during nuclear weapons explosions, as a byproduct in reactors producing electricity, and in special production reactors where the isotope lithium-6 is bombarded to produce tritium.	Increased risk of cancer	No options	12.3	Waste streams can be treated by evaporation or storing until half life diminishes concentration
RDX	2 [h]	52.2	Used in explosives	Increased risk of cancer	Carbon absorption Ultraviolet	none	Waste stream generated with carbon absorption; no waste stream with ultraviolet

[a] Unless otherwise noted
[b] Maximum recent concentration detected in wells, from Appendix A of draft water plan except where otherwise noted
[c] Personal communication from Steve Hanson, July 2006
[d] No MCL has been established for perchlorate; the DWEL is 24.5 ppb and NMED has set an action level of 4 ppb
[e] Intermediate depth aquifer data
[f] Regional aquifer monitor well R-28, May 20, 2005
[g] Alluvial aquifer data from 2005
[h] No MCL has been established for RDX, but EPA has set a maximum lifetime health advisory of 2 ppb
[i] Guaje #2 in 1994, NMED Drinking Water Bureau data
[j] EPA proposed MCL
[k] PM #3 in 2000, NMED Drinking Water Bureau data

EPA MCL = U.S. Environmental Protection Agency maximum contaminant level
µg/L = Micrograms per liter
NA = Information not available
pCi/L = PicoCuries per liter
mrem/yr = Millirems per year

Table 3-9. Summary of Treatment Options

Contaminant	EPA MCL (µg/L [a])	Recent Maximum Concentration [b] (µg/L [a])	Source of Contaminant	Health Effects	Treatment Options at Wellhead [c]	Half-Life (years [a])	Comments
Public supply wells							
Arsenic	10	31 [i]	Occurs naturally in rocks, soil, water, air, plants, and animals. Can be further released into the environment through natural activities such as volcanic action and erosion of rocks and forest fires, or through human actions.	Non-cancerous effects can include thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness. Has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate.	RO Ion exchange	None	20 to 25% of water goes to waste stream in RO; ion exchange impacted by silica concentrations
Radon	300 pCi/L [j]	685 pCi/L [k]	Naturally occurring radioactive breakdown product of uranium that can dissolve and accumulate in groundwater.	Ingestion can cause internal organ cancers, particularly stomach cancer. Inhalation causes lung cancer	De-gas Spray head	3.8 days	

[a] Unless otherwise noted
[b] Maximum recent concentration detected in wells, from Appendix A of draft water plan except where otherwise noted
[c] Personal communication from Steve Hanson, July 2006
[d] No MCL has been established for perchlorate; the DWEL is 24.5 ppb and NMED has set an action level of 4 ppb
[e] Intermediate depth aquifer data
[f] Regional aquifer monitor well R-28, May 20, 2005
[g] Alluvial aquifer data from 2005
[h] No MCL has been established for RDX, but EPA has set a maximum lifetime health advisory of 2 ppb
[i] Guaje #2 in 1994, NMED Drinking Water Bureau data
[j] EPA proposed MCL
[k] PM #3 in 2000, NMED Drinking Water Bureau data

EPA MCL = U.S. Environmental Protection Agency maximum contaminant level
µg/L = Micrograms per liter
NA = Information not available
pCi/L = PicoCuries per liter
mrem/yr = Millirems per year

Treatment of naturally occurring contaminants of arsenic and radon may also be required at some time in the future based on the new arsenic standard and proposed radon standard. Additional discussion of treatment options for these naturally occurring constituents is provided in the following subsections.

3.2.4.1 Arsenic

Due to concerns with arsenic in drinking water, the EPA has enacted what is commonly called the Arsenic Rule (*Arsenic and Clarifications to Compliance and New Source Monitoring Rule,* 66 FR 6976 (January 22, 2001)). Arsenic, which is odorless and tasteless, can enter drinking water supplies from natural processes associated with volcanism. It has been linked to different cancers and can cause a number of non-cancer conditions, including skin damage and problems with the circulatory system. The purpose of the Arsenic Rule is to improve public health by reducing the exposure to arsenic in drinking water.

Pursuant to the Arsenic Rule, EPA has set the arsenic standard for water systems to 10 parts per billion (ppb), a significant decrease from the previous standard of 50 ppb (40 CFR 141.62(b)). The new standard became effective January 23, 2006, five years after the rule was enacted, in order to give public water systems adequate time to comply with the standard (40 CFR 141.6(j)).

Arsenic in the Los Alamos public supply wells has approached the new EPA standard of 10 µg/L. Table 3-10 shows a concentration of 16 µg/L in Pajarito Mesa #3 in November 2000 and 10 µg/L in Guaje #2 in November 1999 (NMED, 2006). In 1994 Guaje #2 had an arsenic concentration of 31 µg/L.

Both treatment and non-treatment strategies are available to meet EPA's new arsenic drinking water standard. The simplest non-treatment methods include modifying pumping schedules to maximize pumping from low-arsenic wells or blending water from other low-arsenic sources. More costly methods include rehabilitating existing wells to improve yields from low-arsenic zones, modifying existing wells to seal off high-arsenic aquifer zones, and installing properly located and designed replacement wells.

Table 3-10. Arsenic Concentrations Detected in Los Alamos Public Supply Wells and Booster Stations

Sample Location	Arsenic (μ/L)	Date of Sample
EPA MCL	*10*	
Pajarito Mesa 1	1	12/13/1999
Pajarito Mesa 3	16	11/15/2000
Pajarito Mesa 4	0.8	11/14/2000
Pajarito Mesa 5	1	12/13/1999
Guaje 1	4	11/10/1999
Guaje 2	10	11/10/1999
Guaje 3	5	11/10/1999
Guaje 4A	2	12/14/1999
Guaje 5	3	11/10/1999
Otowi 1	2.6	11/15/2000
Otowi 4	2	12/13/1999
EP Pajarito Booster	1.1	9/4/2002
Otowi Booster # 2	2	2/14/2005
Guaje Booster # 2	6	2/14/2005

Source: NMED, 2006

Many types of treatment methods are available for removing arsenic from groundwater. EPA details these in a September 1993 document entitled "Treatment and Occurrence, Arsenic in Potable Water Supplies" (summarized in U.S. EPA, 2006b) This document summarizes the results of pilot-scale studies examining low-level arsenic removal, from 50 parts per billion (ppb or µg/L) down to 1 ppb or less. The effective technologies include ion exchange (IE), reverse osmosis (RO), and electrodialysis reversal (EDR). Although IE technology produces a highly concentrated waste byproduct stream that may pose a problem with disposal, EPA recommends IE for small groundwater systems with low sulfate and TDS and as the polishing step after filtration for low-level options. RO results in a water rejection rate of about 20 to 25 percent of influent, which reduces the available supply. EDR also results in a water rejection rate of about 20 to 25 percent of influent and is more expensive than RO.

The waste stream from an RO treatment plant would possibly need either some pretreatment prior to discharge or would need to discharge to the sanitary sewer due to the increase in salinity. The waste stream produced by IE technologies is a highly concentrated brine with high TDS that may require some pretreatment prior to discharge, even to a sanitary sewer (U.S. EPA, 2006b).

Because the concentrations of arsenic are very low in most of the supply wells, the option of blending well water is the best option for the Los Alamos water system.

3.2.4.2 Radon

Radon is a naturally occurring element that is generated as a radioactive breakdown product of uranium. The primary exposure to radon is through inhalation of air inside homes; however, radon can also dissolve and accumulate in groundwater. Most (nearly 90 percent) of the risk from radon in drinking water comes from breathing radon released to indoor air from household water uses. Radon problems in water can be readily fixed by removing radon from the water before it enters the home through aeration techniques, called point-of-entry treatment. Unfortunately, point-of-use treatment will not reduce most of the inhalation risk from radon.

EPA published draft regulations for a radon standard in drinking water in October 1999. The proposed regulation would provide two options to states and water systems for reducing public health risks from radon in both drinking water and indoor air. Under the first option, states can choose to develop enhanced state programs addressing radon in indoor air in conjunction with individual water systems meeting a drinking water standard of 4,000 picoCuries per liter of water (pCi/L, a standard unit of radiation). EPA is encouraging states to adopt this more cost-effective approach, which would address radon in indoor air while requiring individual water systems to reduce the higher levels of radon in drinking water. If a state does not elect this option, individual water systems in that state would either reduce radon in their system's drinking water to 300 pCi/L or develop individual indoor air radon programs and reduce levels in drinking water to 4,000 pCi/L. Water systems already at or below the 300-pCi/L standard will not be required to treat their water for radon (U.S. EPA, 2006c).

Radon concentrations detected in the Los Alamos wells vary from 235 pCi/L in Otowi #1 to 685 pCi/L in Pajarito Mesa #2 (Table 3-11). Four of the eight wells have concentrations above the proposed MCL of 300 pCi/L. Because the other wells are not much below the proposed standard, blending of well water may not be sufficient to ensure compliance with the proposed standard.

Table 3-11. Concentrations of Radon in Los Alamos Public Supply Wells.

Well	Radon Concentration (pCi/L)	Date of Sample
Proposed EPA MCL	*300*	
Pajarito Mesa 1	274	11/15/2000
Pajarito Mesa 2	685	11/15/2000
Pajarito Mesa 3	295	11/15/2000
Pajarito Mesa 4	457	11/15/2000
Guaje 4A	576	12/14/1999
Otowi 1	235	11/15/2000
Otowi 4	461	11/15/2000

Source: NMED, 2006

4. Water Rights

In addition to having sufficient physical supply, Los Alamos County needs to have the legal rights to use that water. New Mexico water law is founded on the principle that all water in New Mexico belongs to the State of New Mexico, which thus has the sole authority to grant or recognize rights to use that water. Two further tenets, both based on New Mexico Constitution Article XVI, Section 2, are that (1) water rights "are subject to appropriation for beneficial use, in accordance with the laws of the state" and (2) "priority of appropriation shall give the better right."

- The concept underlying the principle of prior appropriation is that the first person to use water for a beneficial purpose has a prior right to use that water against subsequent appropriators. Water rights acquired through this system of prior appropriation are a type of property right and may be sold or leased.

- The essential basis of water right ownership is beneficial use. The principle of beneficial use is that a water right arises out of a use that is productive or beneficial, such as agricultural, municipal, industrial, and domestic uses, among others.

The State Engineer, through the Office of the State Engineer (OSE), administers water rights for the State of New Mexico:

- To actively manage groundwater resources in New Mexico, the State Engineer has the authority, as set forth in the Water Code, to delineate groundwater basins that require a permit for groundwater withdrawals. Such a permit specifies (1) how much water a user can withdraw within any given year, (2) the location and type of well that will be used to withdraw the water, and (3) the use to which the water will be put. Many water right permits have special conditions that further define the use and quantity of water allowed under the permit.

- Like groundwater, the diversion of water from New Mexico's surface waters requires either a declaration, a permit, a license, or a court decree to divert the water. Surface water appropriations follow the same standards as groundwater rights in that a transfer or lease cannot impair existing water rights and must not be contrary to public welfare or conservation (NMSA 72-5-23, 72-12-3(D)).

Many of New Mexico's surface waters are governed by interstate compacts that require set amounts of water to be delivered to specified delivery points. The Interstate Stream Commission, an adjunct commission to the OSE, has responsibility for ensuring that specific rivers in New Mexico meet their obligations under their respective interstate compacts.

4.1 Los Alamos County Water Rights

The County has existing water rights from a variety of sources, including water rights from the Rio Grande surface water and underground water basin, rights to use 1,200 acre-feet of water from the San Juan-Chama Project, and water rights appurtenant to U.S. Forest Service (USFS) land that the County expects to purchase. These rights are discussed in Sections 4.1.1 through 4.1.3, respectively.

4.1.1 Rio Grande Surface Water and Groundwater Rights

As discussed in Section 2, Los Alamos County's Rio Grande water rights were originally owned by the U.S. DOE and transferred to the County in 2001. Table 4-1 summarizes these permitted, licensed, and declared water rights.

The rights outlined in Table 4-1 are based on a permit application filed by U.S. Energy Research on May 29, 1975 to combine a series of previously licensed and declared water rights. That application requested a total right of 5,547.1 ac-ft/yr for municipal, industrial, and related purposes that could be diverted from any combination of permitted points of diversion. The OSE approved the application on October 30, 1975 with the exception of subtracting 5.8 ac-ft/yr for evaporation losses at Los Alamos Reservoir. Los Alamos County's water rights under the 1975 combined permit are 5,541.3 ac-ft/yr.

Table 4-1. Summary of Los Alamos County Water Rights

Permit Number	Water Source	Priority Date	Quantity of Water Originally Appropriated (ac-ft/yr)
RG-485 through RG-496-Comb-S-4 [a]	Groundwater	1948-1951	5,329
RG-485 through RG-496-Comb-S-5 [b]	Groundwater	1948-1951	50
1503,1802, and 1802-amended [c]	Surface water	March 14, 1922	168.1
Evaporation loss	Surface water		(5.8)
Total water right	Surface and groundwater		5,541.3

Source: Southwest Water Consultants, Inc., 1999

[a] Permitted August 31, 1965 from numerous underground water right declarations filed on March 5, 1957 and amended in 1965. These declarations identified actual use of 3,966 acre-feet in 1964, a capacity of 6,579 ac-ft/yr, and an OSE feasible diversion of 5,329 ac-ft/yr. Dates that water was put to beneficial use vary.

[b] Subsequent declarations added an additional 50 acre-feet and new points of diversion.

[c] The amendment to Permit 1802 raised the storage capacity from 6.66 acre-feet to 28.33 acre-feet.

4.1.2 San Juan-Chama Surface Water Rights

Los Alamos County has a service contract for 1,200 acre-feet of San Juan-Chama Project surface water, which flows into the Rio Grande through a series of tunnels, conveyance channels, and reservoirs. The current contract has an expiration date of 2017 (USBR, 2006). Los Alamos County's San Juan-Chama service contract is being converted to a repayment contract, which would eliminate expiration dates and the need to renegotiate and renew the contract (Section 7). Under the amended repayment form of contract, the annual payments would be viewed as repayment of Los Alamos's allocated construction cost obligation instead of annual water service charges, as is the case under the present water service form of contract (USBR, 2006).

The conversion of the San Juan-Chama contract is currently going through the National Environmental Policy Act (NEPA) process. The USBR has issued an Environmental Assessment and expects to be able to complete the process and sign the contract in 2006 (USBR, 2006). Should the environmental assessment result in extensive opposition, the USBR could conduct a full Environmental Impact Assessment, which would delay the signing of the repayment contracts by as much as a year or more.

4.1.3 Water Rights Appurtenant to Land Purchase

In 2004, the County of Los Alamos signed an agreement with several federal agencies and San Ildefonso Pueblo as part of the negotiation and settlement of the Pueblo's land claims. The "Los Alamos Agreement," signed January 22, 2004, will allow the County to purchase 400 acres of land from the U.S. Forest Service and secure water rights on several hundred more acres. Implementation of this agreement depends in part on the passage of the Pueblo de San Ildefonso Claims Settlement Act of 2005 (Senate Bill 1773), which has been introduced in the U.S. Congress. The amount and type of water rights that will be available from these land purchases is not clear. Final water right amounts will be determined by the OSE once the County applies for a change of ownership of the existing water rights appurtenant to those lands.

4.2 Water Rights Administration

As part of the planning process, it is important to view Los Alamos County's water rights in the larger context of the administrative and other legal considerations that could affect the County's ability to use and divert its water rights in any given year. This section discusses the administrative policies currently or potentially affecting the County's water rights; Section 4.3 assesses the potential risks to those water rights.

4.2.1 Rio Grande Compact

Water in the Rio Grande is governed by the Rio Grande Compact, an agreement entered into by New Mexico, Texas, and Colorado in 1939 and approved by the United States Congress and the State of New Mexico (NMSA 72-15-23). The Compact applies to the use of surface water of the Rio Grande, from its headwaters in Colorado to Fort Quitman, Texas, by each of the three states. Each upstream state is required to make a surface water delivery to its downstream neighbor. The volumes of water required to be delivered to New Mexico and Texas are calculated based on upstream flows and an annual accounting is conducted to determine each state's actual deliveries in relation to that delivery obligation and the resulting credits or debits (over- or under-deliveries), which are carried over from year to year.

New Mexico's Compact delivery requirements are based on an inflow-outflow schedule where inflow is measured at the Rio Grande at Otowi Bridge near San Ildefonso, NM gage (Otowi gage; east of Los Alamos). Because of the Otowi gage's role in determining delivery amounts, the State Engineer has a long-standing administrative practice of not permitting a change in point of diversion from one side of the gage to the other, whether by sale or by lease (Cartron et al., 2002). This requirement places a significant restriction on the water rights market, and coupled with the fact that few pre-1907 water rights are available for purchase, means that purchasing water rights, whether for municipal use or offsets (Section 4.2.4), will be a significant challenge. Additionally, even if a willing seller can be identified, water rights transfers on the Rio Grande are routinely protested and can require expenditure of significant technical and legal fees.

4.2.2 Protection of Senior Water Rights

As discussed above, the State of New Mexico adheres to the prior appropriation system for water rights administration. This approach is based on a "first in time, first in right" concept, whereby the water right holder with a priority date senior to other rights can exercise that right to the detriment of a right with a junior priority date. When senior water rights are unable to fully exercise their right due to diversions by junior water right holders, they can make a priority call on a river (including stream-connected groundwater rights). This call, which would be administered by the OSE, would require junior users to cease pumping or diverting so that the senior rights could be fulfilled.

To date, priority call-based administration has rarely happened; however, most rivers and connected groundwater basins are over-appropriated. Even though the Rio Grande has not been adjudicated (a legal process that establishes the amounts and priorities dates of all surface water and groundwater rights in a stream system), Los Alamos water rights are junior to a significant number of downstream senior water rights, such as the Middle Rio Grande

Conservancy District, that could be impaired by additional depletions upstream. With additional growth and other pressures, such as endangered species requirements, active administrative protection of senior water rights in groundwater basins and rivers is likely to become more frequent over the 40-year planning horizon.

4.2.3 Active Water Resource Management

In an effort to develop more flexible tools for administering water rights in New Mexico, the OSE adopted Active Water Resource Management (AWRM) regulations (NMAC 19.25.13.1 to 13.49) in December 2004. The AWRM legislation creates an administrative framework within which the OSE will establish water master districts, appoint water masters for those districts, and develop district-specific water rights administration regulations.

The OSE has established seven priority basins for AWRM (NM OSE, 2004a), one of which includes the Rio Grande. In time, the OSE will develop Rio Grande-specific regulations that will address administration of water rights, although the regulations will not become final until the Rio Grande is adjudicated (NM OSE, 2004b). In the Pecos River and connected groundwater basins, the OSE has developed AWRM regulations that clearly lay out several approaches to priority administration, all of which allow for curtailment of junior water rights to protect senior water rights.

4.2.4 Rio Grande Offset Requirements

In accordance with statutory authority and case law, the OSE manages the Rio Grande river and groundwater basins conjunctively and considers Rio Grande surface water to have been fully appropriated as of the year 1939 (the year the Rio Grande Compact was signed) (NM OSE, 2000). This means that the OSE recognizes the groundwater-surface water connection and conditions permits so that new groundwater appropriations will not increase surface water depletions and thereby affect senior water right holders. Specifically, the OSE requires applicants for groundwater rights to purchase and retire valid water rights in an amount equivalent to the effect the groundwater withdrawals will have on the river.

Previously, the OSE didn't require applicants to immediately begin purchasing and retiring water rights. However, current policy, which was upheld in a recent case with the City of Rio Rancho, now specifies that offsets must be in place to counteract the effect of pumping on the river. A phased acquisition of the offsets is possible, especially if the applicant isn't planning on immediately pumping up to the full permitted amount. However, offsets for impacts must be in place by the time those impacts affect the river (i.e., increase depletion).

The OSE has further clarified this policy in recently issued policy stating that offset rights may only be valid for pre-1907 rights, a pre-1907 surface water right previously transferred into a well, or a valid existing groundwater right with a priority date older than May 31, 1939, the date of the Rio Grande Compact (NM OSE, 2006). This policy limits the number of water rights that could be considered for offset requirements.

4.2.5 Rio Grande Declared Groundwater Basin

The Rio Grande Groundwater Basin covers 26,209 square miles along the Rio Grande in the center of the state. Although specific administrative criteria exist for the area near the river in the Middle Rio Grande reach (Cochiti to Socorro) (NM OSE, 2000), the OSE has no unique administrative criteria for the portion of the Rio Grande Basin near Los Alamos County. OSE will evaluate applications for water rights in this reach, including a change in point of diversion or place and purpose of use of water rights, to determine whether the granting of the application will impair existing water rights or be detrimental to the public welfare or contrary to the conservation of water.

4.3 Risks to Los Alamos County Water Rights

Although Los Alamos County owns a specific amount of water rights, the legal right to divert and use those rights in any given year can be affected by the rights of other water rights holders and even as a result of interstate compacts or other agreements governing interstate waters. These risks are discussed in the following subsections.

4.3.1 Protection of Senior Water Rights

As discussed in Section 4.3.1, Los Alamos County could potentially be subject to limitation of its water rights in order to protect senior water rights. A significant yet unquantified number of the water rights on the Rio Grande are senior to those of Los Alamos County. In the event that the OSE began administering priorities based on a call or based on AWRM regulations, Los Alamos could be required to limit its use or to use some of its San Juan-Chama rights to mitigate the effects of its diversions on senior water rights holders. Until the OSE conducts a hydrographic survey and adjudicates the Rio Grande, however, it is impossible to quantitatively evaluate Los Alamos' susceptibility to curtailment of its water rights under priority administration.

4.3.2 Rio Grande Offset Requirements

Even without a priority call, the OSE could potentially require Los Alamos to offset its current pumping to avoid impairment of pre-1939 senior water rights holders. For example, should Los Alamos County submit an application to change the point of diversion or purpose and place of use of a water right, the OSE would evaluate that application with respect to impairment, public welfare, and conservation. Because the County's use of its water rights increases depletions on the Rio Grande, thereby impacting senior water rights holders, the OSE could require offsets due to impairment even though the existing permits have no offset requirement. As discussed in Sections 4.2.4 and 6, Los Alamos County could satisfy those offset requirements by using San Juan-Chama water as offset rights or by purchasing water rights. However, willing sellers of pre-1907 water rights are very difficult to find, and many municipalities have encountered significant difficulties in identifying water rights to purchase.

Los Alamos County might also be able to reduce the number of offset water rights the OSE would require by applying to the OSE for return flow credit for the treated effluent it returns to the Rio Grande. Credit for return flow to the aquifer is also possible. Both types must be demonstrated in a return flow plan subject to OSE approval (NM OSE, 2000, Section 3).

4.3.3 Navajo Water Rights Settlement Provisions

The original legislation authorizing the San Juan-Chama Project includes provisions for sharing shortages among beneficiaries of the project (76 Stat. 96, PL 87-483. A proposed settlement regarding Navajo water rights further defines flows and other requirements in a manner that could result in shortages to the San Juan-Chama Project. These shortages would likely be shared on a pro rata basis among all contractors. Although the Settlement Act has not yet been authorized by Congress and conditions giving rise to shortage sharing may be rare, nonetheless, implementation of the act could reduce the quantity of San Juan-Chama water available to contractors in some years.

4.4 Acquisition of New Water Rights to Meet Future Demand

As discussed in Section 6, Los Alamos County could be required to obtain additional water rights to meet future water demand. Even with the additional water rights the County expects to acquire from the USFS (Section 4.1.3), it is unlikely that the County will have sufficient water rights to meet future growth. As the Rio Grande basin is considered fully appropriated, the County would have to purchase water rights to meet future needs, which may not be feasible given water market limitations. Los Alamos should consider maximizing use of its existing water rights through conservation or reuse and through maximizing return flow credits.

5. Water Demand

In order to assess Los Alamos County's projected future demand for water, this section discusses current and historical water uses (Sections 5.1 and 5.2) and demographic and economic trends (Section 5.3) in the County. Based on this information, projected future water demands for the region are presented in Section 5.4.

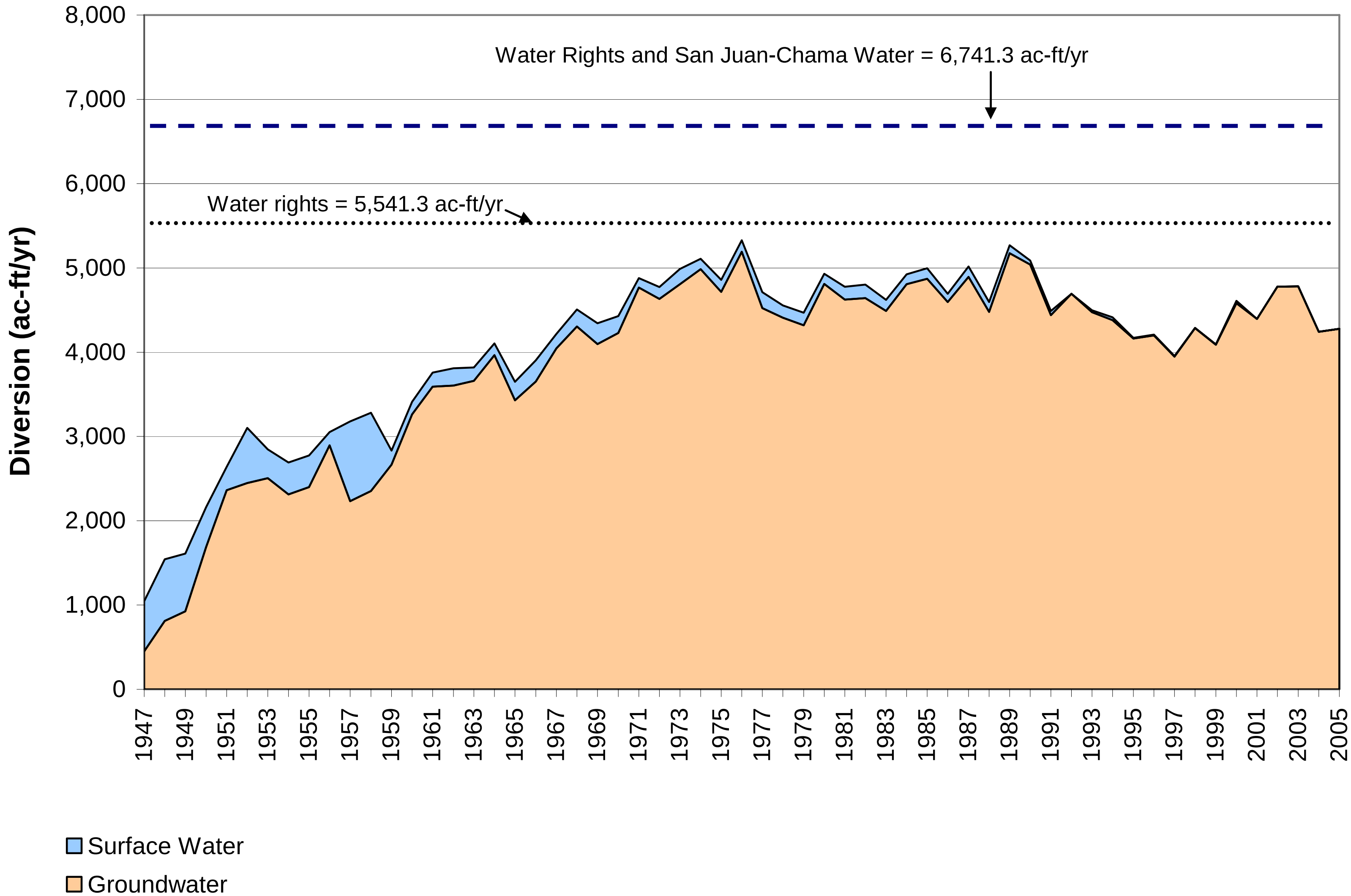
5.1 Historical Use

Groundwater and surface water have supplied the community of Los Alamos for 60 years. Figure 5-1 and Table 5-1 show the metered diversion amounts from wells and surface water from 1947 through 2005. Table 5-2 shows water diversions by decade from 1950 through 2005.

Diversions have increased over the past almost 60 years due to increased population. Diversions also fluctuate significantly from year to year due in part to fluctuating levels of precipitation (Figure 5-2). For instance, in 2002 and 2003 precipitation was 12 and 10 inches, respectively, and demand was about 4,800 ac-ft/yr. In 2004 and 2005 precipitation was 19 and 21 inches, respectively, and demand was less than 4,300 ac-ft/yr.

Demand from the LANL's operations also impacts the magnitude of diversions. A DOE mandate in 1997 required that federal facilities reduce water usage, such that the footprint on the landscape is not increased. In response to this mandate, LANL has begun reducing water usage, as further discussed in Section 8.3.9.

Since 1950, net per capita demand has ranged from 144 to 248 gallons per day including water demands for LANL. Figure 5-3 shows the monthly variation in water use in 2005, with an annual diversion for LANL of 26 percent and 74 percent for the County. Data on the amount used by LANL is only available from 1999 to present, but over that period, water demands by LANL as a percentage of the total diversions have varied from 34 percent in 1999 to 21 percent in 2002. While demand in summer months triples for Los Alamos County due to outdoor watering, LANL use also increases about 35 percent in summer months due to increased use of water in cooling towers.



LOS ALAMOS COUNTY LONG-RANGE WATER PLAN

Historical Los Alamos County Water Diversions

Daniel B. Stephens & Associates, Inc.

5/26/06

Figure 5-1

Daniel B. Stephens & Associates, Inc.

Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2005
Page 1 of 3

Year	Annual Diversions (million gallons per year)									
	Groundwater					Surface Water				Total
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Total	
1947	147	---	---	---	147	84	21.7	87.8	193.5	341
1948	264	---	---	---	264	97	21.9	119.8	238.7	503
1949	302	---	---	---	302	92	14.7	116.1	222.8	525
1950	547	3	---	---	550	54	20.6	79.9	154.5	705
1951	702	68	---	---	770	39	10.5	41	90.5	861
1952	448	350	---	---	798	48	33.6	131	212.6	1,011
1953	444	372	---	---	816	39	14.8	58	111.8	928
1954	380	374	---	---	754	40	16.9	66	122.9	877
1955	407	375	---	---	782	33	18.1	71	122.1	904
1956	437	506	---	---	943	23	4.8	24	51.8	995
1957	350	378	---	---	728	40	54.8	213	307.8	1,036
1958	372	395	---	---	767	60	49.4	193	302.4	1,069
1959	391	478	---	---	869	54	---	0	54	923
1960	530	533	---	---	1,063	48	---	---	48	1,111
1961	546	624	---	---	1,170	54	---	---	54	1,224
1962	577	597	---	---	1,174	67	---	---	67	1,241
1963	539	654	---	---	1,193	51	---	---	51	1,244
1964	627	665	---	---	1,292	45	---	---	45	1,337
1965	447	571	99	---	1,117	72	---	---	72	1,189
1966	450	613	127	---	1,190	82	---	---	82	1,272
1967	373	464	481	---	1,318	56	---	---	56	1,374
1968	345	474	584	---	1,403	65	---	---	65	1,468

Sources: Koch & Rogers, LA-13985-PR (1947-1998)
Los Alamos County Water Utility (1999-2005)

--- = Not applicable (not yet installed or no longer used)

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Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2005

Year	Annual Diversions (million gallons per year)									
	Groundwater					Surface Water				
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Total	Total
1969	331	435	569	---	1,335	80	---	---	80	1,415
1970	360	423	595	---	1,378	65	---	---	65	1,443
1971	412	484	657	---	1,553	37	---	---	37	1,590
1972	380	467	662	---	1,509	40	---	5.8	45.8	1,555
1973	406	475	685	---	1,566	49	---	9.7	58.7	1,625
1974	369	453	802	---	1,624	35	---	4.9	39.9	1,664
1975	356	431	749	---	1,536	42	---	5.3	47.3	1,583
1976	343	531	817	---	1,691	41	---	4.4	45.4	1,736
1977	345	515	614	---	1,474	57	---	4.1	61.1	1,535
1978	302	444	690	---	1,436	45	---	2.8	47.8	1,484
1979	289	456	662	---	1,407	44	1.3	3.7	49	1,456
1980	339	485	743	---	1,567	32	2.3	4.7	39	1,606
1981	336	469	701	---	1,506	45	2.1	2.7	49.8	1,556
1982	317	422	773	---	1,512	46	2.8	3.4	52.2	1,564
1983	221	338	904	---	1,463	38	1.4	3.4	42.8	1,506
1984	326	460	780	---	1,566	34	1.3	3	38.3	1,604
1985	290	456	841	---	1,587	37	0.9	2.8	40.7	1,628
1986	179	460	858	---	1,497	28	1.5	2.4	31.9	1,529
1987	217	485	892	---	1,594	34	3.2	2.8	40	1,634
1988	158	477	824	---	1,459	34.5	1.4	2.4	38.3	1,497
1989	219	506	961	---	1,686	23	3.3	4.6	30.9	1,717
1990	187	532	923	---	1,642	9.3	4.6	2.2	16.1	1,658

Sources: Koch & Rogers, LA-13985-PR (1947-1998)
Los Alamos County Water Utility (1999-2005)

--- = Not applicable (not yet installed or no longer used)

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Table 5-1. Annual Diversions from Groundwater and Surface Water
Los Alamos County, 1947-2005
Page 3 of 3

Year	Annual Diversions (million gallons per year)									
	Groundwater					Surface Water				
	Los Alamos Well Field	Guaje Well Field	Pajarito Well Field	Otowi Well Field	Total	Water Canyon Gallery Spring	Los Alamos Reservoir	Guaje Reservoir	Total	Total
1991	125	502	820	---	1,447	12	2.4	1.5	15.9	1,463
1992	13	472	1,044	---	1,529	0.1	0	0	0.1	1,529
1993	---	298	876	284	1,458	6.4	0.5	0	6.9	1,465
1994	---	179	1,042	206	1,427	11.6	0	0	11.6	1,439
1995	---	230	1,126	0	1,356	1.6	1.6	0	3.2	1,359
1996	---	269	889	210	1,368	0	2.6	0	2.6	1,371
1997	---	272	798	216	1,286	0	2.4	0	2.4	1,288
1998	---	148	941	307	1,396	0	1.6	0	1.6	1,398
1999	---	323	800	209	1,331	0	2	0	2	1,333
2000	---	417	902	174	1,492	0	9.3	0	9.3	1,501
2001	---	269	785	389	1,443	0	0	0	0	1,443
2002	---	405	855	297	1,557	0	0	0	0	1,557
2003	---	430	855	273	1,558	0	0	0	0	1,558
2004	---	370	800	212	1,382	0	0	0	0	1,382
2005	---	303	814	276	1,393	0	0	0	0	1,393

Sources: Koch & Rogers, LA-13985-PR (1947-1998)
Los Alamos County Water Utility (1999-2005)

--- = Not applicable (not yet installed or no longer used)

Table 5-2. Historical Diversions and Population for Los Alamos County 1950-2000

Year	Diversions (ac-ft/yr)			Population
	Groundwater	Surface Water	Total	
1950	1,688	474	2,162	10,476
1960	3,262	147	3,410	13,037
1970	4,229	199	4,429	15,198
1980	4,809	120	4,929	17,599
1990	5,039	49	5,089	18,115
2000	4,580	29	4,608	18,343

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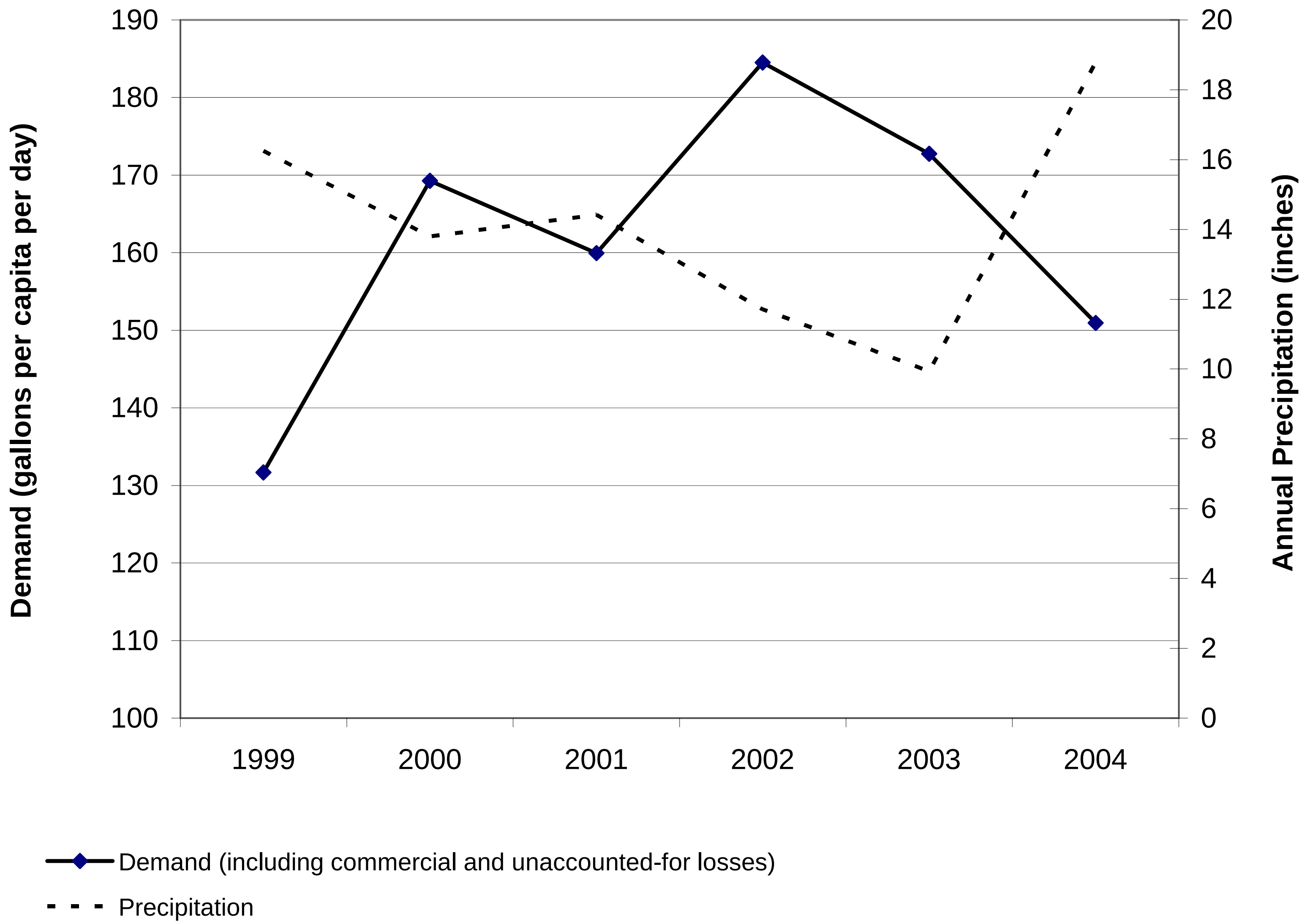


LOS ALAMOS COUNTY LONG-RANGE WATER PLAN

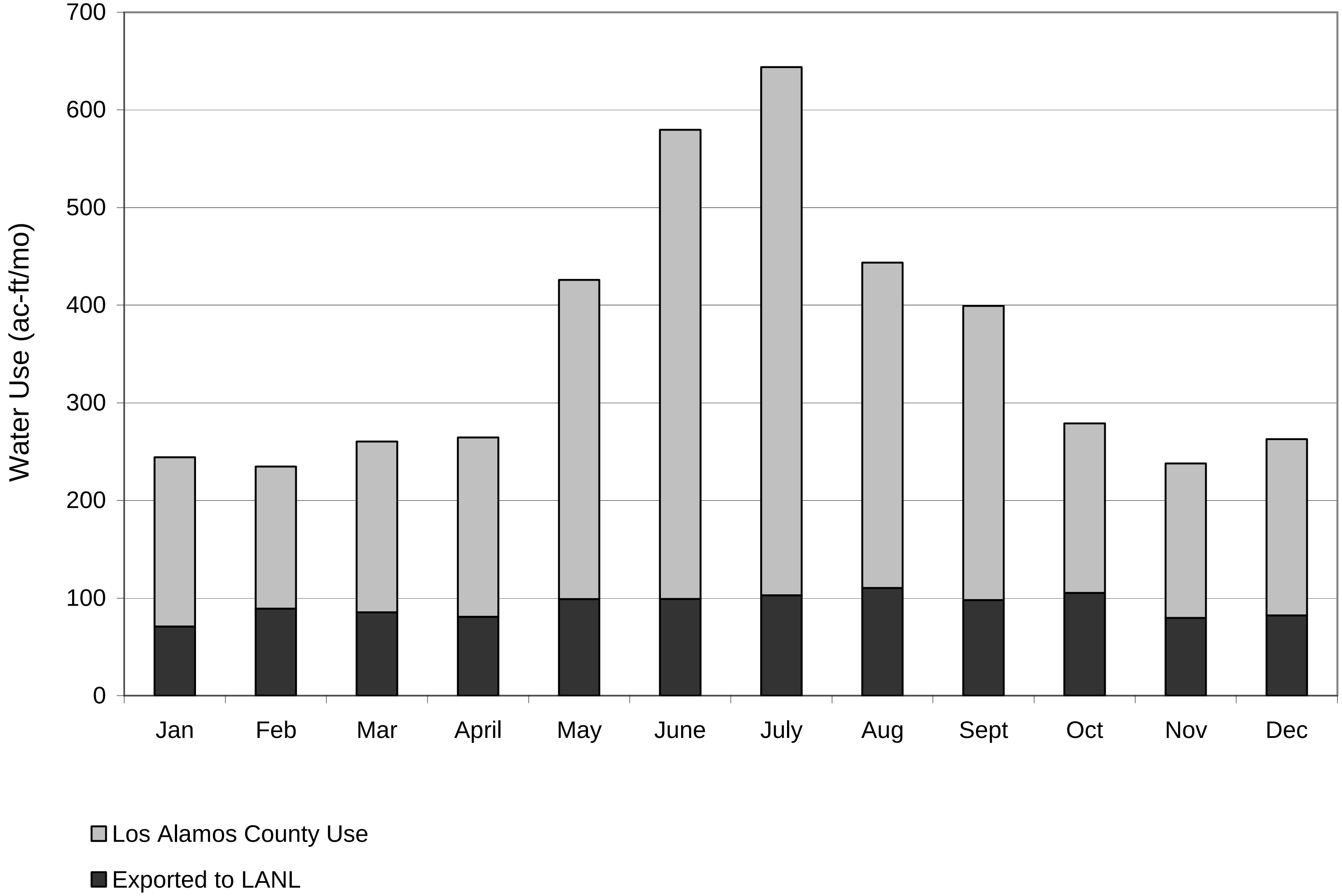
Per Capita Residential Demand and Precipitation in Los Alamos County, 1999-2004

Daniel B. Stephens & Associates, Inc.

5/26/06

Figure 5-2

2005 Annual Water Use: LANL = 1,103 ac-ft/yr (26%)
LAC = 3,173 ac-ft/yr (74%)
Total = 4,276 ac-ft/yr



LOS ALAMOS COUNTY WATER PLAN

Monthly Water Use by Los Alamos County and Los Alamos National Laboratory in 2005

Figure 5-3

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From 1999 to 2004, annual per capita demands varied from 130 to 185 gallons per capita per day (gpcd) for residential and commercial uses, not including LANL demand (Figure 5-2). The demand for residential water use alone (excluding unaccounted-for water) averaged 123 gpcd in 2003 as compared to a much lower demand of 105 gpcd in 2004. The difference was due largely to reduced outdoor irrigation in 2004, presumably as a result of annual precipitation (18. 8 inches) that was almost twice the amount received in 2003 (9.9 inches).

5.2 Current Water Use

The total population served by the LACWU includes the 18,796 residents estimated to live within the Los Alamos County in 2004, primarily in the communities of White Rock and Los Alamos. Table 5-3 shows the monthly and annual water diversions for 2003 and 2004, and Table 5-4 shows water use by service sector for calendar years 2003 and 2004. The overall net per capita use by Los Alamos County is estimated to be about 151 gallons per day for 2004, including commercial and unaccounted-for losses. The per capita demand for residential use only is estimated at 105 gallons per day. As shown in Figure 5-4, water use increases in the summer months for landscape watering.

Residential water use accounts for 70 percent of County water use (not including LANL). Most of the residential use (62 percent) is by single family residents; 8 percent is by residents living in multi-family complexes (apartments). Commercial and municipal and educational water use accounts for 19 percent, and LACWU estimated that unaccounted-for losses are 12 percent of the total diversions (Figure 5-5).

The unaccounted-for losses include unmetered deliveries (when a meter is broken), leaking pipes in the delivery system, and periodic flushing of the system. Table 5-3 shows the monthly metered deliveries and production, the difference of which is the estimate for unaccounted-for water. In some months the unaccounted-for water estimate is negative, indicating that metered deliveries were higher than production, which could be due to a release from water held in storage or a delay in meter readings for that particular month. Conversely, some months show a very high rate of unaccounted-for water, which could be due to filling storage tanks or the timing of meter readings. To even out these anomalies, the total annual loss is the best estimate of unaccounted-for water.

Table 5-3. Monthly and Annual Water Supply and Potential Return Flow Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Production (1,000 gals)			Change in Storage [a] (+/–)	Supply (1,000 gals)				Wastewater					Depletion Ratio (14 / 9)
Month	Surface Water	Groundwater	Total		Imported	Gross Supply (4+5+6)	Exported to LANL	Net Supply [b] (7—8)	Native Inflow	Imported Inflow	Reuse and Evaporation	Return Flow (10–12)	Depletion (9–13)	
2003														
Jan	0	93,350	93,350	0	0	93,350	34,942	58,408	43,918	0	0	43,918	14,490	0.25
Feb	0	86,876	86,876	0	0	86,876	28,633	58,244	43,913	0	0	43,913	14,331	0.25
Mar	0	85,857	85,857	0	0	85,857	30,207	55,650	46,150	0	1,645	44,505	11,145	0.20
Apr	0	116,687	116,687	0	0	116,687	27,116	89,571	42,276	0	7,773	34,503	55,068	0.61
May	0	174,536	174,536	0	0	174,536	28,839	145,697	43,700	0	12,664	31,036	114,661	0.79
Jun	0	177,723	177,723	0	0	177,723	27,503	150,221	41,517	0	12,364	29,153	121,068	0.81
Jul	0	222,798	222,798	0	0	222,798	31,179	191,619	41,376	0	21,709	19,667	171,951	0.90
Aug	0	166,264	166,264	0	0	166,264	40,500	125,764	38,859	0	8,892	29,967	95,796	0.76
Sep	0	139,893	139,893	0	0	139,893	35,093	104,800	36,800	0	12,082	24,718	80,081	0.76
Oct	0	121,222	121,222	0	0	121,222	32,064	89,157	42,325	0	14,739	27,586	61,572	0.69
Nov	0	89,668	89,668	0	0	89,668	35,421	54,247	39,934	0	1,414	38,520	15,727	0.29
Dec	0	82,692	82,692	0	0	82,692	26,271	56,421	41,762	0	0	41,762	14,659	0.26
Total	0	1,557,566	1,557,566	0	0	1,557,566	377,767	1,179,799	502,530	0	93,281	409,249	770,550	0.65
2004														
Jan	0	88,663	88,663	0	0	88,663	30,614	58,049	42,674	0	0	42,674	15,375	0.26
Feb	0	77,897	77,897	0	0	77,897	27,766	50,131	41,130	0	0	41,130	9,001	0.18
Mar	0	94,152	94,152	0	0	94,152	31,416	62,736	29,482	0	1,645	27,837	34,898	0.56
Apr	0	94,021	94,021	0	0	94,021	25,852	68,169	41,381	0	7,773	33,608	34,561	0.51
May	0	167,292	167,292	0	0	167,292	26,502	140,790	39,951	0	12,664	27,287	113,503	0.81
Jun	0	197,523	197,523	0	0	197,523	28,861	168,662	38,202	0	12,364	25,838	142,824	0.85
Jul	0	173,673	173,673	0	0	173,673	28,096	145,577	40,673	0	21,709	18,964	126,613	0.87
Aug	0	125,153	125,153	0	0	125,153	36,427	88,726	37,973	0	8,892	29,081	59,645	0.67
Sep	0	131,048	131,048	0	0	131,048	40,597	90,451	35,680	0	12,082	23,598	66,853	0.74
Oct	0	82,997	82,997	0	0	82,997	29,022	53,975	35,575	0	14,739	20,836	33,139	0.61
Nov	0	71,333	71,333	0	0	71,333	20,639	50,694	40,857	0	1,414	39,443	11,251	0.22
Dec	0	78,332	78,332	0	0	78,332	20,832	57,500	48,353	0	0	48,353	9,147	0.16
Total	0	1,382,084	1,382,084	0	0	1,382,084	346,623	1,035,461	471,931	0	93,281	378,650	656,811	0.63

Form created by B.C. Wilson, P.E., New Mexico Office of the State Engineer, 02/16/2000
Source: Production data provided by Tim Glasco, Los Alamos County Water Utility

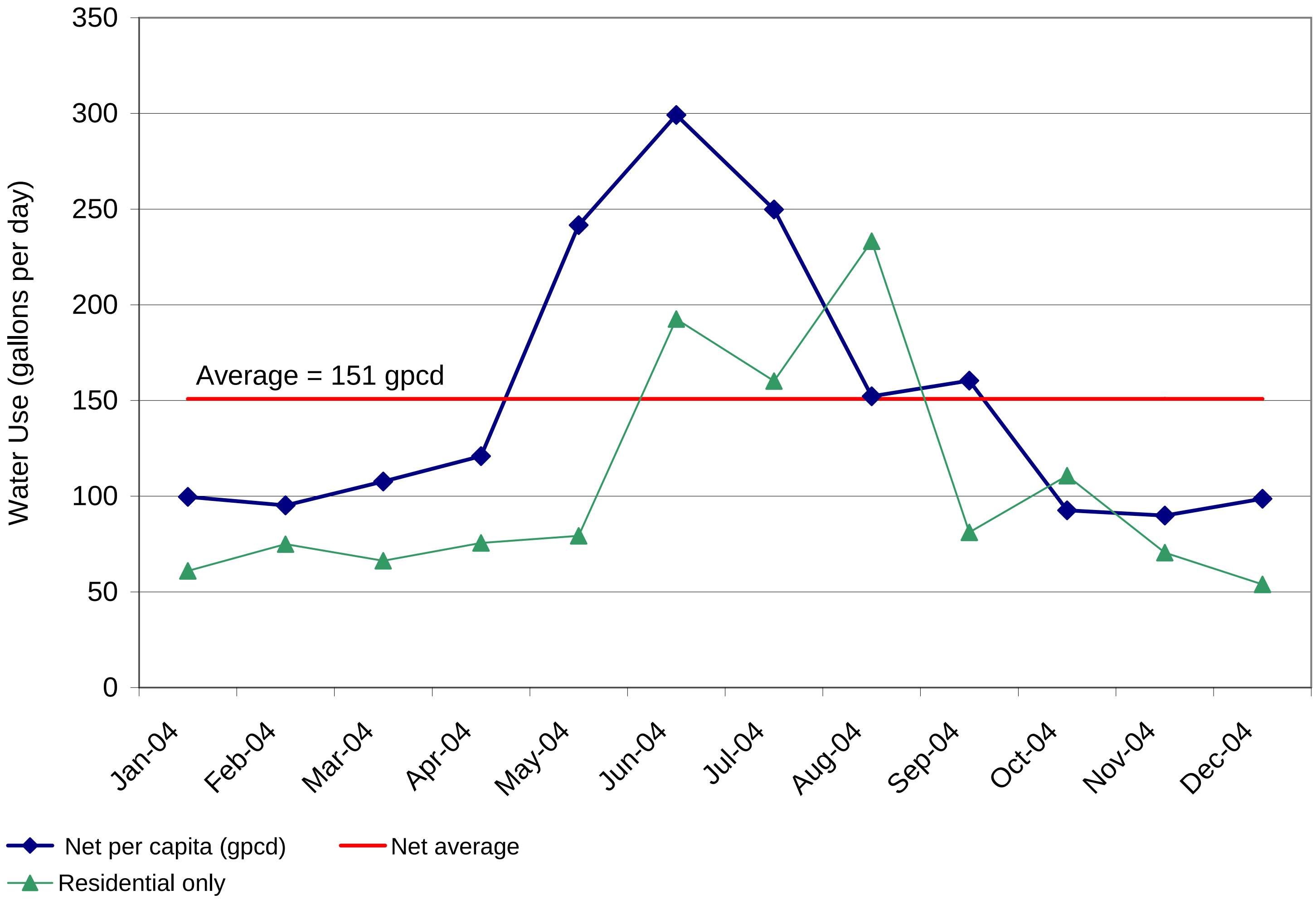
[a] Decreases in storage (-) are added to the supply, storage increases (+) are subtracted from the supply.
[b] If water is exported and the population is enumerated, the net supply is the same as the gross supply: if water is exported and the population served is not enumerated (e.g., commercial or industrial deliveries), the net supply is the gross supply less water exported.

Table 5-4. Water Demand by Customer Class
Los Alamos County Water Utility

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			Residential (1,000 gals [a])				Non-Residential (1,000 gals)									
Month	Days	Population Served	Single Family	Multi-Family	Total	Per Capita (gpcd) (6 / (3x2))	Commercial & Institutional	Industrial	Public Landscape Irrigation [b]	Other [c]	Total	Total Deliveries (6+12)	Net Supply (from Table 3-3)	Net Per Capita (gpcd) (14 / (3x2))	UAW [d] (14–13)	UAW Ratio [d] (16 / 14)
2003																
Jan	31	18,711	29,877	4,986	34,863	52	6,345	0	1,017	0	7,363	42,226	58,408	101	16,183	0.28
Feb	28	18,711	30,960	4,961	35,921	59	6,314	0	2,358	0	8,673	39,632	58,244	111	18,612	0.32
Mar	31	18,711	30,092	5,738	35,830	52	7,303	0	2,304	0	9,607	39,699	55,650	96	15,951	0.29
Apr	30	18,711	32,280	5,433	37,713	58	6,915	0	1,875	0	8,790	41,070	89,571	160	48,501	0.54
May	31	18,711	47,310	6,923	54,233	82	8,811	0	7,164	0	15,974	63,284	145,697	251	82,413	0.57
Jun	30	18,711	80,688	8,489	89,177	144	10,804	0	16,004	0	26,808	107,496	150,221	268	42,725	0.28
Jul	31	18,711	87,476	9,418	96,894	151	11,986	0	15,104	0	27,090	114,566	191,619	330	77,053	0.40
Aug	31	18,711	119,670	11,349	131,019	206	14,444	0	21,022	0	35,466	155,136	125,764	217	–29,373	–0.23
Sep	30	18,711	94,075	11,263	105,338	168	14,334	0	16,919	0	31,253	125,328	104,800	187	–20,528	–0.20
Oct	31	18,711	121,010	9,393	130,403	209	11,955	0	12,492	0	24,446	145,457	89,157	154	–56,299	–0.63
Nov	30	18,711	37,243	5,932	43,175	66	7,550	0	6,052	0	13,602	50,845	54,247	97	3,402	0.06
Dec	31	18,711	38,463	6,043	44,506	66	7,692	0	1,641	0	9,332	47,795	56,421	97	8,626	0.15
Total	365	18711	749,145	89,927.2	839,071.8	123	114,453	0	103,952	0	218,404	1,057,476	1,179,799	173	122,323	0.10
2004																
Jan	31	18,796	31,064	4,431	35,495	61	5,639	0	1,110	0	6,750	42,245	58,049	100	15,805	0.27
Feb	28	18,796	33,760	5,704	39,463	75	7,259	0	1,599	0	8,858	48,321	50,131	95	1,810	0.04
Mar	31	18,796	32,086	6,540	38,626	66	8,324	0	1,432	0	9,756	48,382	62,736	108	14,353	0.23
Apr	30	18,796	37,318	5,299	42,618	76	6,745	0	2,504	0	9,249	51,866	68,169	121	16,303	0.24
May	31	18,796	40,567	5,645	46,212	79	7,184	0	4,838	0	12,022	58,235	140,790	242	82,556	0.59
Jun	30	18,796	99,416	9,157	108,573	193	11,365	0	15,703	0	27,068	135,641	168,662	299	33,021	0.20
Jul	31	18,796	82,731	10,596	93,327	160	9,103	0	7,504	0	16,606	109,933	145,577	250	35,644	0.24
Aug	31	18,796	123,584	12,353	135,937	233	20,397	0	25,570	0	45,968	181,905	88,726	152	–93,179	–1.05
Sep	30	18,796	38,157	7,588	45,745	81	9,075	0	14,947	0	24,022	69,767	90,451	160	20,684	0.23
Oct	31	18,796	57,818	6,664	64,481	111	9,614	0	2,581	0	12,195	76,677	53,975	93	–22,702	–0.42
Nov	30	18,796	34,319	5,416	39,735	70	7,605	0	5,844	0	13,449	53,184	50,694	90	–2,490	–0.05
Dec	31	18,796	26,817	4,584	31,401	54	5,748	0	2,808	0	8,557	39,958	57,500	99	17,542	0.31
Total	365	18796	637,637	83,976	721,614	105	108,059	0	86,442	0	194,501	916,115	1,035,461	151	119,347	0.12

Form created by B.C. WIlson, P.E., New Mexico Office of the State Engineer, 02/16/2000.
Source: Production data provided by Tim Glasco, Los Alamos County Water Utility
gpcd = Gallons per capita per day
UAW = Unaccounted-for water

[a] Unless otherwise noted
[b] Public landscape irrigation includes authorized water deliveries (estimated or metered) to athletic fields, golf courses, parks, cemeteries, and greenbelts.
[c] Other includes authorized water deliveries (estimated or metered) for firefighting training, main flushing, storm drain flushing, sewer cleaning, street cleaning, schools, decorative water facilities, swimming pools, construction projects, water quality and other testing, and process water at treatment plants.
[d] Negative values represent release from storage or inconsistent timing with meter readings



Notes:

1. Net per capita includes commercial and unaccounted for losses, not including LANL
2. Residential is based on amount of sales to residential customers. Per capita rate is higher in August because water was derived from storage.

LOS ALAMOS COUNTY WATER PLAN

Residential and Net Per Capita Demand in 2004

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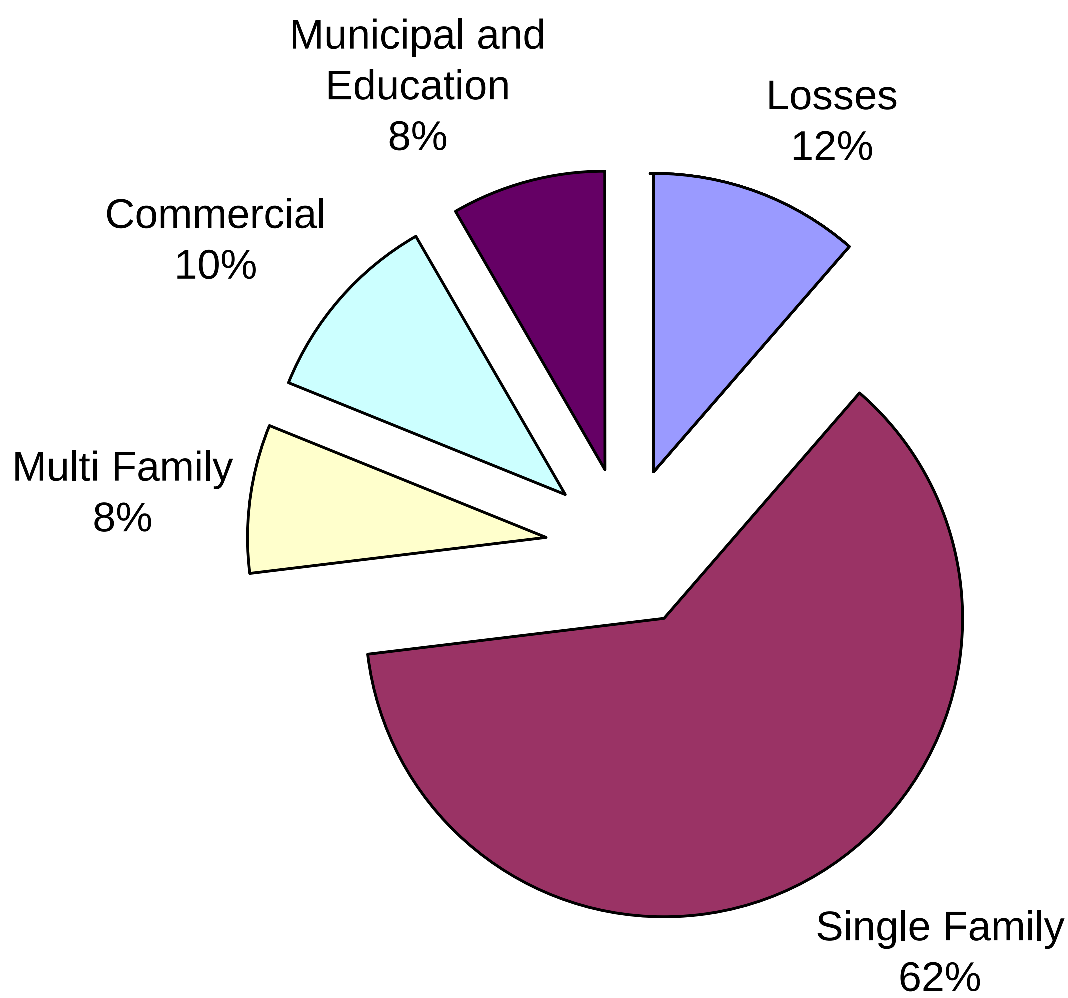
5/26/06

Figure 5-4



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LOS ALAMOS COUNTY WATER PLAN

Water Demand by Customer Class in 2004

Figure 5-5

Per capita demand by residents in multi-family dwellings is much less than single-family residents because the outdoor irrigation needs are usually much less and the dwellings are usually smaller, with fewer fixtures and appliances. Indoor use (based on winter water use) is estimated at 35 gpcd and outside water use is estimated at 15 gpcd. Review of meter records for multi-family dwellings shows multiple months of no charge for water use at more than 20 percent of the accounts over a 17-month period. Therefore, per capita water use for the multi-family dwellings is probably higher than 50 gpcd, although it is within the range reported by Vickers (2001) of 45 to 70 gpcd for multi-family dwellings.

Indoor watering is estimated as the average water use rate for December, January, and February. In 2004 about 60 percent of the water used by Los Alamos and White Rock residents was for indoor use, with the remaining 40 percent for landscape watering. Single family residents used 57 percent for indoor use and 43 percent for outside use, whereas multi-family residents used 70 percent for indoor and 30 percent for outside use. For single family residents, an estimated 71 gpcd was used in 2004 for indoor plumbing, as estimated by consumption during winter months, and an additional 52 gpcd is estimated for landscape watering averaged over a year, giving a total estimated use of 123 gpcd.

In 2003 the indoor use for single family residents was a lower percentage, 53 percent, whereas outdoor irrigation was 47 percent. The greater water use outdoors was due to the lower precipitation in 2003 as compared to 2004. Indoor water use for *single family* residents in 2003 was estimated at 77 gpcd and 68 gpcd for outdoor use, for total use of 144.4 gpcd. With system losses at 18 gpcd, the *total* residential per capita demand in 2003 was 162.3 gpcd. *Multi-family* units used 54 gpcd (38 indoor and 16 outdoor). Table 5-5 summarizes the per capita demand rates.

The overall per capita demand rate for residential customers in 2004 was 105 gpcd (Table 5-6). If unaccounted-for losses, commercial, and municipal uses are included, the demand was 151 gpcd. If water use by LANL is factored in, the demand rate was 201 gpcd.

Table 5-5. Residential Water Use in 2003 and 2004 in Los Alamos County

	Single Family		Multi-Family	
Residential	gpcd	% [a]	gpcd	% [a]
2003				
Indoor	77	53	38	71
Outdoor	68	47	16	29
Unaccounted-for water	18		18	
Total per capita demand	163		72	
2004				
Indoor	71	57	35	70
Outdoor	52	43	15	30
Unaccounted-for water	17		17	
Total per capita demand	140		67	

[a] Percentage of total household use

Table 5-6. Per Capita Demand Rates in 2004 for Single and Multi-Family Residential, Commercial, and LANL Uses

	Demand (gpcd)		
	Residential		
Type	Single Family	Multi-Family	Total
Percentage of residential use	*88%*	*12%*	---
Indoor water use	71	35	62
Outdoor water use	52	15	43
Total residential water use (indoor and outdoor)	123	50	105
Unaccounted-for water	---	---	17
Commercial/municipal per capita demand	---	---	28
Net per capita demand			
Without LANL	---	---	150.9
LANL per capita demand	---	---	50.5
Total (County and LANL)	---	---	201.5

gpcd = Gallons per capita per day   --- = Not applicable

The percentages of water processed by the WWTPs in 2003 and 2004 were:

- 48 and 46 percent of the total metered deliveries
- About 60 to 65 percent of the residential water deliveries

An average 100 percent of the residential use in December through February 2003 was treated at the Bayo and White Rock WWTPs as compared to an average of 31 percent in summer months, reflecting the greater use of water for outdoor irrigation. The monthly per capita demand in 2004 (Figure 5-4) more than tripled from winter to summer.

For more than 60 years, Los Alamos County has used treated wastewater to irrigate turf for a golf course and parks during summer months. The golf course built in Los Alamos in the 1940s has never been irrigated with anything but effluent. Figure 5-6 shows the volume of treated effluent by month and the amount that is reused to irrigate ball fields, parks, a golf course, and school playing fields. Wastewater from the White Rock WWTP that is not reused (in winter) is discharged to the Canada del Buey, which returns to the Rio Grande 1.1 miles downstream. Treated effluent from the Bayo WWTP that is not reused is discharged to Pueblo Canyon.

5.3 Population Projections

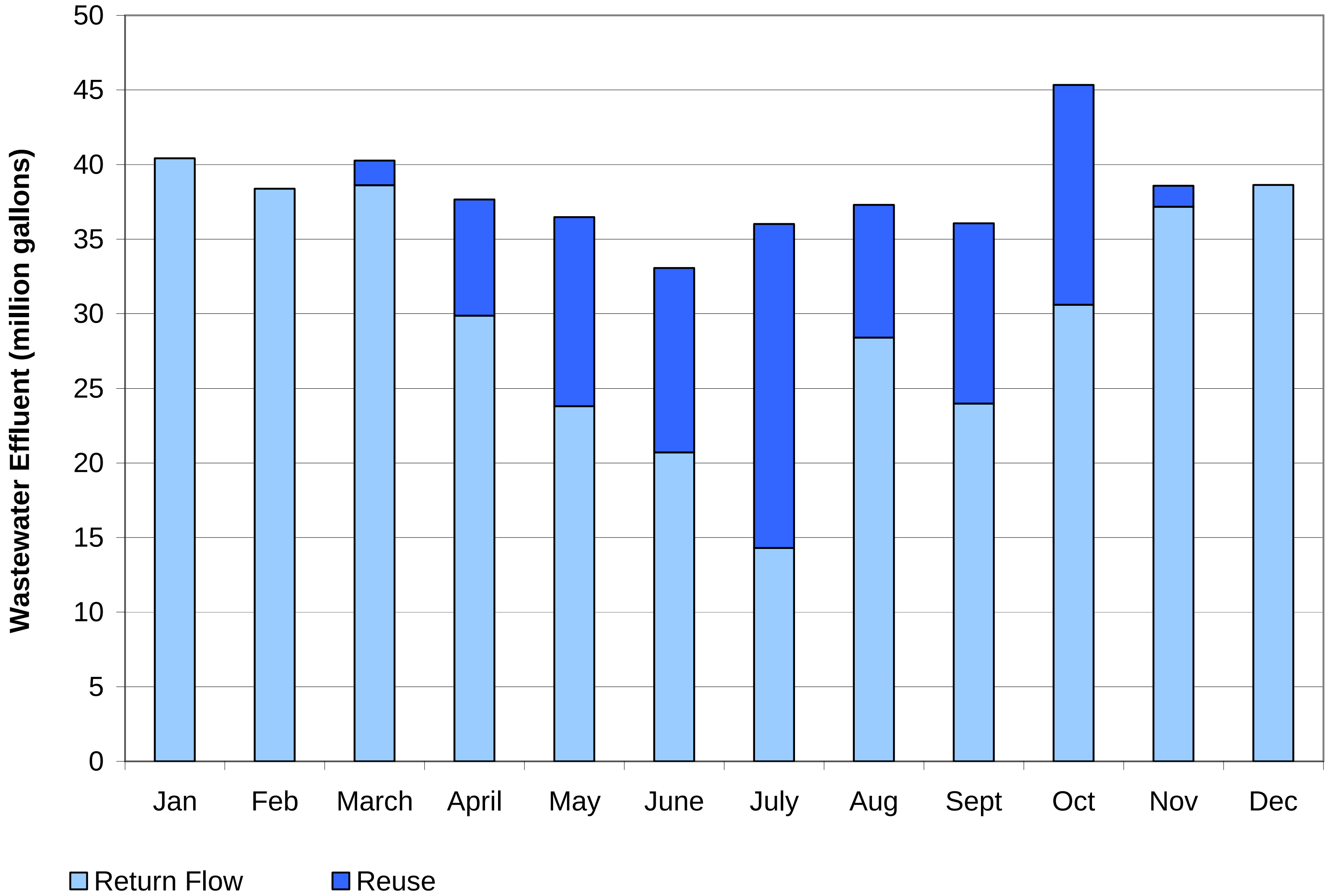
In order to estimate the long-range population growth in Los Alamos County, DBS&A examined the historical population of the County, factors that may impact County growth, and available population projections for the County (Sections 5.3.1 through 5.3.3, respectively).

5.3.1 Historical Growth in the Region

Table 5-7 shows historical population change in Los Alamos County. Because Los Alamos County was not created until 1949, the earliest census estimate is for 1950. From that time to 1980, the population increased steadily. As shown in Table 5-7, however, the ten-year growth rates for the County have dropped from almost 25 percent from 1950 to 1960 (about 2.5 percent per year) to 1.3 percent from 1990 to 2000 (about 0.1 percent per year).

Since the 2000 census, the estimated population has fluctuated by about 1,000, from a low of 17,707 in July 2001 to 18,796 in 2004 (U.S. Census Bureau, 2005):

- April 1, 2000: 18,343
- July 1, 2000: 18,287



LOS ALAMOS COUNTY WATER PLAN

Distribution of Wastewater Effluent in 2003

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8/23/06

Figure 5-6

- July 1, 2001: 17,707
- July 1, 2002: 18,239
- July 1, 2003: 18,711
- July 1, 2004: 18,796

Table 5-7. Historical Population, Los Alamos County

Year	Population	Ten-Year Growth Rate (%)
1950	10,476	
1960	13,037	24.4
1970	15,198	16.6
1980	17,599	15.8
1990	18,115	2.9
2000	18,343	1.3
2004	18,796	

Source: U.S. Census Bureau, 1995, 2006

The population of Los Alamos has been dependent on LANL, but is limited in part by land availability and affordability. As a result, more people work in the County than live in it (Fruth, 2004).

5.3.2 Factors That Could Impact Future Growth

In a New Mexico First Town Hall workshop in August of 2004, the County identified several goals for creating a sustainable Los Alamos County that may impact future growth and water demand (Fruth, 2004), including:

- Increase the availability of housing in the county
- Increase retail opportunities
- Diversify the economy to become less dependent on LANL

Based on these goals, the County is pursuing three growth actions that they hope to complete by 2020. These include (Fruth, 2004):

- Constructing approximately 2,800 new housing units on about 979 acres of land (which would cause the population to grow from about 18,500 to 25,000 people)
- Increasing retail sales by constructing approximately 365,000 square feet of new retail space on 45 acres of land
- Creating 2,500 new high-wage primary industry jobs, which will require the construction of approximately 875,000 square feet of office, laboratory, and industrial space on 67 acres of land

These growth actions are dependent on land transfers from the federal government. Under Public Law 105-119, passed by the U.S. Congress in 1997, DOE will transfer to the County 2,674 acres of land parcels for the purpose of development. This process began in 2002, when DOE conveyed 14 parcels totaling more than 197 acres (Los Alamos County, 2005).

Projected growth at LANL, defined in terms of water demand, was discussed in the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of LANL* (site-wide EIS) (U.S. DOE, 1999). The Record of Decision shows the Expanded Use Alternative as the selected alternative. Under this alternative, water use would increase to 2,330 ac-ft/yr.

5.3.3 Previous Population Projections for the Region

To project population growth, the Bureau of Business and Economic Research (BBER) at the University of New Mexico examined the growth rate in the previous decade, the age of the population, current rates of in-migration, and death and birth rates (BBER, 1996, 2000). Because Los Alamos County's growth rate slowed significantly in the 1980s and 1990s, BBER's projections for growth over the next 60 years were very small, showing an increase of only about 3,000 people (Table 5-8). An estimate by POLICOM Corporation (Fruth, 2004), based on the County's plans for land transfers and increasing available housing, shows a full build-out to occur rapidly, increasing the population to 25,000 people in 2020 (Table 5-8).

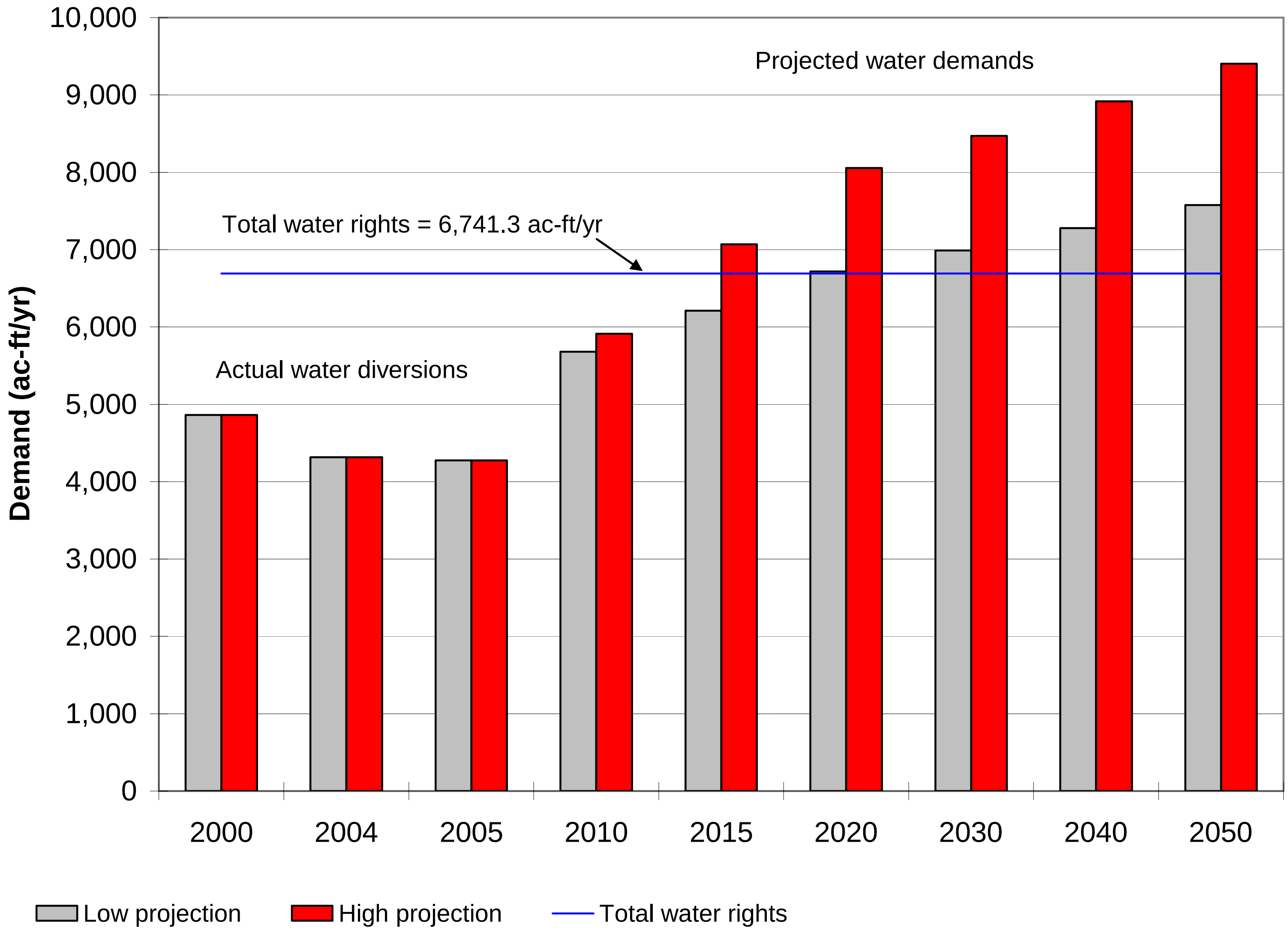
Table 5-8. Population Projections for Los Alamos County 2000 through 2060

Year	Population Census	BBER (1996)	BBER (2000) [a]	Fruth (2004)
2000	18,343	19,317	19,234	18,359
2004	18,796	19,647	19,505	18,796
2005		19,729	19,573	19,189
2010		20,123	19,913	21,155
2015		20,601	20,318	23,120
2020		21,079	20,722	25,086
2030		21,758	21,289	---
2040		22,141	21,627	---
2050		22,291	21,761	---
2060		22,404	21,854	---

[a] Based on BBER's (2000) "most likely" scenario
--- = Population estimated only through 2020

5.4 Future Water Demand

DBS&A developed two projections of future water demand for the LACWU, a low estimate (Projection 1) and a potential high estimate (Projection 2). BBER's projections for growth to 2060 were not used to estimate future water demand because they do not take into account the recent land transfers and plans for growth. Instead, both projections are based on the growth scenario identified in the August 2004 New Mexico First Town Hall (Fruth, 2004). Under this scenario, referred to as the full build-out scenario, the population would increase to 25,086 by 2020, commercial retail space would increase by 365,000 square feet, and 2,500 new high-wage jobs would be created with 875,000 more square feet of office space for these jobs. (Even though it is possible that the goals for full build-out will not be achieved, both the high and low estimates are based on the full build-out scenario so that this water plan will be consistent with other Los Alamos County planning initiatives.) The projected demand for both the low and high projections is shown in Figure 5-7.



LOS ALAMOS COUNTY WATER PLAN

Projected Water Demands Under the Full Build-Out Scenario

Figure 5-7

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The projections also take into account the proportion of single and multi-family dwellings and their per capita demand rate. The single family per capita demand is 163 gpcd (0.182 ac-ft/yr per person) and the multi-family rate is 72 gpcd (0.08 ac-ft/yr per person). The per capita demand rate is based on the demand in 2003, which was a dry year, and includes 18 gpcd of unaccounted-for losses.

For Projection 1, it was assumed that the percentage of population living in multi-family dwellings will increase from a current share of 24.4 percent to 40 percent of the total population. This projected increase is based on the limited amount of land available for housing and the anticipated developments. Because multi-family residents use less than half the water that single family residents use, the projected growth in water demand for the residential sector is less than the rate of population growth. Accordingly, although the population is projected to increase by 30 percent in 2020, the residential water use is projected to increase from 3,014 ac-ft/yr in 2005 to 3,542 ac-ft/yr in 2020, an increase of only 17.5 percent (Table 5-9, Figure 5-8). (Because the population is projected to increase by only 0.5 percent per year after 2020, the differences between rates of population growth and water use are less dramatic in ensuing years.)

Commercial water use is projected to increase relatively dramatically to 2020, but then slow to a rate of 0.5 percent after 2020 (Table 5-9, Figure 5-8). The assumptions used to estimate the increases in commercial water use are described below:

- The water use from the increased commercial retail space is based on the current water use rate of 670 ac-ft/yr for 299,000 square feet, or 0.0022 ac-ft/yr per square foot of commercial retail space. With the addition of 365,000 square feet of retail space, water use should increase to 1,489 ac-ft/yr.

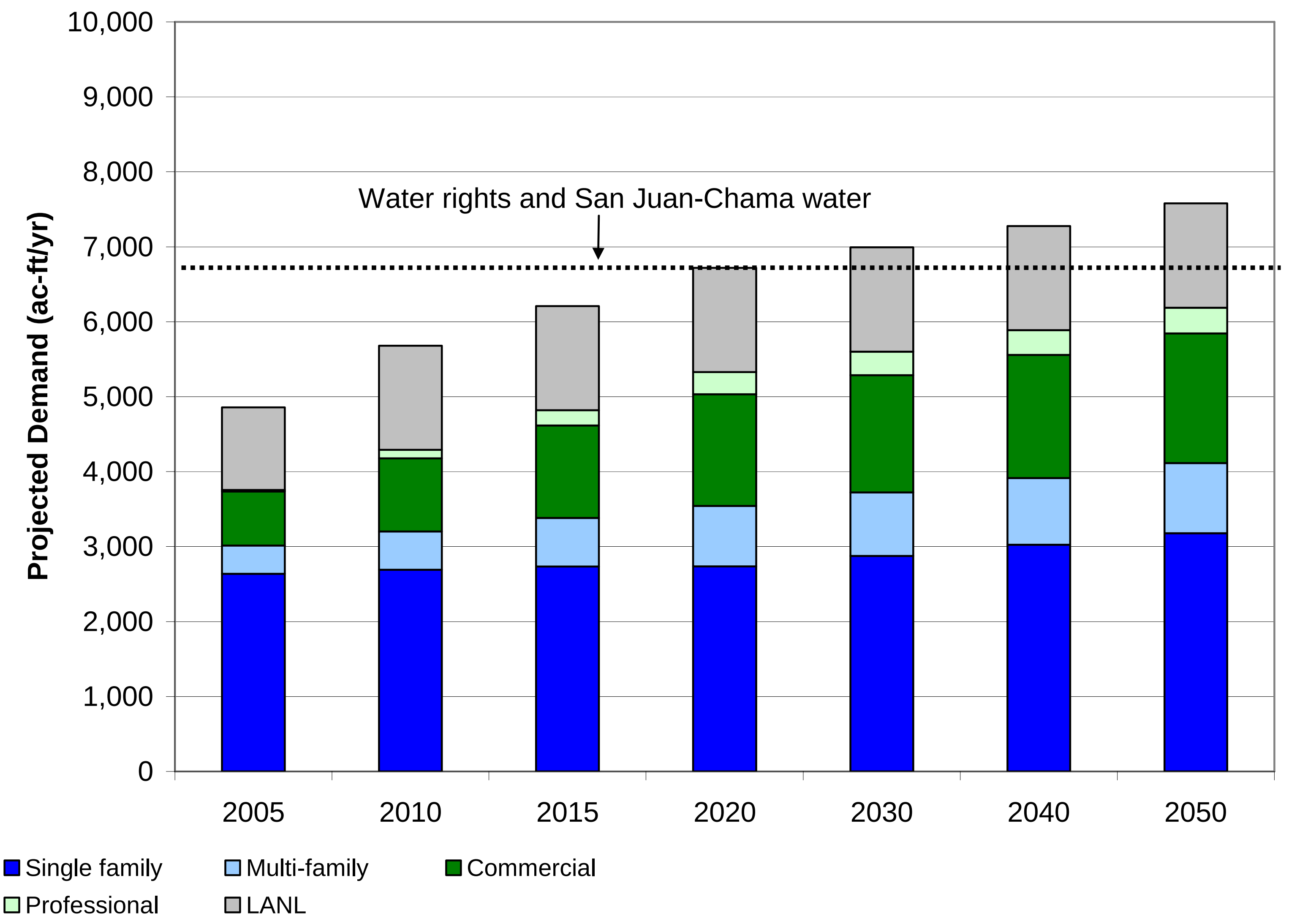
- The water use to support the 2,500 additional jobs that are projected is estimated based on the assumption that each employee uses 106 gallons per day (Vickers, 2001) or about 0.12 ac-ft/yr for a total of about 300 ac-ft/yr.

Table 5-9. Low Projected Water Use Under Full Build-Out Scenario (Projection 1) Los Alamos County

Year	Projected Population [a]			Projected Per Capita Residential Water Use [a] (ac-ft/yr)			Commercial Retail Space [a] (sq ft)	Projected Commercial Water Use [a] (ac-ft/yr)				Total Projected Water Demands [a] (ac-ft/yr)
	Total	Single Family	Multi-Family	Single Family	Multi-Family	Total		Per Square Foot	Retail	New High-Paying Jobs	LANL	
2000	*18,343*											*4,862*
2004	18,796	14,214	4,582	0.157	0.076	*2,581*	299,000	0.0022	670	0	1,064	*4,315*
2005	19,189	14,511	4,678	0.182	0.080	3,014	321,813	0.0022	721	19	1,103	*4,276*
2010	21,155	14,808	6,346	0.182	0.080	3,202	435,875	0.0022	977	111	1,391	5,681
2015	23,120	15,028	8,092	0.182	0.080	3,382	549,938	0.0022	1,233	204	1,391	6,210
2020	25,086	15,052	10,034	0.182	0.080	3,542	664,000	0.0022	1,489	297	1,391	6,719
2030	26,369	15,821	10,548	0.182	0.080	3,724	697,957	0.0022	1,565	312	1,391	6,991
2040	27,717	16,630	11,087	0.182	0.080	3,914	733,651	0.0022	1,645	328	1,391	7,277
2050	29,135	17,481	11,654	0.182	0.080	4,114	771,170	0.0022	1,729	345	1,391	7,578
Assumptions for Projections	Fruth (2004) for 2004 to 2020, then assume ½% annual to 2050	2000 Census updated for 2004	2000 Census updated for 2004	2003 billing data, includes UAW	2003 billing data, includes UAW	Based on 2003 per capita demand	Fruth (2004)	2003 billing data including landscape irrigation	Los Alamos County commercial use per sq ft in 2003	Based on # of employees	Water use in 1999	
	Assumes 979 acres are available (so far only 53.53 acres in transfer for residential)	Single family dwelling units 75.6% in 2005, decreasing to 60% by 2020	Multi-family dwelling units 24.4% in 2005, increasing to 40% in 2020	Chose 2003 for projection because precipitation <10 inches so demand higher than wet year						Vickers (2001) shows 106 gal per employee per day for public administration and social services		

[a] Italicized values indicate measured, not projected, demand

ac-ft/yr = Acre-feet per year
sq ft = Square foot
LANL = Los Alamos National Laboratory



LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under Low Water Use Projection

Figure 5-8

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Water use by LANL under Projection 1 is based on the highest water use (from the period 1999 to 2005) of 1,391 ac-ft/yr in 1999. While LANL used only 1,103 ac-ft in 2005, their water use may increase in the future. Therefore, the projection to 2050 shows a constant rate of water use at the 1999 rate (Table 5-9, Figure 5-8). Water use by LANL will likely fluctuate depending on future laboratory activities.

The total projected water use under the low full build-out scenario (Projection 1) is estimated to increase from about 4,300 ac-ft/yr in 2005 to 6,719 ac-ft/yr in 2020 without any conservation efforts (Table 5-9, Figure 5-8). This amount is almost equal to the total water rights held by the County of 6,741.3, including San Juan-Chama water. By 2050, the water use would increase to 7,578 ac-ft/yr, or 837 ac-ft more than the combined water rights and San Juan-Chama water.

Projection 2 is a high estimate under the full build-out scenario. The projection is the same as Projection 1, except that the ratio of single family and multi-family dwellings does not change from the current ratio and the amount of water use by LANL is increased to 2,330 ac-ft/yr based on the site-wide EIS (U.S. DOE, 1999). Under this projection, water demand would increase to 8,055 ac-ft/yr by the year 2020 (Table 5-10, Figure 5-9), or about 1,314 ac-ft/yr more than the total water rights including San Juan-Chama water. After 2020, residential and commercial water use would increase at 1 percent per year. By the year 2050, water demand under this projection would be 9,374 ac-ft/yr or 2,633 ac-ft more than the combined water rights and San Juan-Chama water (Table 5-10, Figure 5-9).

Population projections are highly uncertain; while it is conceivable that the population will grow very little, it is also possible that the high projection is underestimating the potential growth. The County's current plans have developed around the land transfer of 2,674 acres from DOE that began in 1997. An additional 3,000 acres may also be transferred to the County, thus allowing more area for development.

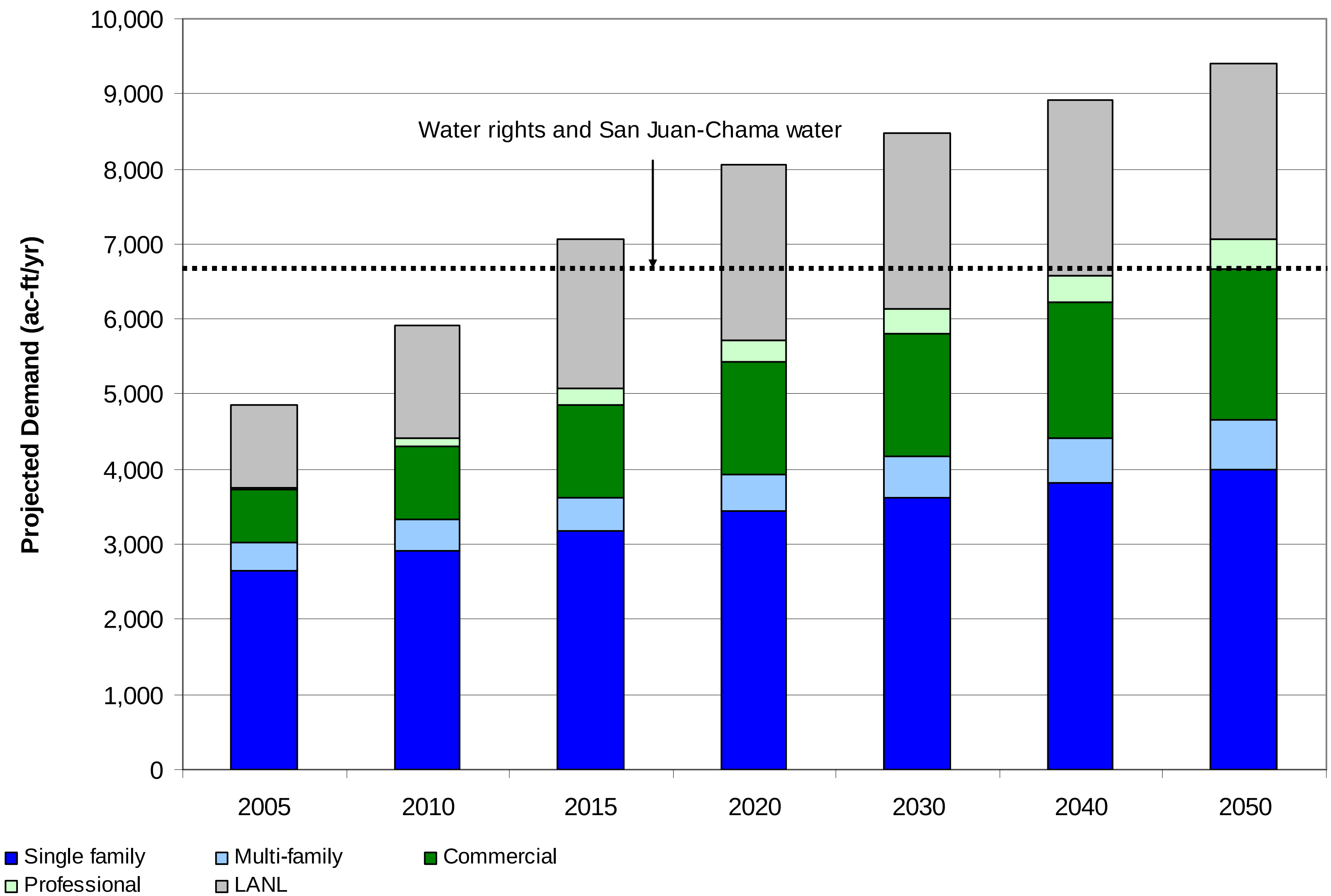
Another way to plan for the future of the water system is to consider the amount of growth that could potentially be sustained without having to purchase and transfer new water rights. The potential population that could be sustained by the County's existing water rights of 6,741.3 ac-ft/yr can be estimated based on different levels of conservation (Figure 5-10):

Table 5-10. High Projected Water Use Under Full Build-Out Scenario (Projection 2) Los Alamos County

Year	Projected Population			Projected Per Capita Residential Water Use (ac-ft/yr)			Commercial Retail Space (sq ft)	Projected Commercial Water Use (ac-ft/yr)				Total Projected Water Demands (ac-ft/yr)
	Total	Single Family	Multi-Family	Single Family	Multi-Family	Total		Per Square Foot	Retail	New High-Paying Jobs	LANL	
2000	*18,343*											*4,862*
2004	18,796	14,214	4,582	0.157	0.076	*2,581*	299,000	0.0022	670	0	1,064	*4,315*
2005	19,189	14,511	4,678	0.182	0.080	3,014	321,813	0.0022	721	19	1,103	4,276
2010	21,155	15,993	5,162	0.182	0.080	3,322	435,875	0.0022	977	111	1,500	5,911
2015	23,120	17,479	5,641	0.182	0.080	3,631	549,938	0.0022	1,233	204	2,000	7,068
2020	25,086	18,965	6,121	0.182	0.080	3,940	664,000	0.0022	1,489	297	2,300	8,025
2030	27,711	19,935	6,761	0.182	0.080	4,168	733,469	0.0022	1,644	328	2,300	8,440
2040	30,610	20,954	7,469	0.182	0.080	4,410	810,206	0.0022	1,816	362	2,300	8,888
2050	33,812	22,026	8,250	0.182	0.080	4,667	894,972	0.0022	2,006	400	2,330	9,374
Assumptions for Projections	Fruth (2004) for 2004 to 2020, then assume 1% annual after	2000 Census updated for 2004 (U.S. Census Bureau, 2006)	2000 Census updated for 2004 (U.S. Census Bureau, 2006)	2003 billing data, includes unaccounted-for water (UAW)	2003 billing data, includes UAW	Based on 2003 per capita demand	Fruth (2004)	2003 billing data including landscape irrigation	Los Alamos County commercial use per sq ft in 2003	Based on # of employees	Site-wide EIS (U.S. DOE,1999) projection for continued operation	
	Assumes 979 acres are available (so far only 53.53 acres in transfer for residential)	Single family dwelling units 75.6% of all dwellings	Multi-family dwelling units 24.4% of all dwellings	Chose 2003 for projection because precipitation <10 inches so demand higher than wet year						Vickers (2001) shows 106 gallons per employee per day for public administration and social services		

[a] Italicized values indicate measured, not projected, demand

ac-ft/yr = Acre-feet per year
sq ft = Square foot
LANL = Los Alamos National Laboratory



LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand Under High Water Use Projection

Figure 5-9

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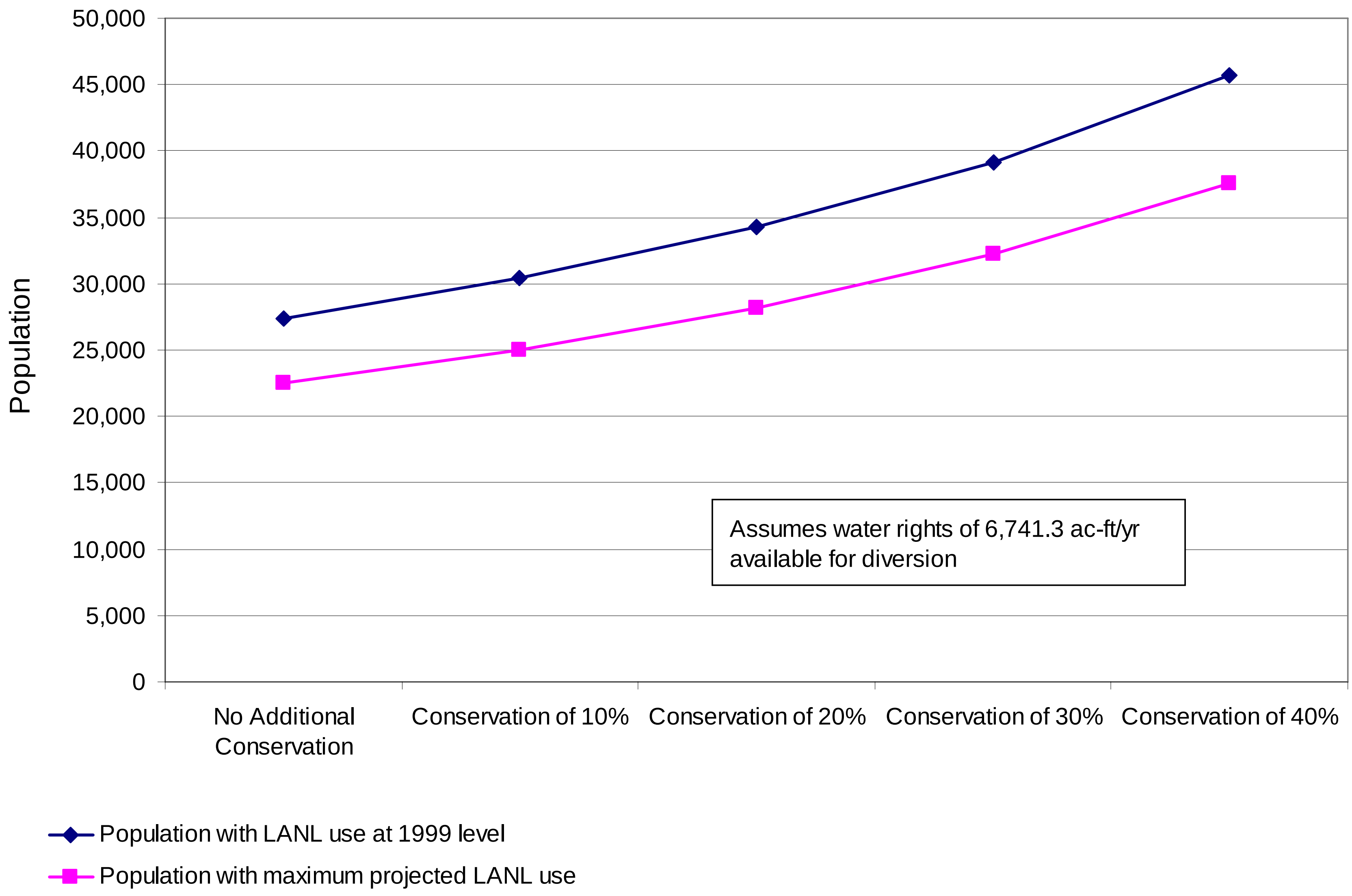

Figure 5-10

LOS ALAMOS COUNTY WATER PLAN

Sustainable Population Under Different Conservation Levels

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- If LANL uses as much as they used in 1999 (1,391 ac-ft) and the demand rate remains the same as it was in 2003 (172 gpcd including commercial and unaccounted-for losses), the County could support 27,800 people on the remaining 5,350.3 ac-ft/yr of water rights.

- If the County pursues more aggressive conservation plans and demand is reduced by 40 percent to 104 gpcd (including commercial and unaccounted for losses), the population that could be supported could go as high as 45,900 people.

- If, however, LANL uses the maximum projected under the Site-Wide EIS of 2,330 ac-ft/yr, only 4,411.3 ac-ft/yr would remain for County residents, and the population that can be sustained would vary from 22,900 with no increased conservation efforts to 37,900 with a demand reduction of 40 percent.

All of these projections assume that the water supply remains available in terms of water rights and contamination.

6. Reconciliation of Supply with Demand

To ensure that adequate water resources are available to meet future demands, Los Alamos County must take into consideration the quantity of supply available, limitations to the supply due to water quality concerns, and the legal ability to use the available supply (water rights).

The physical water supply is discussed in detail in Section 3. Given the amount of water in storage and the large saturated thickness in relation to observed rates of water level decline, and assuming that Los Alamos County remains the primary diverter in the area, the County is expected to have an adequate quantity of supply to meet the projected demands over a 40-year time frame. Wells may need to be replaced or moved to new locations, but it is expected that the available supply somewhere in the vicinity of Los Alamos will be adequate to fulfill the County's existing water rights. Ongoing monitoring of water levels and aquifer testing is recommended to confirm that threats to water supply do not develop.

As discussed in Section 3.2, there is some risk to the supply due to contamination. Though current drinking water supplies have not exceeded water quality standards, County supply wells could become unusable over the 40-year plan horizon due to contamination. Continued monitoring, in conjunction with LANL monitoring efforts, is recommended to determine if any contaminant concentrations exceed acceptable levels. If excessive contaminant levels are detected in any supply well, the County can redrill the well in an alternate location and continue to pump the same amount, providing that the transfer of the diversion point is approved by the OSE. Additional discussion of contaminant and water rights risks is presented in Sections 3.3.2 and 4.3 and recommendations for responding to these risks are discussed in Section 10.

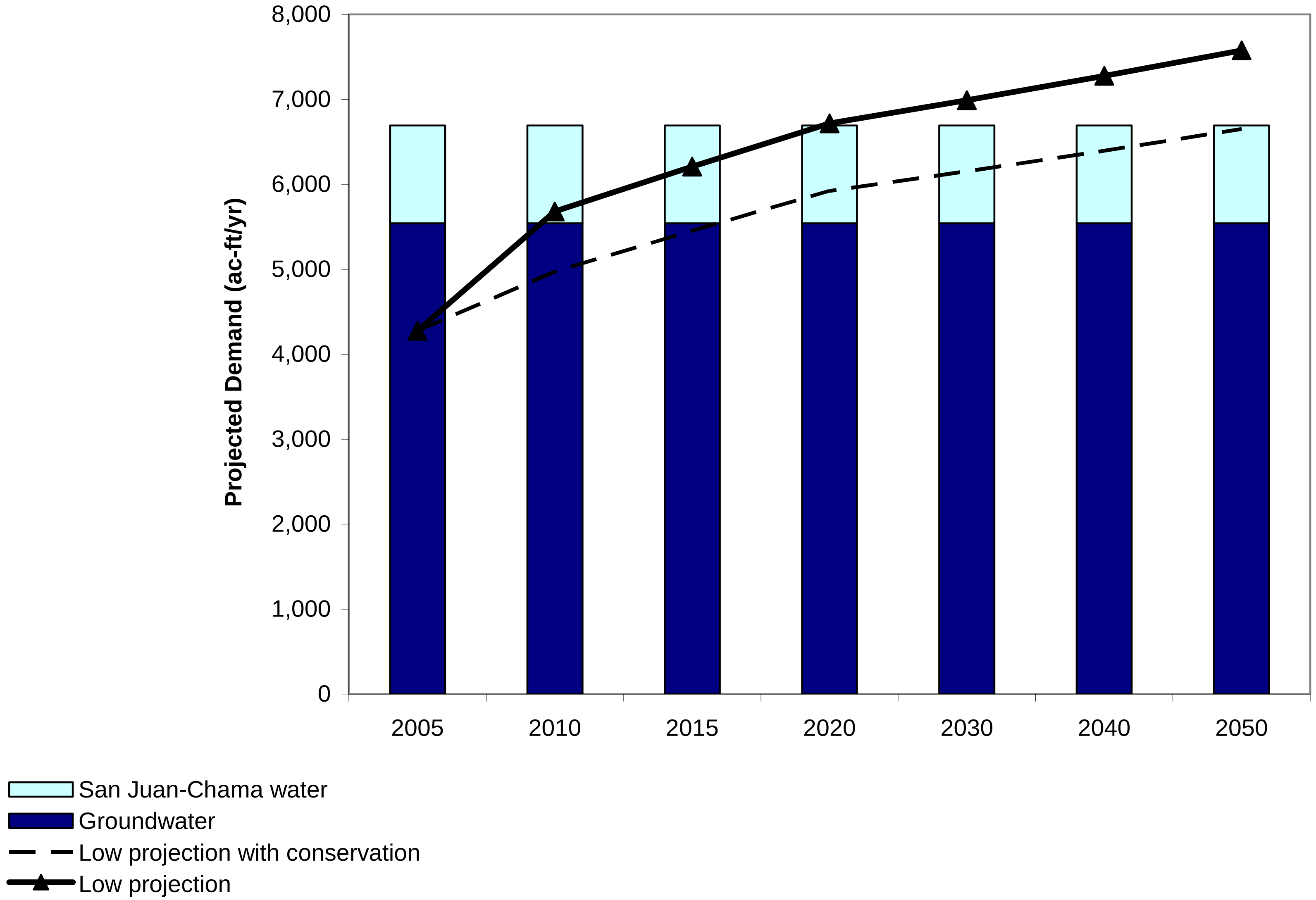
As discussed in Section 5.4, both a low- and a high-water-use projection were developed based on growth projections that had previously been developed by the Los Alamos County Planning Department. To evaluate the gap between the projected demands and the available supply, two scenarios were considered:

- *Scenario 1: Low-water-use projection and supply available to fulfill water rights.* The total projected water use under the low water use scenario (Projection 1) is estimated to increase from about 4,300 ac-ft/yr in 2005 to 6,719 ac-ft/yr in 2020 without any additional conservation efforts (Table 5-9, Figure 5-8). This amount is almost equal to the total water rights held by the County of 6,741.3 ac-ft/yr, including the County's allotment of San Juan-Chama water. By 2050, the water use would increase to 7,578 ac-ft/yr, or 837 ac-ft more than the combined water rights and San Juan-Chama water. Figure 6-1 shows the water supply in relation to the demands under Projection 1 both with and without implementation of the water conservation measures discussed in Section 8. For this scenario, it was assumed that the County can continue to produce water for which it has a water right, recognizing that either treatment or moving of wells to alternate uncontaminated locations may be required to fulfill those water rights.

- *Scenario 2: High-water-use projection and loss of water rights.* The total projected water use under the high water use scenario (Projection 2) is estimated to increase to 8,055 ac-ft/yr by the year 2020 (Table 5-10, Figure 5-9), or about 1,314 ac-ft/yr more than the total water rights including San Juan-Chama water. After 2020, residential and commercial water use would increase at 1 percent per year so that by the year 2050, water demand under this projection would be 9,374 ac-ft/yr or 2,633 ac-ft more than the combined water rights and San Juan-Chama water (Table 5-10, Figure 5-9). As discussed in Section 4.3.2, there is some risk that if wells need to be moved or other changes are needed that require OSE approval, additional water rights may be required to offset pumping impacts on the Rio Grande. If additional water rights could not be purchased and transferred to the Los Alamos area, the San Juan-Chama water rights might need to be used to offset pumping effects, in which case physical diversion of the San Juan-Chama water would not be possible.

  This scenario envisions such a situation, where a portion of the groundwater supply is contaminated, necessitating the relocation of 2,000 ac-ft of supply well diversions. The scenario further assumes that the OSE requires that the impacts to the Rio Grande be offset in an amount equal to the production of the new wells, necessitating the purchase of native Rio Grande water rights or the use of San Juan-Chama water in an equal amount to offset the pumping. In effect, the groundwater rights would be diminished as shown in Figure 6-2.

In both scenarios, there is a gap between supply and projected demand that will need to be addressed through both water supply initiatives and demand reductions (water conservation).



LOS ALAMOS COUNTY WATER PLAN

Supply and Projected Water Demand Under Low Water Use Projection

Figure 6-1

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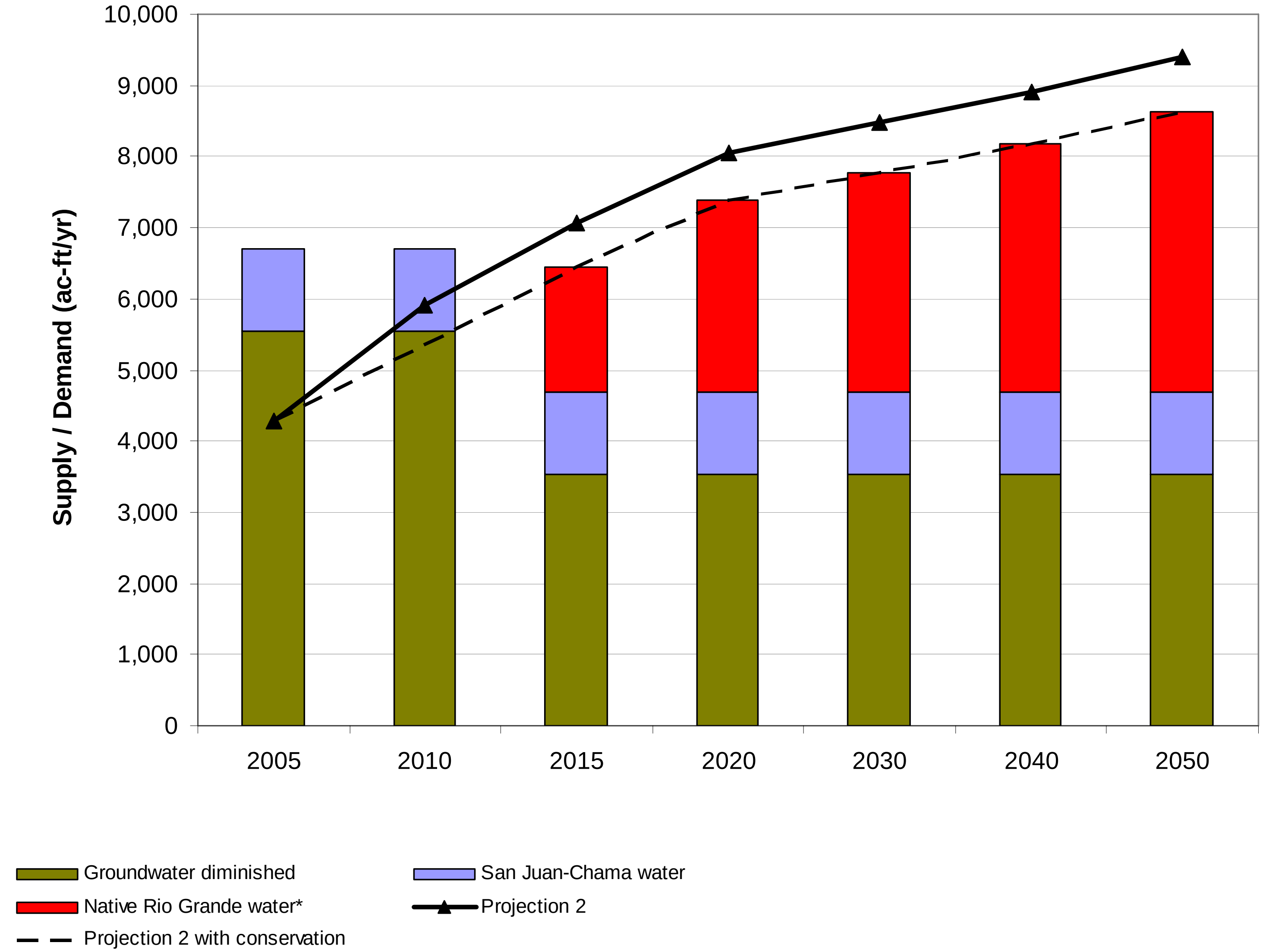

* Additional water rights needed

LOS ALAMOS COUNTY WATER PLAN

Supply and Projected Water Demand Under High Water Use Projection with Diminished Water Rights

Figure 6-2

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7. Timeline for Incorporation of San Juan-Chama Project Water into Los Alamos County Water Supply

As discussed in Section 6, if the County plans for housing development and growth are realized, there will be a gap between supply and demand. One of the solutions to addressing the gap between supply and demand is to increase supply through the use of water contracted to the County from the San Juan-Chama Project. This document represents only a general overall timeline for the project rather than a detailed plan of action for particular facilities; feasibility, conceptual design, and environmental issues related to the San Juan-Chama project either have been or will be addressed by Los Alamos County in separate studies. Nevertheless, the timeline presented herein will allow the County to integrate efforts to implement a project to divert and treat San Juan-Chama water to use as a drinking water supply for Los Alamos County with other water planning efforts.

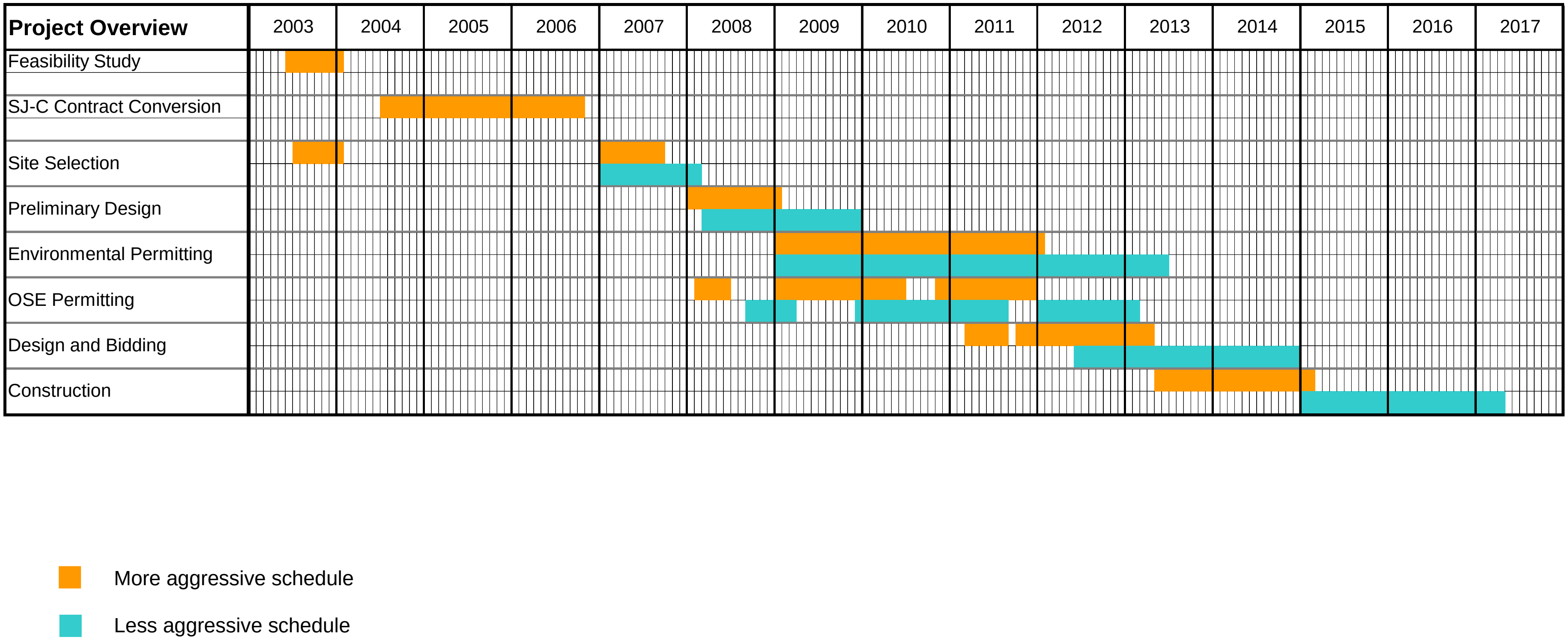
The County of Los Alamos San Juan-Chama Project Utilization Feasibility Study prepared by Boyle Engineering (2004) identified two possible projects that could be used to divert water from the Rio Grande: (1) the river bank option and (2) the mesa top option. The river bank option places a pumping station adjacent the river, and the mesa top option places the pumping station on top of the mesa in White Rock. The river bank option is less expensive ($2.02 per thousand gallons as opposed to $2.42), but would entail greater National Environmental Policy Act (NEPA) complications and would require significant modification of the *Santa Fe National Forest* [SFNF] *Plan* (USFS, 1987).

Since the feasibility study was completed, Los Alamos County has also considered other options, including possible delivery of the diverted San Juan-Chama Project water to LANL instead of groundwater. This option would facilitate a reduction in the overall LANL water demand because half of the water used at LANL is for cooling purposes and use of low-silica water would allow more cycles of the cooling water before it must be discharged, thereby saving on total water use.

The construction elements and duration presented herein may be slightly altered by the option chosen, and additional negotiation may be necessary. Consideration of new alternatives may cause the basic steps and time necessary to complete and implement the project to be extended more significantly.

An overall timeline for implementation of the San Juan-Chama project is shown in Figure 7-1, with task-specific details presented in Appendix B. The timeline, which was developed using the plans for the City of Albuquerque and the County of Santa Fe (entities that have already proceeded with developing San Juan-Chama water) diversion projects as guides, outlines the anticipated steps the County of Los Alamos will be required to take in order to site, design, permit, and construct facilities necessary to divert and treat San Juan-Chama drinking water for distribution to County of Los Alamos water users.

The specific dates in the timeline are dependent on remaining task work beginning in earnest starting early in 2008 and contract conversion (Section 4.1.2) being complete (or the outcome assured) by that time. The timeline also assumes aggressive pursuit of the steps involved. Some of the steps are more or less independent, but others are strongly dependent on a previous task. For example, a delay in starting preliminary design delays detail design, environmental permitting, OSE and NMED approvals, and construction. For the purpose of constructing the timeline, the current assumption is that the long-range water plan and other information that will feed into a final decision on the best alternative can be digested during the remainder of 2006 and 2007 so that preliminary design can begin in 2008.



LOS ALAMOS COUNTY LONG-RANGE WATER PLAN

San Juan-Chama Drinking Water Project Timeline Overview

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Figure 7-1

8. Water Conservation Plan

As discussed previously, if Los Alamos County growth objectives are realized, existing available water supplies will be insufficient to meet projected demand. One option to address the gap is to reduce demand through conservation measures. Even if growth objectives are not realized, conservation is an important component of a sustainable water plan for the County for other reasons:

- For any water rights permitting change that requires OSE approval, such as a change in point of diversion or place of use, the OSE will consider conservation. This requirement is part of an overall strategy by the State to ensure that water is being used wisely before additional diversions are permitted.

- The New Mexico 40-year water planning statute, as well as Section 72-14-3.2 of the NMSA 1978, calls for conservation planning as a prerequisite for funding from key state funding agencies.

- Water conservation can also prevent or delay the need for expensive capital expenditures for developing new water supplies and acquiring additional water rights.

- The Bureau of Reclamation requires a conservation plan to divert San Juan-Chama Project water.

Accordingly, the water conservation recommendations presented in this section are an important part of the Los Alamos County long range water supply plan and will allow the County to make efficient use of and extend its existing resources. This document addresses State conservation requirements and also includes emergency conservation measures for use during times of drought.

8.1 Existing Conservation Practices

The LACWU currently promotes conservation through several actions and programs. This section details these existing conservation practices.

8.1.1 Prohibition of Water Waste

The LACWU Board adopted Rule W-8 in July 2005 as part of the Rules and Regulations of the Water Utility Department. Under Section W-8.04 of Rule W-8:

> . . . no person, firm, corporation, county, school, or state facility or operation shall cause or allow to occur water waste". Wasting of water is defined as:
>
> a. Produced water applied to landscape in such a manner, rate and/or quantity that it overflows the landscaped area being watered and runs onto streets;
>
> b. Produced water applied to landscape which leaves a sprinkler, sprinkler system, or other application device in such a manner or direction as to spray onto streets;
>
> c. Application of produced water to landscape at prohibited times;
>
> d. Washing of vehicles, equipment, or hard surfaces such as parking lots, aprons, pads, driveways, or other surfaced areas when produced water is applied in sufficient quantity to flow from that surface onto streets; and without the use of an automatic shutoff nozzle.
>
> e. Failing to repair a leak in a system which delivers produced water within five (5) working days of the discovery of same.

Because the rule is adopted only by the LACWU Board and is not an ordinance adopted by the Council, the rule cannot be enforced by police and no penalties are associated with violations of the rule. However, the LACWU does have the authority to disconnect a water customer for wasting water.

8.1.2 Limitations to Outdoor Watering

Section W-8.05 of Rule W-8 prohibits the outdoor watering of grass, trees, plants or other vegetation between the hours of 10:00 a.m. and 5:00 p.m. from May 1 through September 30. Outdoor watering is also restricted to certain days of the week depending on the address: users with odd-numbered addresses can water on Wednesdays, Fridays, and Sundays while users with even-numbered addresses can water on Tuesdays, Thursdays, and Saturdays. No outdoor watering is allowed on Mondays.

These restrictions do not apply to (1) any person, firm or corporation engaged in the business of growing plants for sale, (2) construction activities, (3) newly planted sod, trees and bushes (for a period of up to 1 month), or (4) personnel of the County Fire Department engaged in the operation, maintenance or testing of any fire protection system. As with water wasting, the rule is voluntary until adopted by the Los Alamos County Council as an ordinance.

8.1.3 Improvements to Park Irrigation

The Parks Division is in the process of replacing many of the old bubbler systems with new drip irrigation with in-line emitters, replacing old sprinkler systems with new systems that are more water efficient, planting medians with low-water-use plants, and installing moisture detectors in some areas that will shut off sprinklers if ground is sufficiently moist.

8.1.4 Water Rates

The LACWU water rate for residential customers is a flat rate of $3.72 per 1,000 gallons plus a service charge of $7.02 per meter. Commercial rates are also the same with a service charge ranging from $7.02 for water meters less than 1 inch to $41.81 for a 6-inch water meter. The LACWU Board adopted the current water rates in 1998, decreasing the rate by 60 cents per 1,000 gallons to remove the costs of DOE overhead.

Table 8-1 lists the number of residential and commercial connections and the average monthly fee, including the meter service charge, for Los Alamos and other New Mexico communities of comparable size. As demonstrated in this table, the water rates for Los Alamos are high in comparison to other communities of its size. These relatively high water rates have allowed the LACWU to repair and upgrade the water system, which had received little maintenance when operated by the DOE.

Table 8-1. Water Rates in New Mexico Communities

Municipality	Residential: Number of Connections	Residential: Charge for 6000 Gallons per Month [a] ($)	Commercial: Number of Connections	Commercial: Average Monthly Rate [a] ($)
Carlsbad	9,140	9.91	1468	12.56
Farmington	12,243	17.83	2118	17.19
Hobbs	9,191	10.50	1601	10.50
Las Vegas	5,349	21.06	746	37.59
Los Alamos	6,501	29.34	525	24.90
Village of Ruidoso	7,623	22.74	634	26.59
Average of all New Mexico towns/cities	3,898	19.39	447	23.18

Source: NMED Construction Programs Bureau Municipal Water and Wastewater User Charge Survey, May 1, 2004
[a] Includes monthly meter service charge

8.1.5 Automated Billing System

In May of 2004 the LACWU updated its Cayenta billing system to better monitor water use. The updated system allows LACWU staff to track use by customers and provides ready access to the LACWU's water use data. The program flags accounts when monthly use is out of the normal range of the previous month or the same month of the previous year.

The LACWU staff investigates the flagged accounts on a monthly basis, which has allowed for leak identification and repair. LACWU will first re-read accounts that have been flagged to ensure that the reading is correct. If so, staff will then check the condition of the meter and look for obvious leaks or new landscaping that may explain the anomalous reading. If no explanation for the high water use is obvious, then LACWU will contact the customer for further investigation.

8.1.6 Meter Maintenance and Replacement

Since 1998, LACWU has had an ongoing program to replace water meters. As of April 2006, all commercial meters greater than 2 inches have been replaced with touch-read meters, 75 percent of residential meters have been replaced (Glasco, 2006b), and the remaining 25 percent of residential meters will be replaced in the next year. LACWU Rule W-15 requires that all meters be tested at or prior to the time of installation, and no meters are placed in service that register more than 2 percent error.

8.1.7 Leak Detection Program

Although no formal leak detection program is in place, LACWU has periodically hired a firm to test for leaks in the system. The tests have focused on areas where the LACWU knew that a leak had occurred, but were unable to locate the source. The program has been very successful at accurately locating leaks.

8.1.8 Water Pressure Maintenance

Rule W-70 sets a pressure range of 40 to 90 pounds per square inch (psi). This upper range is lower than many cities; for instance, Santa Fe allows up to 110 psi. The lower pressure is more expensive to maintain (more pressure-reducing valves and more pressure zones, the latter of which are highly complex due to the varied terrain), but it results in a lower volume rate of loss when leaks do occur.

8.1.9 Standards for Water Line Construction

Unaccounted-for water rates in 2003 and 2004 were 10 and 12 percent respectively, which is about average for a water utility. Standards for water line construction help to ensure that undue leakage does not occur.

8.1.10 Wastewater Reuse

Los Alamos County has been reusing wastewater since at least the 1960s. Drawings from the 1950s show an effluent reuse line leading from the now abandoned East Road WWTP to the Los Alamos golf course. The Pueblo WWTP that was abandoned in the 1950s also sent its effluent to the golf course (Glasco, 2006a).

Currently, 335 acres of golf courses, parks, and playing fields are irrigated with effluent. In 2003 and 2004, more than 93 million gallons of water were used to irrigate turf, reducing the demand on potable water by 285 ac-ft/yr.

8.1.11 County-Provided Mulch

Because of its importance in reducing outdoor water demands for irrigation, the County provides mulch free to the public. Two types of mulch are available at the landfill: one type composed of shredded yard waste and the other, yard waste mixed with composted horse manure and biosolids from the WWTPs.

8.1.12 Subdivision Regulations

Los Alamos County subdivision regulations (Section 16-571) include site landscaping standards, which specify that designs should emphasize native plants and water conservation.

8.1.13 Education

The LACWU is very active in educating the public about water conservation. In addition to the public meetings held in October 2005 and March 2006, LACWU provides educational materials on conservation through billing inserts and their web site (http://www.lac-nm.us). The LACWU web site encourages conservation and provides a link to information on specific conservation actions, such as using xeriscaping principles, drip irrigation, and mulch (http://spectre.nmsu.edu/county/special.html?i=Los%20Alamos%20County%20Extens), and the Los Alamos Master Gardeners' Demonstration Xeriscape Garden located at the corner of Central and Oppenheimer is free and open to the public.

Specific educational activities related to water conservation include:

- More than 40 library books and 5 videos that focus on waterwise gardening, including guidance on native plants, drip irrigation, gray water use, and lawns, were donated by LACWU to the Los Alamos library (both the main library and the branch in White Rock). The main library will periodically put the books out in a special display.

- Los Alamos County in coordination with the New Mexico State Extension Service has developed a full color wall-calendar with xeric landscapes in Los Alamos, along with water conservation and gardening tips and begun a series of workshops that will extend into September 2006 including:

  – April 13: Water Harvesting Forum (in conjunction with the Pajarito Plateau Watershed Partnership and the Pajarito Environmental Education Center)

  – April 22: Distributed water conservation materials at the Pajarito Environmental Education Center's Earth Day event.

  – May 6: Drip Irrigation Workshop

  – May 25: Keeping your Lawn Healthy (in conjunction with the Pajarito Environmental Education Center)

  – June 22– (White Rock): Xeriscape Gardens (plant selection, care, maintenance, etc.)

  – June 29 (Los Alamos): Xeriscape Gardens (plant selection in Los Alamos town site, care, maintenance, etc.)

- During the months of May through September, a newsletter is included with the utilities bill. Each issue focuses in detail on a specific xeriscape principle and includes information on upcoming workshops, precipitation map, and a plant of the month.

- Color-coded water drops to indicate which days individuals could water, advertisements, press releases, and magnets (with the designated days) were included in the April 26 edition of the Los Alamos Monitor.

8.2 Water Conservation Goals

The overall objective of the LACWU water conservation plan is to lower water use through a variety of conservation measures that can be easily implemented by the County and its residents in a phased approach. The water conservation program objectives are to:

- Ensure careful management of the program by hiring or designating an existing staff person as a water conservation coordinator to oversee the program.
- Reduce water waste.
- Promote public awareness of conservation programs and public participation in voluntary conservation measures.
- As water conservation measures are implemented, carefully monitor changes in water use, taking into account climatic variations, to evaluate the effectiveness of water conservation measures.
- Periodically update the water conservation plan to focus on the programs that result in the highest measured use reductions.

In order to achieve these goals, the LACWU water conservation plan focuses on the following

- A continuing public education program focusing on minimizing water waste and reducing indoor and outdoor water use through voluntary measures for both residential and commercial users

- Good management of the water system, including meter replacement, leak detection, and record-keeping
- Continued implementation of the LACWU existing conservation programs such as wastewater reuse
- Promotion of xeriscaping and landscape requirements for new development
- Encouraging voluntary conservation through xeriscape rebate programs, supplying mulch, and supplying indoor plumbing retrofit kits
- Working with LANL to promote conservation

The water conservation plan will be implemented over time as resources and funding become available. A phased approach will allow for careful evaluation of the effectiveness of individual conservation measures in reducing demand. Consequently, the programs that are discussed in this section are recommendations that will be considered by the Utility Board and County Council and implemented as deemed appropriate by these governing bodies. As initial conservation programs are implemented, their success will be evaluated prior to proceeding with implementation of additional conservation recommendations.

8.3 Conservation Measures

A variety of conservation measures are recommended for consideration in Los Alamos County as described in Sections 8.3.1 through 8.3.10.

8.3.1 Public Education Program for Residential and Commercial Users

Section 8.1.13 describes public education measures that Los Alamos County has already initiated. This existing public education program will be continued and expanded as the Los Alamos water conservation program continues. A number of tools have been and will continue to be used to share water conservation tips with customers and the general public, including bill inserts, feature articles and announcements in the news media, workshops, booklets and calendars, and distribution of water-saving devices (Section 8.1.13). Copies of water conservation literature will also continue to be made available at public libraries.

Public school education is also an important means for instilling water conservation awareness (Grisham and Fleming, 1989, as cited by U.S. EPA, 2006a). In addition to educating future adult citizens, children who learn about conservation in the classroom may take that information home and educate their own families.

8.3.2 Efficient Utility Management

Efficient utility management and efficient water use for County-supplied facilities (i.e., parks and golf courses) are essential components of the County's water conservation plan. It is recommended that the automated billing, leak detection, drip irrigation, and meter replacement programs described in Section 8.1 be continued. Recommendations for additional LACWU programs include:

- Scheduling leak detection at regular intervals
- Continuing quality assurance checks of residential and commercial meters to ensure accurate results
- Increasing wastewater use where feasible
- Renovating Los Alamos Reservoir for nonpotable supply use

These recommendations are discussed in the following subsections.

8.3.2.1 Leak Detection.

LACWU should consider initiating a program of systematically surveying portions of the water system twice a year. A leak detection and repair program includes the use of computer-assisted leak detection equipment, a sonic leak detection survey, or any other acceptable method for detecting and locating leaks along water mains, at valves, and at meters. To help prevent leaks from occurring in the first place, a loss prevention program should also be implemented. Such a program includes pipe inspection, cleaning, and lining, as well as other maintenance and improvement of the distribution system to prevent leaks and ruptures from occurring. Remote sensors, which can provide ongoing monitoring of source, transmission, and distribution facilities as well as provide alerts to operators regarding leaks, pressure changes, equipment failures, and other issues, are also valuable.

8.3.2.2 Meter Quality Assurance.

A schedule for checking water customer meters against a calibrated meter is recommended. If meter readings are consistently above the 2 percent error that was required at the time of installation, the meter should be repaired or replaced.

8.3.2.3 Wastewater Reuse

As discussed in Section 8.1.10, 335 acres of golf courses, parks, and playing fields are currently irrigated with wastewater effluent, reducing demand on potable water by 285 ac-ft/yr. The reuse lines will be expanded in the near future to irrigate 8.7 acres of turf at the Guaje Pines Cemetery. The majority of the remaining County-maintained turf (more than 200 acres) is inaccessible to reuse lines and will continue to be irrigated with potable water.

8.3.2.4 Los Alamos Reservoir

Los Alamos Reservoir was damaged from massive soil movement following the rains after the high-intensity Cerro Grande Fire in 2000. LACWU is planning to repair the reservoir in 2007 so that it can be used to irrigate 25 acres of Sullivan Field, Western Area Park, Urban Park, the high school, Mountain Elementary School, and Pueblo Complex.

8.3.3 Reducing Water Waste

Common types of water waste are overwatering (applying more water than is needed to keep landscapes green) and fugitive water, which can be seen in the form of runoff into City streets from lawns and landscaping for buildings and other properties. Overwatering also results in higher outdoor water use due to increased evaporation and evapotranspiration. LACWU passed Rule W-8 in 2005 to address water waste (Section 8.1.1). To continue to reduce water waste, LACWU will consider:

- Monitoring the effectiveness of Rule W-8 in reducing water use.

- If there is not good voluntary compliance with the rule, passing an ordinance that will provide for fines or surcharges when water waste occurs.

8.3.4 Promotion of Xeriscaping

Xeriscaping is a type of landscaping that can significantly reduce outdoor water use, especially during the summer months. Los Alamos County will consider promoting xeriscaping by:

- Developing an ordinance to require xeriscaping on new development
- Promoting xeriscaping at existing residences through
  - Public education
  - Development of xeriscape demonstration projects at County facilities and other technical assistance
  - Rate structures that provide an incentive for voluntary conservation measures
  - Implementation of a rebate program for replacement of existing lawns with xeriscaping.

Xeriscaping involves much more than simply removing grass and replacing it with gravel or other types of turf. A number of different principles or approaches are considered xeriscaping:

- *Low-water-use plants:* Select plant varieties that are most appropriate for the landscape design and that require low amounts of water.

- *Soil improvement:* Improve soil composition to increase water retention and promote root development and proper drainage.

- *Small turf areas:* Create small areas of turf for a specific function or aesthetics and use low-water-use grass varieties.

- *Efficient irrigation:* Design a landscape by zoning plants according to water needs, and use efficient watering techniques such as drip irrigation, which delivers water directly to the roots of the plant. Maintenance of an irrigation system is essential.

- *Soil covering:* Use mulch to cover the soil, thereby reducing evaporation and erosion.

8.3.5 Graywater Use

LACWU will consider supporting graywater reuse in the County by:

- Providing educational materials for residents who want to install systems
- Requiring graywater reuse on new construction

New Mexico allows individual residences to apply up to 250 gallons per day (gpd) of graywater to household gardening and landscape irrigation without a discharge permit (Sections 74-6-2 and 74-6-4, NMSA 1978). Advantages of reusing graywater include the following:

- Replaces potable water use and therefore lowers water bills and possibly sewer bills for utility customers
- When used for outdoor irrigation, may support plant growth (due to the nutrients in graywater)
- Reduces energy and chemical use
- Possibly decreases the need to expand wastewater treatment facilities

Reusing graywater also has some disadvantages:

- May spread disease if system is not properly operated
- May develop odors if stored more than 24 hours
- May adversely impact soil (salt buildup)

- Decreases the amount of wastewater going to the treatment plant, which may affect the overall wastewater system
- Lowers the availability of reclaimed water for return flow credits (where applicable) or other uses

The standard components of a graywater system include (Little, 2003):

- Conveyance piping to collect water from a source and deliver it to the graywater system
- Surge tank to hold flows (e.g., plastic trash barrel)
- Filter to remove particles such as lint and hair (e.g., sock, sand filter)
- Storage tank to hold water until ready to use
- Three-way valve to allow graywater to go to sewer or septic system
- Pump to move water to distribution point such as irrigation system

A permit is required by NMED for use of more than 250 gpd of graywater. The permit needed is the same type of permit required for a septic system (Duttle, 1994). In issuing the permit, NMED considers treatment, storage, and disposal of the water (underground leach field versus surface disposal for irrigation).

No permit is required for less than 250 gpd if the following conditions are met:

- System overflow is directed to an existing wastewater system.
- Storage tank is enclosed and access is restricted.
- System is outside the floodway.
- The vertical distance between graywater and the groundwater table is at least 5 feet.
- Pipes for the graywater system are marked as nonpotable water.
- Graywater does not leave the property.
- Standing water is minimized and prohibited for more than 24 hours.
- Graywater is never applied by spraying.
- Graywater use complies with local ordinances.

8.3.6 Rainwater Harvesting

It is recommended that Los Alamos County consider requiring new construction with landscaping to include rainwater harvesting systems. The County may want to use a rainwater harvesting ordinance similar to the one recently adopted by Santa Fe County (Santa Fe County, Ordinance No. 2003-6). Under this new ordinance, Santa Fe County requires all commercial and residential developments (of 2,500 square feet [ft^2] of heated area or greater) to collect roof drainage into cisterns for reuse in landscape irrigation. Residential developments of less than 2,500 ft^2 of heated area are required to have cisterns, rainbarrels, or other catchment basins to capture water from at least 85 percent of the roofed area.

Historically, people have relied on rainwater harvesting for crop irrigation, drinking water, and landscape watering. Rainwater harvesting is the collection of water from surfaces, including roofs, patios, and parking lots, and can be used for landscape irrigation, indoor plant irrigation, and fire protection, as well as many other applications. Rainwater harvesting opportunities exist for residential and commercial sites and can easily be incorporated into a landscape during the design phase of new development. Harvested rainwater can also be used for drinking water, but is not recommended for Los Alamos County since it can be expensive to treat captured rainwater to meet drinking water standards.

The use of rainwater for landscaping can significantly reduce potable water use, since in Los Alamos, outdoor water use was 47 and 43 percent of total use in 2003 and 2004, respectively (Section 5.2). Advantages of rainwater harvesting include the following (TWDB, 2005; COA, 1995; Waterfall, 2004):

- The water is free, not derived from the municipal supply; the only cost is associated with collection and use.
- Rainwater provides a source of water when other sources are not viable or available.
- Plants thrive on rainwater because it is free of salts, disinfection byproducts, and other chemicals that can be harmful to root growth.
- Holding rainwater on site can reduce off-site flooding and erosion.
- Use of rainwater can reduce dependence on groundwater.
- When relatively large volumes of water are held in areas with underlying pervious materials, some of that water may percolate to groundwater.

- Rainwater use helps the utilities reduce the summer water demand peaks.
- Consumer's water utility bills may be reduced.
- There are few limitations, and many harvesting systems are simple and inexpensive.

Many methods for rainwater harvesting are available, and many of them are inexpensive and have a relatively simple design. The three primary components of a rainwater harvesting system include the supply (rainfall), the demand (plant requirements), and the delivery system (Waterfall, 2004). Rainwater harvesting systems generally include a catchment, a distribution system, and a landscape holding area. A catchment is any system (preferably hard and smooth surfaces) from which rainwater can be harvested, such as roofs, pavements, and patios. The distribution system connects the catchments with the landscape holding areas and can include (Waterfall, 2004):

- Gutters and downspouts that direct roof water to the holding area
- Sloped sidewalks that move water directly to plants
- Channels, ditches, and swales that direct water to holding areas
- Curb cutouts that channel water runoff from streets and other impervious surfaces in urban centers, such as parking lots and sidewalks, to landscaped areas

Landscape holding areas are areas that hold water in the soil for use by plants. Holding areas can include crescent-shaped soil berms downslope of trees or planting areas to catch runoff, concave depressions vegetated with grasses or other plants that decrease erosion and increase the penetration of water into the soil, a grouping of large rocks covered in mesh wire (gabions) to contain water and reduce erosion, as well as other forms of holding areas.

Designing and installing rainwater harvesting systems can be as simple as diverting rainwater runoff to planted areas using a contoured landscape. More complex systems capture and store large amounts of water and distribute the water with a pump and drip irrigation delivery system. The OSE, through the New Mexico Water Conservation Program, provides information on the types of rainwater harvesting systems available, as well as how to determine the amount of water that can be collected and how to build, install, and maintain a rainwater harvesting system (http://www.ose.state.nm.us/water-info/conservation/rainwater.html).

8.3.7 Indoor Conservation Incentives

Toilets, washing machines, faucets, and showers account for more than 90% of indoor use (Vickers 2001); therefore, efficient water-use appliances can significantly reduce indoor water use. To achieve reductions in indoor use, it is recommended that Los Alamos County consider offering the following incentives to utility customers:

- A rebate for installation of low-water-use washing machines approved by the LACWU
- Free toilet leak detection kits
- Free retrofit kits that have a low-flow showerhead and faucet components

In addition, standards requiring the use of water-saving plumbing fixtures will be included in all local building codes and subdivision requirements in accordance with OSE guidelines for new subdivisions.

8.3.8 New Construction Standards

The easiest way to implement water conservation into residential and commercial uses is to design and build water conservation features during construction. Construction standards can address issues such as graywater harvesting, rainwater harvesting, indoor plumbing fixtures, low-water-use appliances, and xeriscaping. As Los Alamos County plans to encourage considerable growth (Fruth, 2004), it is important to ensure that new construction optimizes water use efficiency. Consequently, it is recommended that Los Alamos County adopt new construction standards prior to approving significant new construction.

8.3.9 LANL Conservation

LANL water use increases about 35 percent in summer months due to increased use of water in cooling towers. The high silica content of the groundwater has limited the ability to cycle the water in the LANL cooling towers. To reduce the water use for a new facility, LANL installed a $4 million reverse osmosis (RO) unit at TA-3 in 2002 and began using treated effluent in the cooling tower. Direct use at LANL of San Juan-Chama water, with its low silica content, would increase the ability to cycle the water and thus reduce water demand without the high energy costs of operating an RO unit. It is recommended that LACWU continue to work with LANL to identify feasible conservation measures.

8.3.10 Inclining Block Rate Structure

Los Alamos County currently has a flat rate for water use. Although its water rate is relatively high for the State of New Mexico (Section 8.1.4), the rate structure does not create as much of an incentive for users to avoid using large quantities as would an inclining block rate structure (also called inverted block). It is therefore recommended that Los Alamos County develop an inclining block rate structure for water use to encourage water conservation. Under an inclining block rate structure, costs to the customer increase with increased water consumption, so that individuals who want to reduce cost will have an incentive to use less water.

It is recommended that LACWU first conduct a rate study to ensure that the inclining block rates are revenue-neutral and then work with decision makers to ensure that the new rates ordinance will be implemented. Because conservation rate structures may result in uncertainty in forecasting revenue, the rate study should include an evaluation of the interrelationships among rates, consumption, and costs and the effects that these issues may have on the revenue requirements of the utility.

8.4 Water Conservation Potential

The first step in developing a water conservation plan is to establish a goal for reducing demand. While the LACWU has already implemented several aspects of a conservation plan (Section 8.1), more can be achieved. Goals can be short-term, such as during a drought (as discussed in Section 8.6) or long-term. This section discusses goals for meeting demands by 2050 based on the low-water-use projection discussed in Section 5.4. Growth and water use should continue to be monitored, and if high rates do occur, more stringent goals may need to be set. The total projected water use under the low projection is estimated to increase from about 4,300 ac-ft/yr in 2005 to 7,578 ac-ft/yr, or 837 ac-ft more than the combined water rights and San Juan-Chama water. Therefore, the demand of 7,578 in 2050 is about 12 percent more than the projected available supply based on groundwater and San Juan-Chama water rights. Accordingly, an initial minimum goal of a 12 percent reduction in demand is recommended.

As discussed in Section 5.2, current residential water use represents about 70 percent of the water use, not including LANL. Consequently, any successful water conservation program needs to focus on reducing residential water demand. Most of the residential use (62 percent of total use) is by single-family households; 8 percent is by residents living in multi-family complexes (apartments). Commercial, municipal and educational water use accounts for 19 percent, and LACWU estimated that unaccounted-for losses are 12 percent of the total diversions.

Per capita demand by residents in multi-family dwellings is much less than demand by single-family residents because the outdoor irrigation needs are usually much less and the dwellings are usually smaller, with fewer fixtures and appliances (Section 5.2). Because the water use for multi-family dwellings is very low, this conservation discussion focuses on single-family water use.

Demand reduction potential is discussed in terms of indoor use and outdoor use at single-family dwellings. In evaluating the impacts of an enhanced conservation program, the current water use was based on 2003 demands because rainfall was fairly low (less than 10 inches) as compared to almost 19 inches in 2004. As discussed in Section 5.2, the total residential per capita demand in 2003 was 163 gpcd. Table 8-2 summarizes the per capita demand rates for single family dwellings in 2003.

Table 8-2. Single Family Residential Water Use in 2003 in Los Alamos County

	Single Family	
Demand Type	gpcd	% [a]
Indoor	77	53
Outdoor	68	47
Unaccounted-for losses	18	---
Total per capita demand	163	100

[a] Percentage of total household use

8.4.1.1 Indoor Potential

To examine the potential for saving water through conservation of indoor water use, the amount of water used by Los Alamos residents in single-family homes was compared to the water used in a conserving household. Vickers (2001) estimates the water use in a conserving household to be about 44 gpcd, about 33 gpcd less than the current indoor demand by single family residents in Los Alamos. The distribution of indoor water use by Los Alamos residents was estimated based on the typical water use by households with pre-1980s fixtures. As shown in Table 8-3, the greatest savings could be achieved through toilet use and leakage, washing machines and showers.

Table 8-3. Potential Demand Reduction for Indoor Water Fixtures

	Per Capita Water Use (gpcd)		
Fixture	Conserving Household [a]	Los Alamos [b]	Potential Savings
Toilet use	8.2	20.9	12.8
Retrofit devices for toilets	17.85	20.9	2.55
Toilet leakage	4.0	10.7	6.7
Showers	8.8	13.3	4.5
Baths	1.2	1.2	0
Faucets	10.8	12.3	1.5
Dishwashers	0.7	1.1	0.4
Washing machines	10.0	17	7.0
Total indoor water use [c]	43.7	76.6	32.9

[a] Vickers, 2001
[b] Indoor single family 2003
[c] Excluding toilet retrofit devices (i.e., assumes toilet replacement instead of retrofitting; if toilets are retrofitted instead of replaced, the total potential savings would be 22.7 gpcd)

8.4.1.2 Outdoor Potential

In order to asses the potential savings in per capita demand in outdoor water use, the amount of water needed to irrigate lawns, trees and vegetable gardens of a typical size was compared to the amount used in Los Alamos. Table 8-4 shows the estimated outdoor water demand in Los Alamos for different lawn types and irrigations systems assuming an average landscaped area (Wilson, 1996). If residential irrigation was limited to an 800-square-foot (ft^2) lawn of Kentucky bluegrass, 1000 ft^2 of trees and 200 ft^2 of garden irrigated by conventional methods, water demand would be 40 gpcd, or about 41 percent less than the estimated current per capita

Table 8-4. Potential Savings, Outdoor Use

	Per Capita Demand (gpcd)	Per Unit (gal/yr)	Lawns		Trees		Gardens	
			Area (ft^2)	Irrigation Requirement (gal/ft^2/yr)	Area (ft^2)	Irrigation Requirement (gal/ft^2/yr)	Area (ft^2)	Irrigation Requirement (gal/ft^2/yr)
Actual Year 2003 Outdoor Use [a]	*68*							
Kentucky bluegrass	40	37,860	800	28.76	1,000	12.44	200	12.06
Buffalo grass	25	23,748	800	11.12	1,000	12.44	200	12.06
Buffalo grass with drip	19	17,634	800	11.12	1,000	7.32	200	7.09
Bermuda grass with drip	25	24,234	800	19.37	1,000	7.32	200	7.09

[a] Single family outdoor demand based on annual average daily demand minus winter demands.

demand in Los Alamos, indicating that residents are now watering greater areas and/or are wasting water above what is needed to maintain lawn health. If buffalo grass is used for lawn and trees and gardens are irrigated through drip irrigation, the outdoor demand could be reduced by 72 percent, to 19 gpcd (Table 8-4). The actual area of irrigated turf may be greater than 800 ft^2; thus the potential reduction by replacing turf may be less than estimated.

8.4.1.3 Total Potential Demand Reduction

The total residential demand through indoor conservation efforts could be reduced by 32.9 gpcd if all residents implemented every possible conservation action. This would reduce total single family use by 20 percent. By modifying outdoor landscaping techniques and turf type and area, water demand could be reduced by another 49 gpcd or 30 percent of the total single family demand. Thus a total demand reduction of 50% for single family residents is theoretically possible if all residents participate; however, in estimating potential demand reduction, it is more reasonable to assume varying participation rates.

To achieve the conservation goal of reducing total demand by 12%, multiple conservation actions must be pursued. Some of the actions affect only existing homes and others will impact new construction. To assess the potential for reducing demand through a variety of conservation actions, the following programs and participation rates are assumed:

- Initiate rebate program for toilet replacement in existing homes (25 percent participation).

- Provide incentives to replace turf with buffalo grass and to use drip irrigation at existing homes (25 percent participation).

- Provide rebates for low-water-use washing machines in all existing dwellings and new single-family residential construction (25 percent participation)

- Require low-flow toilets, faucets and showers in all new single-family residential construction (100 percent participation)

- Require xeriscape landscaping for all new single-family homes (100 percent participation)

- Provide retrofit kits for toilets, faucets and showers in existing homes (50 percent participation)

- Provide kits to reduce toilet leaks in all homes (50 percent participation)

Figure 8-1 shows the several scenarios for reducing demand through single actions and the comprehensive action. The reduction in demand of 12% by 2050 will reduce the projected demand to less than the available supply.

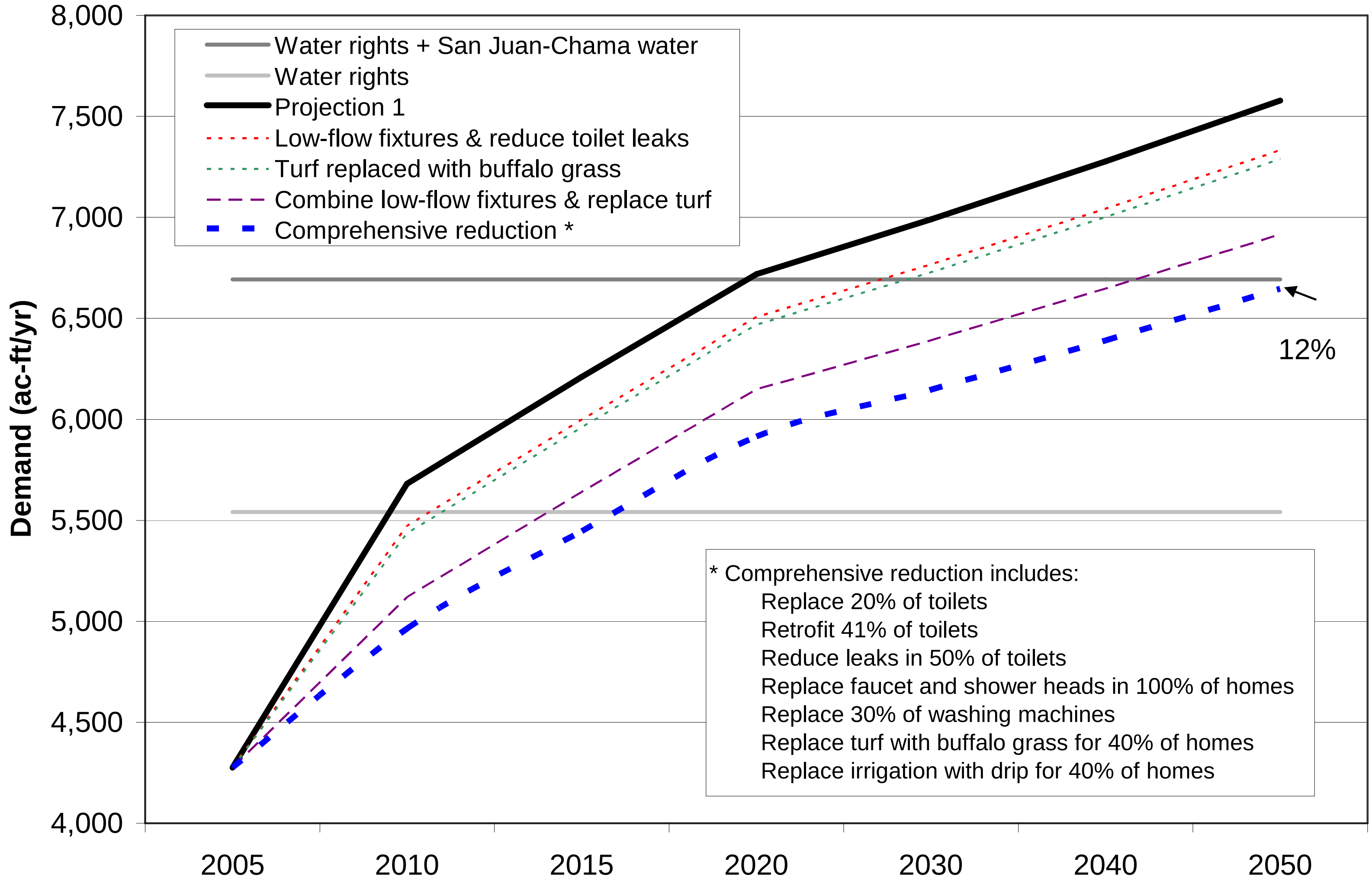
This demand reduction is possible, as demonstrated by other communities that have had very successful demand reduction programs. Santa Fe, for instance, reduced demand by 41 percent (from 189 gpcd to 112 gpcd between 1995 and 2004). Albuquerque has reduced demand by 23 percent through its conservation efforts in the past decade.

8.5 Funding and Implementation of Los Alamos County's Water Conservation Plan

Los Alamos County can begin implementation of this water conservation plan with existing staff and funding. However, to implement all phases of the conservation effort and to continually monitor demand data and improve conservation efforts, the County will need to obtain additional sources of funding. Table 8-5 lists sources of funding for the types of water conservation activities outlined in the water conservation plan.

8.6 Drought Management

Periods of drought (prolonged time with below-average cumulative rainfall) is part of the natural climate cycle in the Southwest and can have a significant impact on communities in New Mexico. To reduce the effects of the impacts, a drought management plan can be implemented during periods of low precipitation. Since Los Alamos County relies on groundwater, LACWU is not vulnerable to lowered supplies during drought periods. Consequently, the focus of the drought management program is to reduce demands during periods of drought, when outdoor watering would normally increase significantly.



LOS ALAMOS COUNTY WATER PLAN

Projected Water Demand with Conservation
Under Low Water Use Projection

Daniel B. Stephens & Associates, Inc.

5/26/06

Figure 8-1

Table 8-5. State and Federal Funding Sources

Program Title	Agency	Web Site or Contact	Funding Availability	Description
General Information				
Catalog of Federal Domestic Assistance	General Services Administration	http://www.cfda.gov/		Information about funding sources, grant writing, etc.
Federal Drought Programs	U.S. Army Corps of Engineers	http://www.iwr.usace.army.mil/iwr/drought/feddrghtprogs.htm#_Toc491241963		Summary of federal funding sources available for drought programs.
Links to private funding sources	U.S. EPA	http://www.epa.gov/owow/nps/capacity/funding.htm#private		List of links for private funding sources for nonpoint source pollution.
Federal Funding Sources for Water Quality Activities	Natural Resources Conservation Service	http://www.nm.nrcs.usda.gov/technical/water/fund.html		Summary of federal, state, and private funding sources available for water quality programs.
Funding Sources	New Mexico Rural Water Association	http://www.nmrwa.org/funding.php		List of funding sources related to water and wastewater systems.
Funding Programs				
State Programs				
New Mexico Clean Water State Revolving Fund	NMED Construction Programs Bureau	Santa Fe: 505-827-2806 http://www.nmenv.state.nm.us/cpb/cwsrf.html	Low-interest loans ranging from $215,000 to $22,000,000.	Eligible projects include water supply development, conservation, watershed management, infrastructure, and water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.

[a] Web site address as of November 2005; address and information found there is subject to change.

U.S. EPA = U.S. Environmental Protection Agency
NMED = New Mexico Environment Department
USDA = U.S. Department of Agriculture

Table 8-5. State and Federal Funding Sources

Program Title	Agency	Web Site or Contact	Funding Availability	Description
New Mexico Clean Water State Revolving Fund	New Mexico Water Trust Board Contact New Mexico Finance Authority U.S. EPA	http://www.epa.gov/owm/cwfinance/cwsrf/index.htm http://www.nmenv.state.nm.us/cpb/cwsrf.pdf	4 billion annually available through this program through low-interest loans.	Eligible water conservation measures may include meter installation/replacement, plumbing fixture retrofits/replacements, efficient land-scape irrigation equipment, gray water recycling, wastewater reuse, water use ordinances or regulations, and public education programs.
New Mexico Rural Water Association Technical Assistance	New Mexico Rural Water Association (NMRWA)	Albuquerque: 1-800-819-9893 http://www.nmrwa.org/techassistance.php	Free training and technical assistance to water and wastewater systems.	Example services include: rate structures, leak detection, operator accreditation, wellhead and source water protection planning, regulatory assistance, sustainable development.
Public Project Revolving Fund	New Mexico Finance Authority	Santa Fe: (877) ASK-NMFA http://www.nmfa.net/Funding/PPRF.htm	The program has an estimated capacity of $1.2 billion; there is no maximum or minimum amount that may be awarded.	Funds can be used for infrastructure projects such as water, water rights, and municipal utilities.
Federal Programs				
Community Facilities (CF) Direct Loans and Grants	U.S. Department of Agriculture	http://www.rurdev.usda.gov/rhs/cf/cp_dir_grant.htm	No set maximum award.	Provides loans for the development of essential community facilities for public use in rural areas and towns with a population of 20,000 or less.

[a] Web site address as of November 2005; address and information found there is subject to change.

U.S. EPA = U.S. Environmental Protection Agency
NMED = New Mexico Environment Department
USDA = U.S. Department of Agriculture

Table 8-5. State and Federal Funding Sources
Page 3 of 4

Program Title	Agency	Web Site or Contact	Funding Availability	Description
Planning Assistance to States	U.S. Army Corps of Engineers	Albuquerque: (505) 342-3109 http://www.usace.army.mil/civilworks/cecwp/cecwp_temp/pas.htm http://www.federalgrantswire.com/planning_assistance_to_states.html	Federal program funds are limited to $10,000,000 annually, and no more than $500,000 in Federal funds shall be expended in any one year in any one State.	Assists in planning for the development, utilization, and conservation of water and related land resources and ecosystems.
Economic Development Administration's Public Works and Economic Development Facilities Grants Program	Economic Development Administration, U.S. Department of Commerce	National Contact: (212) 482-5265 http://www.eda.gov/InvestmentsGrants/FFON.xml http://www.eda.gov/NewsEvents/NewInvestments.xml http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs/ffo_5fgeneral051210_2epdf/v1/ffo_5fgeneral cost-sharing 051210.pdf	Funds of over $250 million were appropriated for this program in Fiscal Year 2005.	Eligible water conservation measures include metering, leak detection, gray water recycling, plumbing fixture retrofits/replacements, commercial/institutional conservation measures, industrial reuse or recycling, and wastewater reclamation and reuse.
Water Conservation Field Services Program/Efficiency Incentives Program	U.S. Bureau of Reclamation	El Paso Field Office: David Allen, (915) 534-6316 http://www.usbr.gov/waterconservation/		The WCFSP assists water agencies in the development of water conservation plans and management practices, provides funds for implementation, sponsors conservation demonstration projects and activities, coordinates financial assistance for joint projects and partnerships with other agencies
Reclamation States Emergency Drought Relief Act of 1991 - Title II	U.S. Bureau of Reclamation	Albuquerque Area Office: 505-248-5323 http://www.usbr.gov/uc/progact/waterconsv http://www.usbr.gov/uc/albuq/index.html		Assistance in the construction and planning of projects that mitigate effects of drought.

[a] Web site address as of November 2005; address and information found there is subject to change.

U.S. EPA = U.S. Environmental Protection Agency
NMED = New Mexico Environment Department
USDA = U.S. Department of Agriculture

Table 8-5. State and Federal Funding Sources
Page 4 of 4

Program Title	Agency	Web Site or Contact	Funding Availability	Description
Reclamation Wastewater and Groundwater Study Program	U.S. Bureau of Reclamation	Albuquerque: 505-248-5323 http://www.mnisose.org/guidebook/bor-all.pdf		Appraisal and feasibility studies on water reclamation and reuse projects.
Community Development Block Grants	U.S. Department of Housing and Urban Development	National contact: (202) 708-1322 ext. 4378 http://www.hud.gov http://www.hud.gov/offices/cpd/community development/programs/index.cfm	Grants and loans.	Eligible water conservation measures include meters, leak detection, plumbing fixture retrofits/replacements, water-efficient appliances and landscaping/irrigation equipment, gray water recycling, commercial/institutional conservation measures, industrial reuse or recycling, wastewater reclamation and reuse, development of water rate structures and water use regulations or wastewater ordinances.
Emergency Conservation Program	USDA Farm Services	Albuquerque: 505-761-4407 800-410-2067 http://disaster.fsa.usda.gov/ecp.htm	Cost-share assistance up to 75 percent of the cost to implement approved emergency conservation practices, as determined by county Farm Services Agency committees. Individual or cumulative cost-sharing of $50,000 or less per person. Cost-sharing from $50,001 to $100,000 is approved at the state committee level. Cost-sharing over $100,000 is approved by FSA's national office.	Rehabilitation of farm lands and conservation facilities. To rehabilitate farmland, ECP program participants may implement emergency conservation practices, such as removing debris, restoring fences and conservation structures, and providing water for livestock in drought situations. Other conservation measures may be authorized by county FSA committees, with approval from state FSA committees and FSA's national office.

[a] Web site address as of November 2005; address and information found there is subject to change.

U.S. EPA = U.S. Environmental Protection Agency
NMED = New Mexico Environment Department
USDA = U.S. Department of Agriculture

Drought management plans commonly use a tiered system of triggers and responses based upon the severity of the drought, with voluntary initiatives implemented at the initial stage of a drought and more severe measures implemented as the need to reduce demand increases. Some recommended criteria for drought stages and actions to be implemented by LACWU at each stage are summarized in Table 8-6.

Table 8-6. Summary of Recommended Conservation Measures and Drought Stages

Stage 1	Stage 2	Stage 3
Water shortage advisory: Voluntary conservation and normal conditions	*Water shortage watch: Mandatory increased conservation*	*Water shortage warning: Mandatory restrictions*
Trigger: Annual precipitation 75 percent of normal	*Trigger: Annual precipitation 50 percent or less of normal*	*Trigger: Inadequate storage/system capacity to meet demand*
• Provide public with current storage levels. • Conduct public education campaign regarding need to reduce use.	• Ban sprinkler use. • Restrict outside watering to two days per week. • Prohibit washing paved areas. • Prohibit allowing water runoff into street. • Prohibit filling swimming pools and water fountains. • Ban car washing, except for solid waste vehicles for public health reasons. • Reduce flushing of water mains, sewers, storm drains, streets. • Reduce frequency and duration of irrigation of public landscape (e.g., golf courses, parks).	• Implement a moratorium on new water hookups. • Ban use of water hoses. • Prohibit all outdoor water use. • Ban new landscaping with water from the utility. • Curtail irrigation of parks, athletic fields, cemeteries, and golf courses.

9. Facilities Assessment

In August through October 2005, Molzen-Corbin & Associates (MCA) conducted an assessment of Los Alamos County's water facilities. Following a kickoff meeting with the County in August 2005, MCA developed a detailed inventory of facility descriptions and capacities based on maps and data provided by the County. MCA then conducted a field investigation of the inventoried facilities (except for the MIOX disinfection stations, which are new and in good condition).

The field visits to each facility focused on the processes and working condition of the electrical components. Facilities inspected included 12 wells, 22 tanks, 17 pump stations, 14 pressure reducing valves (PRVs) and 6 maintenance storage buildings. Findings of the inspections include:

- *Wells:* Floor drains and locks on gravel chutes are needed, lubrication oil leaks need repair. A number of transformers need to be replaced and electrical gear protected from gunshots.

- *Tanks:* Security fencing needs to be either installed or repaired at all tanks. Positive drainage should also be provided, and several tanks are due for painting. Some cathodic protection systems need repair and a schedule should be developed for replacing anodes.

- *Pump stations:* Security fences should be installed around all pump stations, and a larger masonry enclosure is needed for electrical gear at one station. Several pumps exhibit vibrations and noise that should be investigated. Needed repairs and replacements include:
  - Replace several pumps
  - Repair leaks in valves and joints
  - Replace broken flow meters
  - Replace a number of transformers
  - Replace some motor control centers (MCCs) and electrical panels

- *PRVs:* Vault vents are needed and some valves need calibration to operate properly.

- *Maintenance facilities:* LACWU maintenance facilities are inadequate. A central maintenance office, shop, and storage building for 10 personnel is needed for the Water Production Department. Parts storage is currently scattered among whatever space is available in eight existing buildings used for other purposes, and maintenance personnel have no office space.

More detail concerning the facilities assessment and further discussion of the recommendations are provided in Appendix C.

10. Recommendations

Los Alamos County is anticipating future growth and increased demands that are projected to exceed existing water rights unless demand is reduced through conservation. While the water supply will likely produce at current rates for well beyond the 40-year planning period, issues regarding water rights and potential water quality concerns indicate that the County needs to proactively plan for future use. A summary of recommendations for addressing the future water supply needs of the County follows.

Water Supply (Quantity)

- Complete conversion of the San Juan-Chama contract to a repayment contract.
- Initiate steps toward implementation of the San Juan-Chama project as identified on the timeline provided in Section 7.
- Monitor water levels in the vicinity of the water supply wells and evaluate declines on a regular basis, with particular emphasis on monitoring the Guaje well field.
- Implement recommendations for maintenance and infrastructure improvements described in the facilities assessment.

Water Quality/Contaminant Risk Recommendations

- Work closely with LANL and NMED regarding ongoing monitoring of contaminants and assessment of anticipated transport velocities and flow paths.
- Evaluate contaminant data on a quarterly basis to be sure that any trends or changes are identified quickly.
- Begin contingency planning for alternate well locations. In a worst case scenario, many wells could be affected by contaminants over the planning period. To prepare for this

contingency, identify possible locations for new wells that are upgradient from or off-gradient of key source areas, and begin to resolve infrastructure, land access, and water rights transfer issues so that alternative wells can be developed in a timely manner.

Water Rights

- Secure services of water rights attorney to advise and plan for water rights acquisition (availability of pre-1907 water rights, return flow credits, costs, time to secure, potential litigation).

- Pursue return flow credits as identified in 1999 return flow study (SWC, 1999).

- Finalize acquisition of water rights from newly acquired lands.

- Evaluate and quantify pumping effects on the river from current water production regime and potential changes in pumping amounts and locations in order to be prepared to address OSE concerns during a potential water rights transfer application process.

- Meet with the OSE to discuss priority administration and the number and amount of water rights that are senior to Los Alamos County.

Water Conservation

- Hire or designate an existing staff person as a water conservation coordinator so that the program can be carefully managed.

- Continue and expand existing water conservation initiatives, including public education, automated billing, meter replacement, leak detection, and others.

- Monitor the effectiveness of voluntary compliance with Rule W-8 in reducing water waste, and if necessary, pass an enforceable ordinance so that penalties can be assessed.

- Update subdivision regulations to include requirements for graywater reuse, water harvesting, xeriscaping, and low-water-use indoor plumbing for all new commercial and residential development.

- Establish rebate programs for xeriscaping and washing machine replacement.

- Distribute indoor plumbing leak detection and retrofit kits.

- Conduct updated rate study as basis for setting a revenue-neutral inclining block rate structure.

- Monitor the effectiveness of existing and new conservation measures and refine the conservation program appropriately.

Implementation of these recommendations will help the County to be prepared to meet its future water supply needs.

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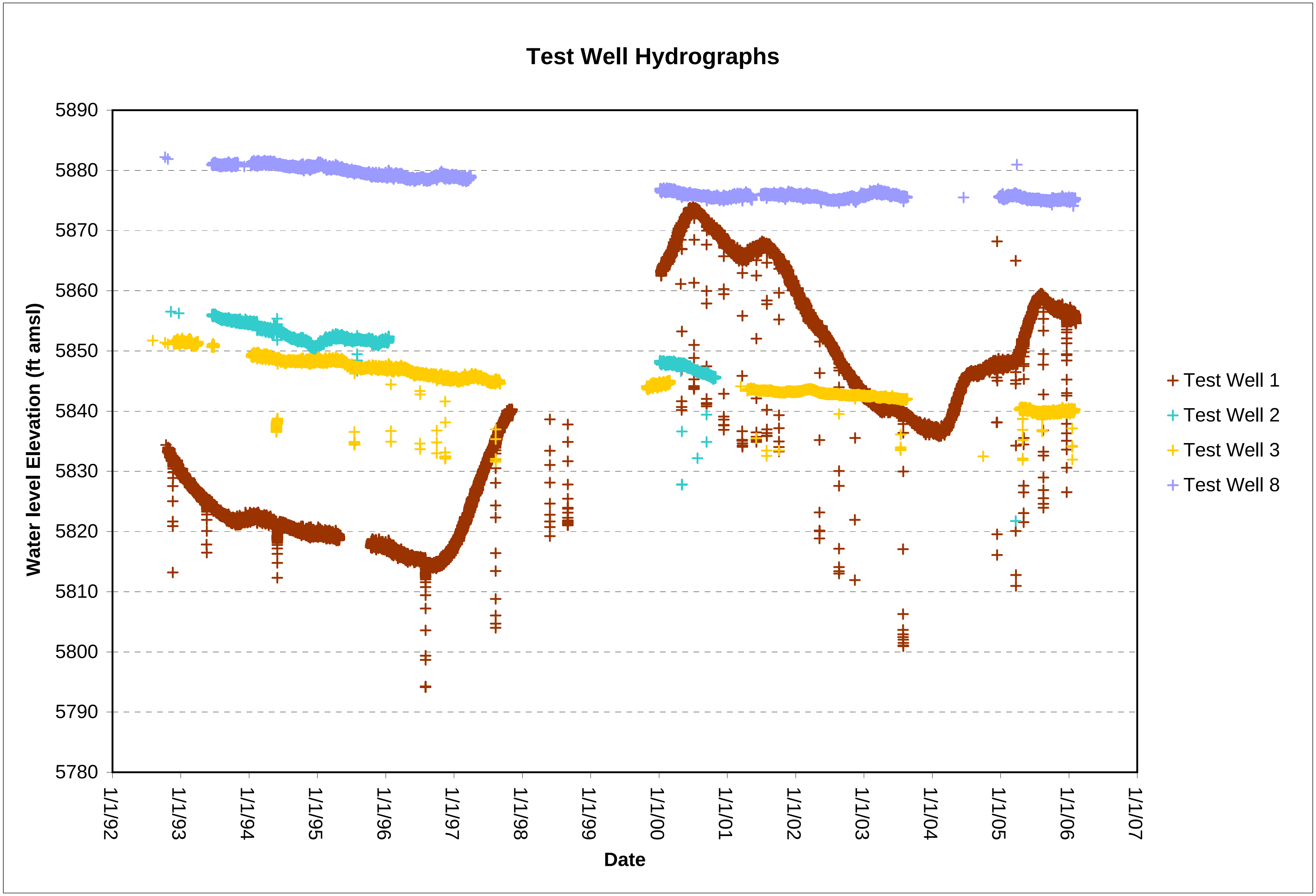
Appendix A

Water Supply Information

Appendix A1

Regional Aquifer
Test Well Hydrographs



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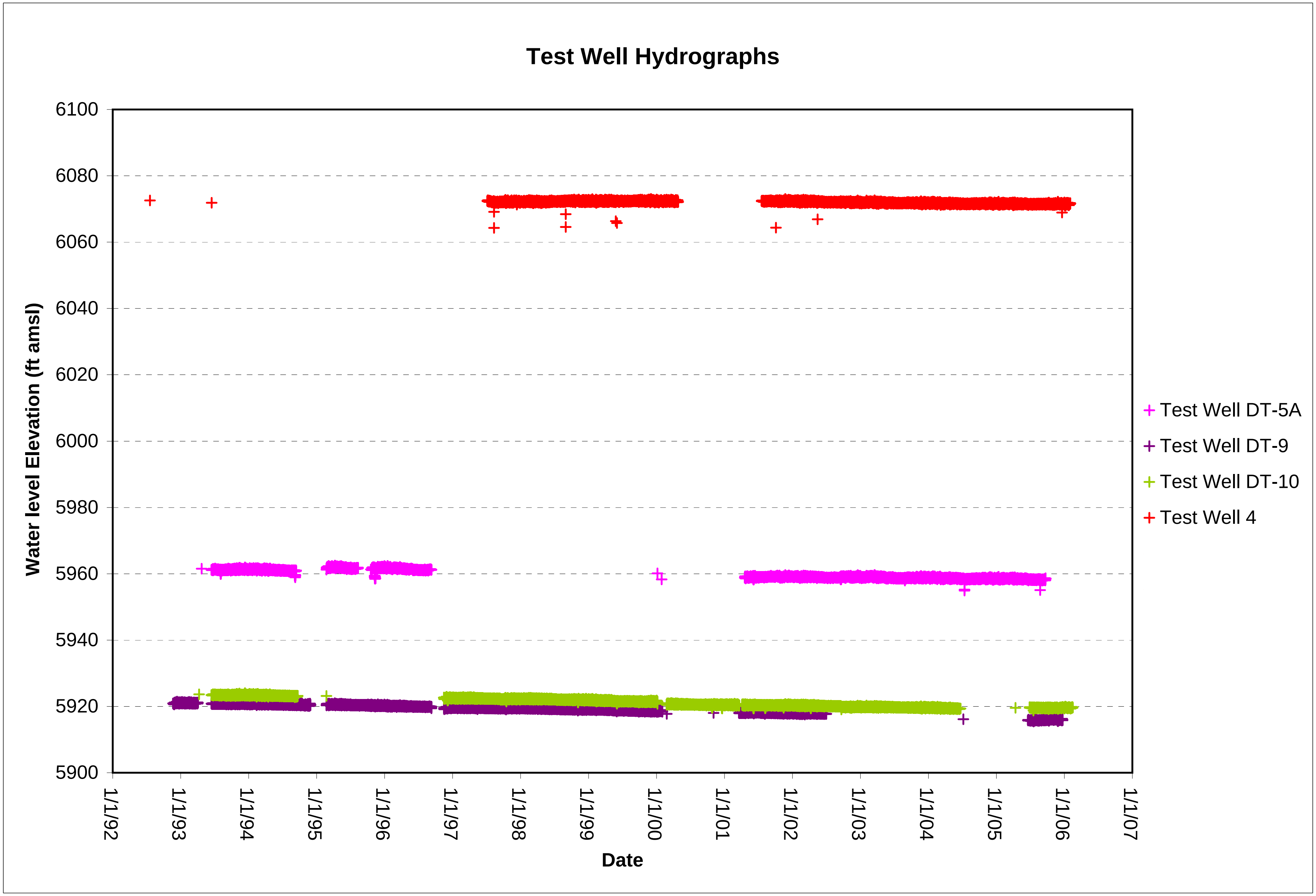

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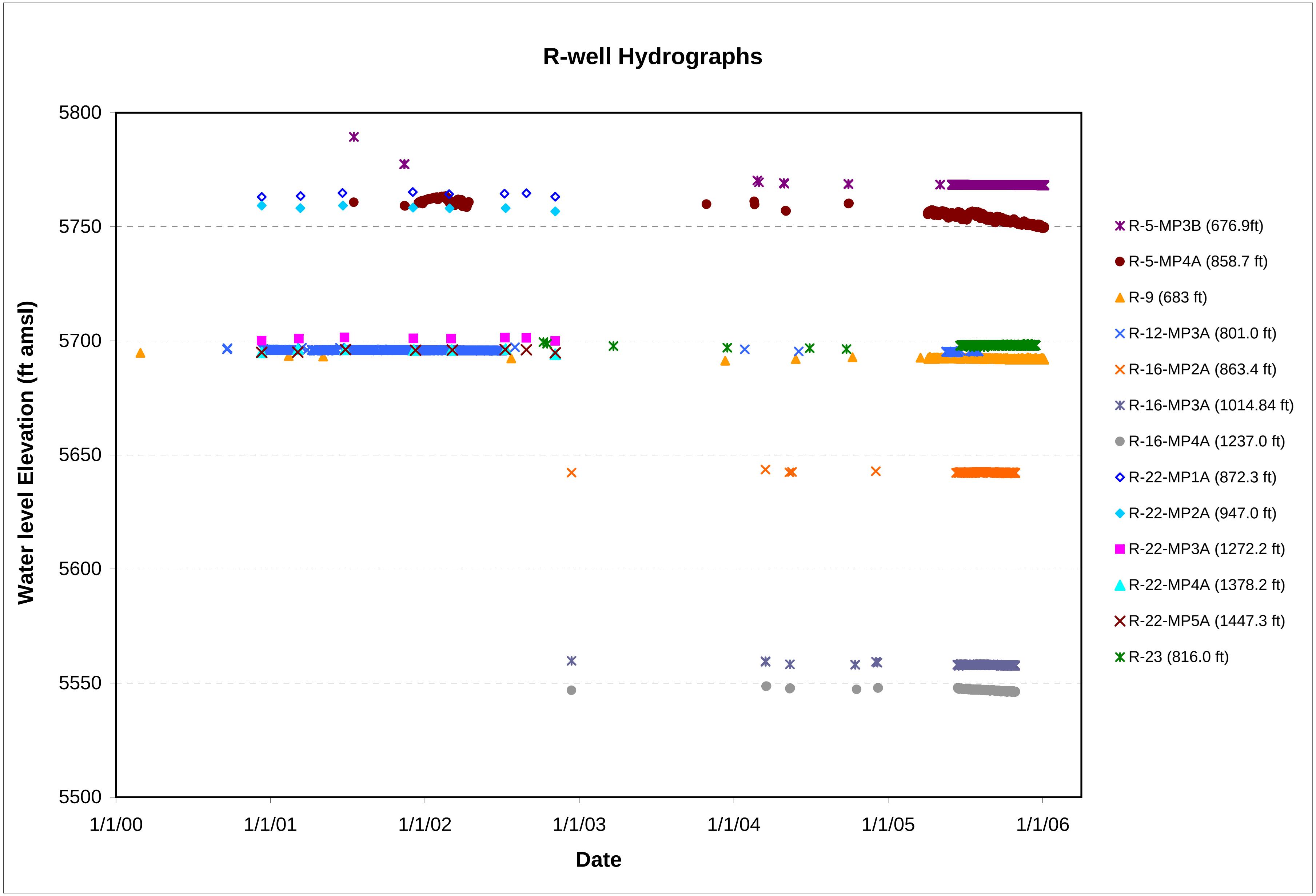
Appendix A2

Regional Aquifer Monitor Well Hydrographs



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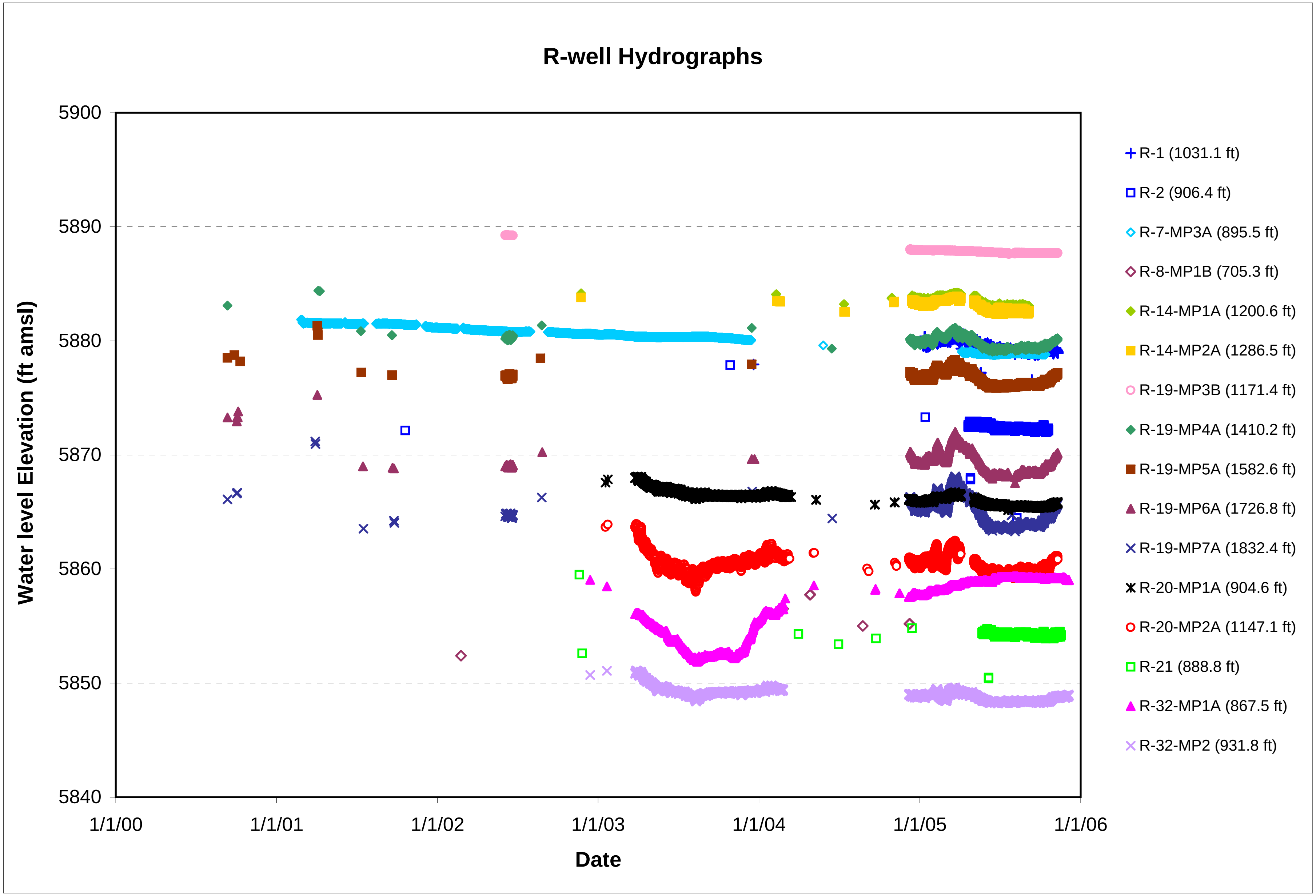

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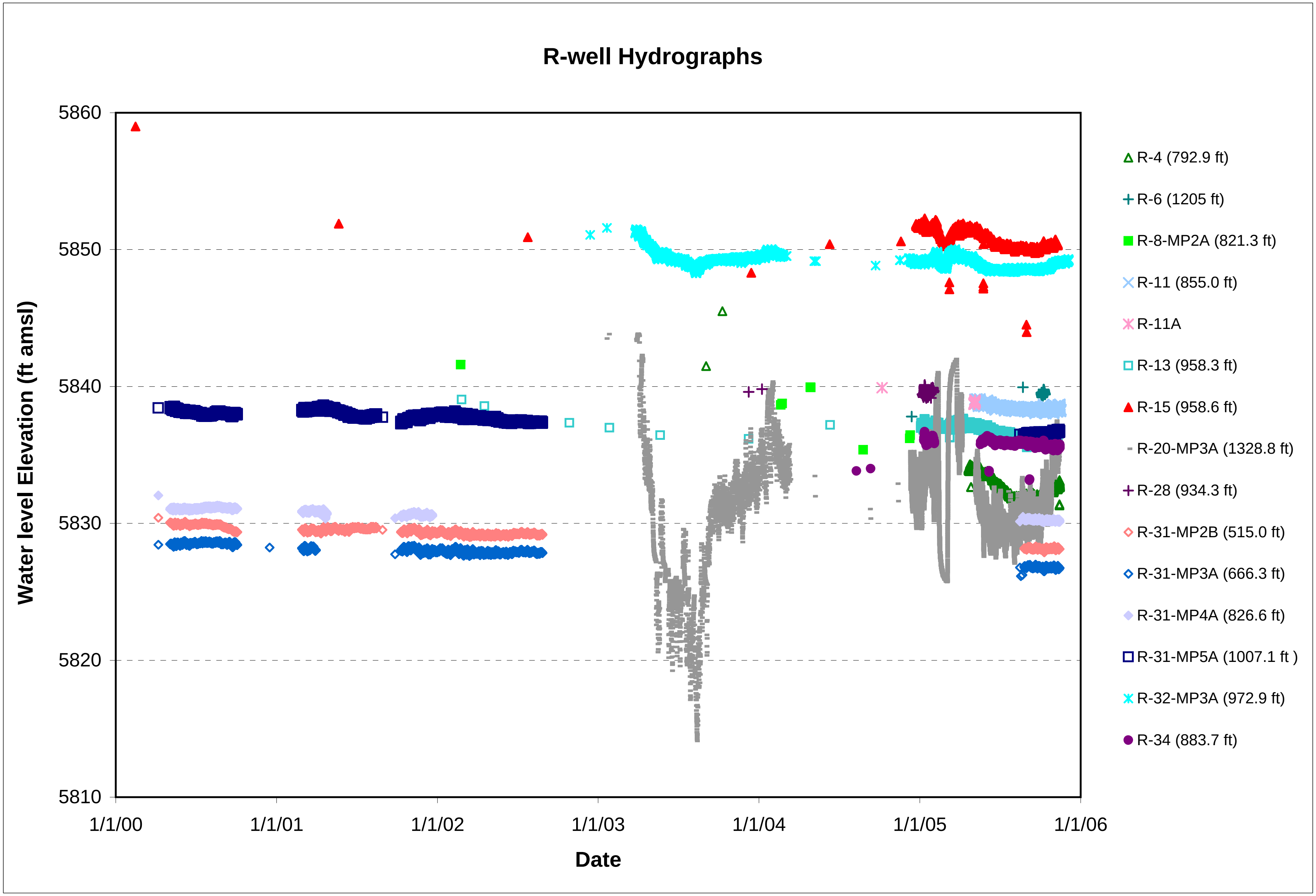

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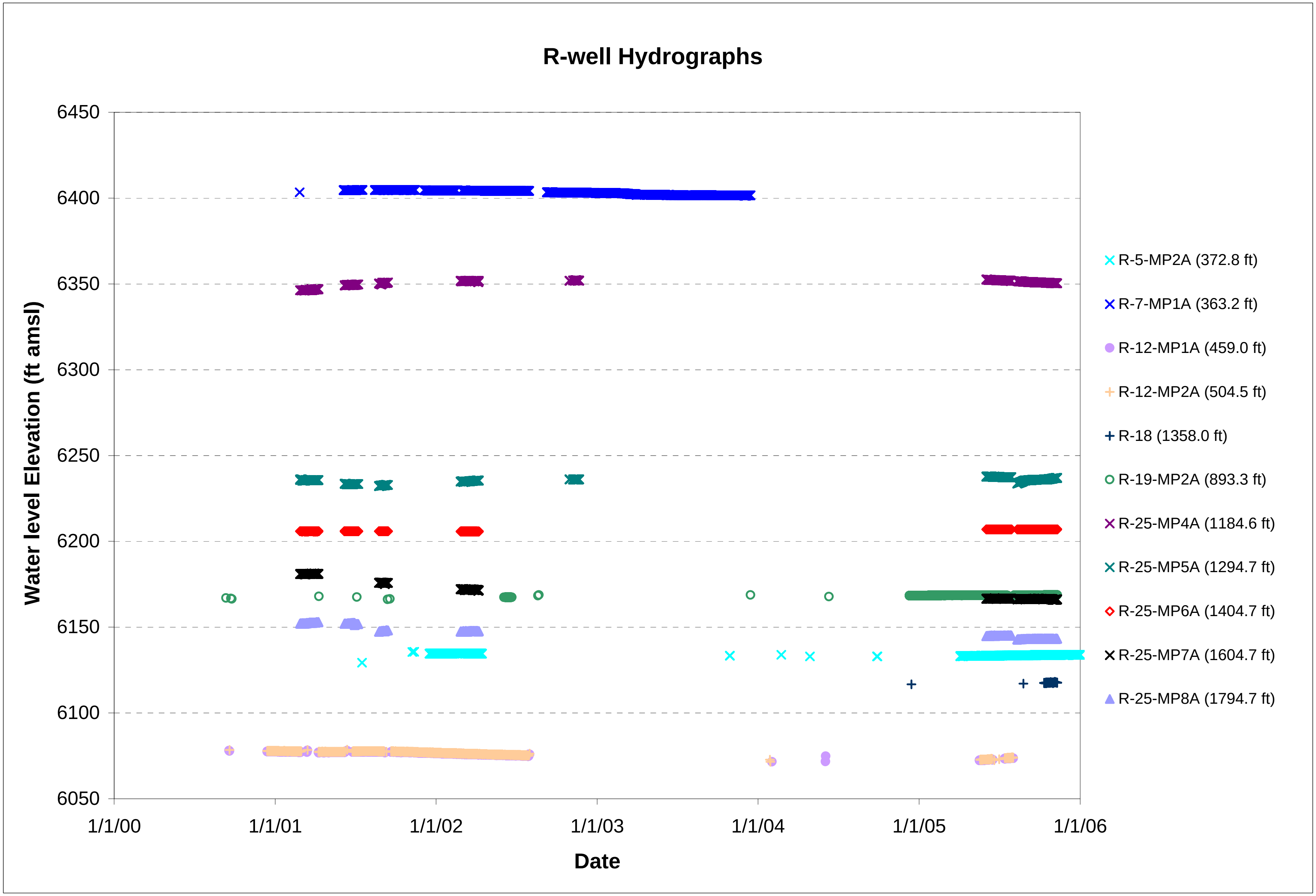

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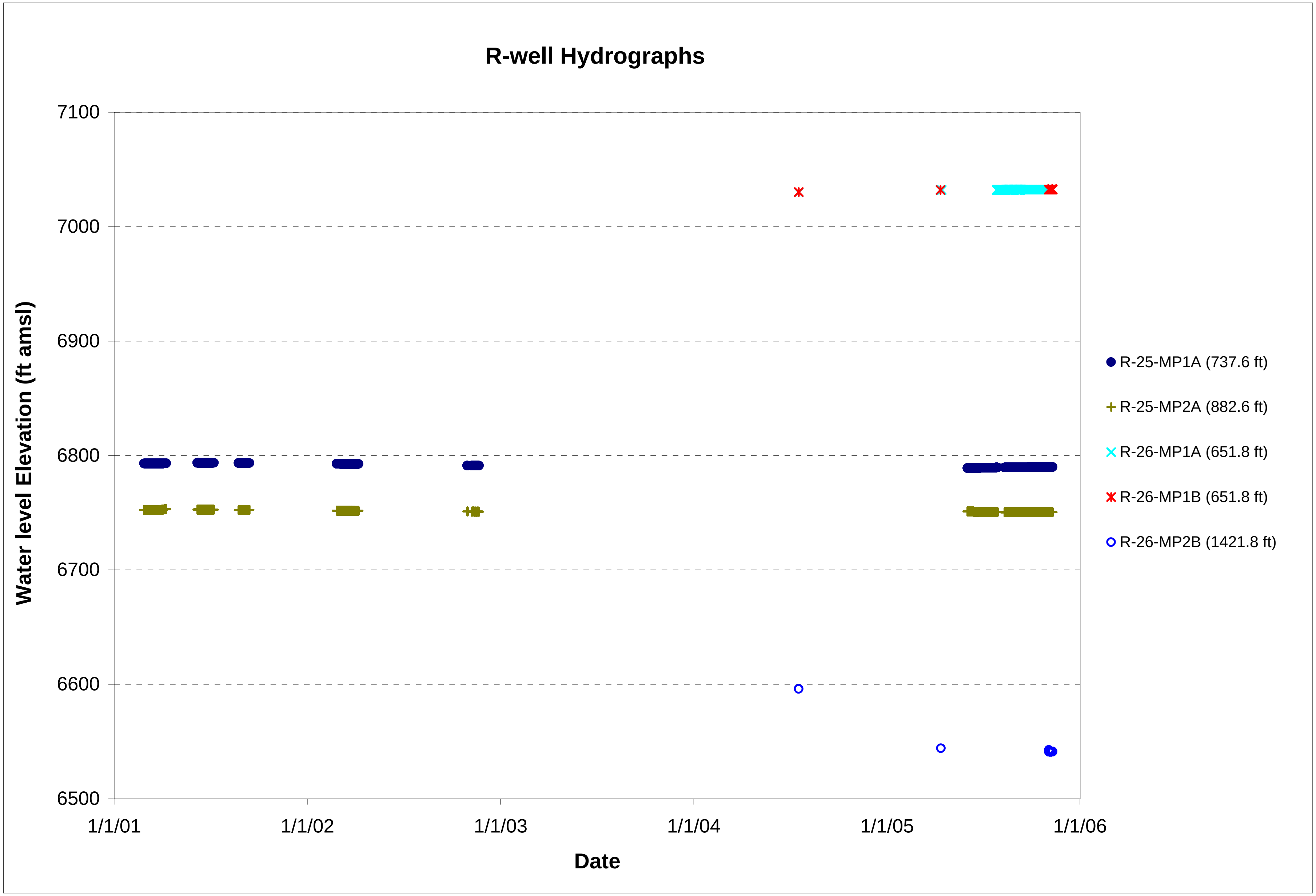


A2_combined R-well hydrographs.xls [R-well hydrographs - Fig. 3.13]

Appendix A3

Water Quality Information

Table A3-1. R-well exceedances of EPA primary drinking water standards in LANL WQDB

Location Name	Analyte Desc	Sample Date	Result	Units	Uncertainty	Field Prep Code	Valid Flag Code	Lab Qualifier Code	Port Depth (ft)	Analytical Method Code	Lab Sample Type Code	Field QC Type Code	EPA Primary DW Standard: Screening Level pCi/L	EPA Primary DW Standard: Screening Level ug/L	EPA Primary DW Standard: Ratio (Result/ Screening Level) pCi/L	EPA Primary DW Standard: Ratio (Result/ Screening Level) ug/L	Drilling Fluid Influence	Comment
R-7	Bis(2-ethylhexyl)phthalate	2/19/2002	18.7	ug/L		UF	J-		378	SW-846:8270C	CS	NA		6		3.12	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Chromium	2/7/2001	300	ug/L		UF			350	SW-846:6010	CS	NA		100		3	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Nickel	2/7/2001	170	ug/L		UF			350	SW-846:6010	CS	NA		100		1.7	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Nickel	5/30/2001	210	ug/L		F	NQ		915.1	SW-846:6010	CS	NA		100		2.1	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Nickel	5/30/2001	220	ug/L		UF	NQ		915.1	SW-846:6010	CS	NA		100		2.2	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Nickel	8/9/2001	120	ug/L		F	NQ		915.1	SW-846:6010	CS	NA		100		1.2	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Nickel	8/9/2001	130	ug/L		UF	NQ		915.1	SW-846:6010	CS	NA		100		1.3	Y	Data from wells that show drilling fluid influences are questionable.
R-7	Thallium	2/7/2001	4.6	ug/L		UF	J	B	350	SW-846:6010	CS	NA		2		2.3	Y	Data from wells that show drilling fluid influences are questionable.
R-9	Thallium	2/28/2000	3.9	ug/L		UF	J	B	684	SW-846:6010	CS	NA		2		1.95	Y	Data from wells that show drilling fluid influences are questionable.
R-10a	Bis(2-ethylhexyl)phthalate	11/30/2005	14.8	ug/L		UF				SW-846:8270C	CS			6		2.47	?	
R-14	Chrysene	5/11/2005	0.38	ug/L		UF	J	J	1204.5	SW-846:8270C	RE			0.2		1.9	Y	Data from wells that show drilling fluid influences are questionable.
R-15	Bis(2-ethylhexyl)phthalate	2/24/2000	9.3	ug/L		UF	J	J	958.6	SW-846:8270	CS	NA		6		1.55	Y	Data from wells that show drilling fluid influences are questionable.
R-15	Thallium	2/24/2000	5.40	ug/L		F	J	B	958.6	SW-846:6010	CS	NA		2		2.7	Y	Data from wells that show drilling fluid influences are questionable.
R-16	Pentachlorophenol	3/19/2004	10	ug/L		UF		J	1238	SW-846:8270	CS			1		10	Y	Data from wells that show drilling fluid influences are questionable.
R-16	Pentachlorophenol	3/19/2004	10.6	ug/L		UF		J	1238	SW-846:8270	CS	FD		1		10.6	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Arsenic	7/17/2001	11	ug/L		UF	NQ		1834.7	SW-846:6010B	CS	NA		10		1.1	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Arsenic	9/24/2001	11.4	ug/L		F	NQ		1834.7	SW-846:6010B	CS	NA		10		1.14	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Arsenic	9/24/2001	11	ug/L		UF	NQ		1834.7	SW-846:6010B	CS	NA		10		1.1	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Benzo(a)pyrene	9/19/2001	1.30	ug/L		UF	NQ		1190.7	SW-846:8270		NA		0.2		6.5	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Chrysene	9/19/2001	1.30	ug/L		UF	NQ		1190.7	SW-846:8270		NA		0.2		6.5	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Dibromo-3-Chloropropane[1,2-]	9/19/2001	1	ug/L		UF	NQ		1190.7	SW-846:8260		NA		0.2		5	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Dibromoethane[1,2-]	9/19/2001	1	ug/L		UF	NQ		1190.7	SW-846:8260		NA		0.05		20	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Hexachlorobenzene	9/19/2001	12.80	ug/L		UF	NQ		1190.7	SW-846:8270		NA		1		12.8	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Methylene Chloride	9/19/2001	5	ug/L		UF	NQ		1190.7	SW-846:8260		NA		5		1	Y	Data from wells that show drilling fluid influences are questionable.
R-19	Pentachlorophenol	9/19/2001	12.80	ug/L		UF	NQ		1190.7	SW-846:8270		NA		1		12.8	Y	Data from wells that show drilling fluid influences are questionable.
R-20	Arsenic	7/18/2005	10.6	ug/L		F		J	1330	SW-846:6010B	CS			10		1.06	Y	Data from wells that show drilling fluid influences are questionable.
R-23	Bis(2-ethylhexyl)phthalate	12/17/2003	7.6	ug/L		UF		J	816	SW-846:8270	CS			6		1.27	?	
R-25	Beryllium	5/7/2001	10.1	ug/L		F	NQ		1192.4	SW-846:6020	CS	NA		4		2.53	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Chromium	8/9/2002	139	ug/L		UF			1303.4	SW-846:6010B	CS			100		1.39	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Chromium	8/2/2005	153	ug/L		UF			754.8	SW-846:6010B	CS			100		1.53	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Chromium	8/2/2005	153	ug/L		UF			754.8	SW-846:6010B	DUP			100		1.53	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Lead	12/12/2000	23	ug/L		UF	NQ		1796	SW-846:6010	CS	NA		15		1.53	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Lead	12/12/2000	18.1	ug/L		UF	NQ		1796	SW-846:6020	CS	NA		15		1.21	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	5/3/2001	170	ug/L		F	NQ		754.8	SW-846:6010	CS	NA		100		1.7	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	5/3/2001	220	ug/L		UF	NQ		754.8	SW-846:6010	CS	NA		100		2.2	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/13/2001	380	ug/L		F	NQ		754.8	SW-846:6010	CS	NA		100		3.8	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/13/2001	470	ug/L		UF	NQ		754.8	SW-846:6010	CS	NA		100		4.7	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	2/4/2002	460	ug/L		F	NQ		754.8	SW-846:6010B	CS	NA		100		4.6	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	2/4/2002	469	ug/L		UF	NQ		754.8	SW-846:6010B	CS	NA		100		4.69	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/7/2002	812	ug/L		UF			754.8	SW-846:6010B	CS			100		8.12	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/7/2002	809	ug/L		UF			754.8	SW-846:6010B	CS	FD		100		8.09	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	12/10/2003	126	ug/L		UF			891.8	SW-846:6010B	CS			100		1.26	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	12/11/2003	1060	ug/L		UF			754.8	SW-846:6010B	CS			100		10.6	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	12/11/2003	1060	ug/L		UF			754.8	SW-846:6010B	DUP			100		10.6	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	12/11/2003	905	ug/L		UF			754.8	SW-846:6010B	CS	FD		100		9.05	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	9/1/2004	1720	ug/L		UF			754.8	SW-846:6010B	CS			100		17.2	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	9/1/2004	1670	ug/L		UF			754.8	SW-846:6010B	DUP			100		16.7	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	9/1/2004	1710	ug/L		UF			754.8	SW-846:6010B	CS	FD		100		17.1	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/2/2005	723	ug/L		F			754.8	SW-846:6020	CS			100		7.23	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/2/2005	704	ug/L		F			754.8	SW-846:6020	DUP			100		7.04	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/2/2005	742	ug/L		UF			754.8	SW-846:6020	CS			100		7.42	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/2/2005	751	ug/L		UF			754.8	SW-846:6020	DUP			100		7.51	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/3/2005	520	ug/L		F	J		891.8	SW-846:6020	CS			100		5.2	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/3/2005	512	ug/L		F			891.8	SW-846:6020	DUP			100		5.12	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Nickel	8/3/2005	537	ug/L		UF	J		891.8	SW-846:6020	CS			100		5.37	Y	Data from wells that show drilling fluid influences are questionable.

Table A3-1. R-well exceedances of EPA primary drinking water standards in LANL WQDB

Location Name	Analyte Desc	Sample Date	Result	Units	Uncertainty	Field Prep Code	Valid Flag Code	Lab Qualifier Code	Port Depth (ft)	Analytical Method Code	Lab Sample Type Code	Field QC Type Code	EPA Primary DW Standard: Screening Level pCi/L	EPA Primary DW Standard: Screening Level ug/L	EPA Primary DW Standard: Ratio (Result/ Screening Level) pCi/L	EPA Primary DW Standard: Ratio (Result/ Screening Level) ug/L	Drilling Fluid Influence	Comment
R-25	Nickel	8/3/2005	534	ug/L		UF			891.8	SW-846:6020	DUP			100		5.34	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	12/1/2000	5.1	ug/L		UF	J	B	1063.4	SW-846:6010	CS	NA		2		2.55	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	12/4/2000	5.2	ug/L		F	J	B	1192.4	SW-846:6010	CS	NA		2		2.6	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	12/4/2000	4.7	ug/L		UF	J	B	1192.4	SW-846:6010	CS	NA		2		2.35	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	12/7/2000	2.2	ug/L		F	J	B	1303.4	SW-846:6010	CS	NA		2		1.1	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	12/7/2000	2.4	ug/L		UF	J	B	1303.4	SW-846:6010	CS	NA		2		1.2	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	5/4/2001	3.2	ug/L		UF	J	B	891.8	SW-846:6010	CS	NA		2		1.6	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	5/8/2001	2	ug/L		F	J	B	1303.4	SW-846:6010	CS	NA		2		1	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	5/14/2001	2.3	ug/L		UF	J	B	1796	SW-846:6010	CS	NA		2		1.15	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	8/13/2001	3.6	ug/L		F	J	B	754.8	SW-846:6010	CS	NA		2		1.8	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	8/13/2001	3.1	ug/L		UF	J	B	754.8	SW-846:6010	CS	NA		2		1.55	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	8/14/2001	2.5	ug/L		F	J	B	1192.4	SW-846:6010	CS	NA		2		1.25	Y	Data from wells that show drilling fluid influences are questionable.
R-25	Thallium	8/15/2001	2.2	ug/L		UF	J	B	1192.4	SW-846:6010	CS	NA		2		1.1	Y	Data from wells that show drilling fluid influences are questionable.
R-28	Chromium	5/20/2005	375	ug/L		F			946.2	SW-846:6010B	CS			100		3.75	N	
R-28	Chromium	5/20/2005	373	ug/L		F			946.2	SW-846:6010B	DUP			100		3.73	N	
R-28	Chromium	5/20/2005	389	ug/L		UF	J		946.2	SW-846:6010B	CS			100		3.89	N	
R-28	Chromium	9/1/2005	397	ug/L		F			946.2	SW-846:6010B	CS			100		3.97	N	
R-28	Chromium	9/1/2005	404	ug/L		UF			946.2	SW-846:6010B	CS			100		4.04	N	
R-28	Chromium	9/1/2005	405	ug/L		UF			946.2	SW-846:6010B	DUP			100		4.05	N	
R-28	Chromium	11/10/2005	404	ug/L		F			946.2	SW-846:6010B	CS			100		4.04	N	
R-28	Chromium	11/10/2005	416	ug/L		UF			946.2	SW-846:6010B	CS			100		4.16	N	
R-33	Bis(2-ethylhexyl)phthalate	6/24/2005	8.2	ug/L		UF		J	1112.4	SW-846:8270C	CS			6		1.37	Y	Data from wells that show drilling fluid influences are questionable.
R-33	Nickel	6/24/2005	168	ug/L		F			1112.4	SW-846:6010B	CS			100		1.68	Y	Data from wells that show drilling fluid influences are questionable.
R-33	Nickel	6/24/2005	164	ug/L		F			1112.4	SW-846:6010B	DUP			100		1.64	Y	Data from wells that show drilling fluid influences are questionable.

Notes: Analytical data from water samples collected prior to well construction are not representative of developed well water quality and are omitted here.
EPA = Environmental Protection Agency
ug/L = micrograms per liter
pCi/L = picoCuries per Liter
QC = Quality control
DW = Drinking water
Y = Yes
N = No
L = Likely
? = Uncertain

Field Prep Codes:
UF = unfiltered sample; F = filtered sample

Valid Flag Codes:
NQ = No validation qualifier flag; analyte is classified as detected
J = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual
J- = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual with a potential negative bias
J+ = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual with a potential positive bias

Lab Qualifier Codes:
B = Reported value was obtained from a reading that was less than the contract required detection limit but greater than or equal to the instrument detection limit
N = Spiked sample recovery not within control limits
E = Reported value is estimated because of the presence of interference
J = Reported value is greater than the method detection limit but less than the practical quantitation limit

Lab Sample Type Codes:
CS = Customer sample
DUP = Duplicate
RE = Reanalysis

Field QC Type Codes:
NA = Not applicable
FD = Field duplicate

Table A3-2. Supply well exceedances of EPA primary drinking water standards in LANL WQDB

Location Name	Analyte Desc	Sample Date	Result	Units	Uncertainty	Field Prep Code	Valid Flag Code	Lab Qualifier Code	Port Depth (ft)	Analytical Method Code	Lab Sample Type Code	Field QC Type Code	EPA Primary Drinking Water Standard: Screening Level			EPA Primary Drinking Water Standard: Ratio (Result/ Screening Level)			Comment
													mg/L	pCi/L	ug/L	mg/L	pCi/L	ug/L	
G-1A	Arsenic	4/10/1990	14	ug/L		UF			272	LEGACY	CS				10			1.4	
G-1A	Arsenic	5/9/1991	13	ug/L		UF			272	LEGACY	CS				10			1.3	
G-1A	Arsenic		13	ug/L		UF			272	LEGACY	CS				10			1.3	
G-1A	Arsenic	6/2/1993	14	ug/L					272	LEGACY	CS				10			1.4	
G-1A	Arsenic	5/24/1994	11.9	ug/L					272	LEGACY	CS				10			1.19	
G-1A	Arsenic	6/12/1995	16	ug/L	3	UF			272	GENERIC ETVAA	CS				10			1.6	
G-1A	Arsenic	6/12/1995	18	ug/L	4	UF			272	GENERIC ETVAA	CS				10			1.8	
G-1A	Arsenic	9/8/1996	14	ug/L	2	UF			272	SW-846:7060	CS				10			1.4	
G-1A	Arsenic	9/8/1996	13	ug/L	2	UF			272	SW-846:7060	CS				10			1.3	
G-1A	Arsenic	6/25/1997	14	ug/L	2	UF			272	GENERIC ETVAA	CS				10			1.4	
G-1A	Arsenic	9/27/2000	10	ug/L		UF			272	EPA:200.9	CS				10			1	
G-2A	Arsenic	11/30/1999	13	ug/L	3	UF			565	GENERIC ETVAA	CS				10			1.3	
G-3A	Arsenic	11/30/1999	12	ug/L	3	UF			590	GENERIC ETVAA	CS				10			1.2	
G-5A	Arsenic	11/30/1999	12	ug/L	3	UF			746.6	GENERIC ETVAA	CS				10			1.2	
Otowi House Well	Nitrate as Nitrogen	7/29/1994	10.8	mg/L					-1	LEGACY	CS		10			1.08			Sample mistakenly acidified
PM-2	Lead	6/25/1997	19	ug/L	3	UF			1004	GENERIC ICPMS	CS				15			1.27	
PM-4	Thallium	8/18/1993	19	ug/L					1004	LEGACY	CS				2			9.5	
PM-5	Fluoride	4/25/1996	28	mg/L	0.1	UF			1440	EPA:340.2	CS		4			7			
PM-5	Thallium	8/18/1993	14	ug/L					1440	LEGACY	CS				2			7	

Notes:

The LANL WQDB includes numerous apparent detections for cadmium, thallium, and beryllium in 1998 that were actually non-detects (the < sign was omitted from the database entry). Those data are omitted here.

Analytical data from water samples collected prior to well construction are not representative of developed well water quality and are omitted here.

EPA = Environmental Protection Agency
ug/L = micrograms per liter
pCi/L - picoCuries per Liter
QC = Quality control
DW = Drinking water
ICPMS = Inductively coupled mass spectrometry
ICPES = Inductively couple plasma emissions spectrometry
ETVAA = electrothermal vaporization atomic absorption

Field Prep Codes:
UF = unfiltered sample
F = filtered sample

Valid Flag Codes:
J = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual
J- = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual with a potential negative bias

Lab Sample Type Codes:
CS = Customer sample
DUP = Duplicate

Field QC Type Codes:
FD = Field duplicate

Table A3-3. Test Well exceedances of EPA primary drinking water standards in LANL WQDB

Location Name	Analyte Desc	Sample Date	Result	Units	Uncertainty	Field Prep Code	Valid Flag Code	Lab Qualifier Code	Port Depth (ft)	Analytical Method Code	Lab Sample Type Code	Field QC Type Code	EPA Primary Drinking Water Standard						Comment
													Screening Level			Ratio (Result/ Screening Level)			
													mg/L	pCi/L	ug/L	mg/L	pCi/L	ug/L	
Test Well 1	Antimony	9/23/1991	8.5	ug/L		UF			632	LEGACY	CS				6			1.42	Data suspect
Test Well 1	Antimony	10/8/1992	8	ug/L		UF			632	LEGACY	CS				6			1.33	Data suspect
Test Well 1	Antimony	5/19/1993	16.4	ug/L					632	LEGACY	CS				6			2.73	Data suspect
Test Well 1	Antimony	6/19/1995	6	ug/L	2	UF			632	Generic:ICPMS	CS				6			1.00	Data suspect
Test Well 1	Antimony	8/11/1997	9	ug/L	6	UF			632	GENERIC ICPMS	CS				6			1.50	Data suspect
Test Well 1	Antimony	5/27/1999	6	ug/L	4	UF			632	GENERIC ICPMS	CS				6			1.00	Data suspect
Test Well 1	Lead	9/23/1991	22	ug/L		UF			632	LEGACY	CS				15			1.47	Data suspect
Test Well 1	Lead	5/19/1993	1037	ug/L					632	LEGACY	CS				15			69.13	Data suspect
Test Well 1	Lead	5/31/1994	178	ug/L					632	LEGACY	CS				15			11.87	Data suspect
Test Well 1	Lead	5/31/1994	68	ug/L		UF			632	LEGACY	CS				15			4.53	Data suspect
Test Well 1	Lead	6/19/1995	49	ug/L	5	UF			632	Generic:ICPMS	CS				15			3.27	Data suspect
Test Well 1	Lead	8/1/1996	62	ug/L	3	UF			632	SW-846:6020	CS				15			4.13	Data suspect
Test Well 1	Lead	8/11/1997	88	ug/L	3	UF			632	GENERIC ICPMS	CS				15			5.87	Data suspect
Test Well 1	Lead	8/11/1997	96	ug/L		UF			632	LEGACY	CS				15			6.40	Data suspect
Test Well 1	Lead	5/27/1999	77	ug/L	4	UF			632	GENERIC ICPMS	CS				15			5.13	Data suspect
Test Well 1	Lead	5/2/2000	42	ug/L	5	UF			632	GENERIC ICPMS	CS				15			2.80	Data suspect
Test Well 1	Lead	6/5/2001	15.4	ug/L		UF			632	SW-846:6020	CS				15			1.03	Data suspect
Test Well 1	Lead	5/9/2002	28.4	ug/L		UF			632	SW-846:6020	CS				15			1.89	Data suspect
Test Well 1	Lead	7/30/2003	19.9	ug/L		UF			632	SW-846:6020	CS				15			1.33	Data suspect
Test Well 1	Lead	12/13/2004	23.3	ug/L		UF	J	E	632	SW-846:6020	CS				15			1.55	Data suspect
Test Well 1	Lead	12/13/2004	24	ug/L		UF			632	SW-846:6020	DUP				15			1.60	Data suspect
Test Well 1	Nitrate as Nitrogen	6/5/1952	121.9	mg/L					632	LEGACY	CS		10			12.19			Suspected database error
Test Well 1	Nitrate as Nitrogen	5/31/1994	23	mg/L					632	LEGACY	CS		10			2.30			Suspected field contamination error
Test Well 1	Nitrate as Nitrogen	6/19/1995	12.9	mg/L	1.3	UF			632	Generic: FIA	CS		10			1.29			
Test Well 1	Strontium-90	5/27/1999	20.57	pCi/L	1.16	UF			632	Liquid Scintillation Counting	CS			8			2.57		Data questionable because of lab analytical error
Test Well 2	Arsenic	8/21/1996	12	ug/L	4	UF			768	SW-846:7060	CS				10			1.20	
Test Well 2	Cadmium	3/10/1978	6	ug/L	3	UF			768	LEGACY	CS				5			1.20	
Test Well 2	Cadmium	5/22/1991	7.9	ug/L		UF			768	LEGACY	CS				5			1.58	
Test Well 2	Lead	2/15/1980	114	ug/L		UF			768	LEGACY	CS				15			7.60	Data suspect
Test Well 2	Lead	5/22/1991	53	ug/L		UF			768	LEGACY	CS				15			3.53	Data suspect
Test Well 2	Lead	5/19/1993	30.4	ug/L					768	LEGACY	CS				15			2.03	Data suspect
Test Well 2	Lead	5/31/1994	47.6	ug/L					768	LEGACY	CS				15			3.17	Data suspect
Test Well 2	Lead	5/31/1994	46	ug/L		UF			768	LEGACY	CS				15			3.07	Data suspect
Test Well 2	Lead	8/1/1995	170	ug/L	20	UF			768	Generic:ICPMS	CS				15			11.33	Data suspect
Test Well 2	Lead	9/9/1997	54	ug/L		UF			768	LEGACY	CS				15			3.60	Data suspect
Test Well 2	Lead	12/11/1997	45	ug/L	3	UF			768	GENERIC ICPMS	CS				15			3.00	Data suspect
Test Well 2	Lead	5/3/2000	40	ug/L	5	UF			768	GENERIC ICPMS	CS				15			2.67	Data suspect
Test Well 2	Lead	3/22/2005	44.9	ug/L	1.4	UF			768	EPA:200.8	CS				15			2.99	Data suspect
Test Well 2	Nitrate as Nitrogen	9/26/1951	11.21	mg/L					768	LEGACY	CS		10			1.12			
Test Well 2	Tritium	10/21/1982	25000	pCi/L	1000	UF			768	LEGACY	CS			20000			1.25		Suspected lab analytical error
Test Well 3	Cadmium	3/10/1978	6	ug/L	3	UF			805	LEGACY	CS				5			1.20	
Test Well 3	Cadmium	7/18/1995	5	ug/L	4	UF			805	Generic:ICPES	CS				5			1.00	
Test Well 3	Lead	7/18/1995	24	ug/L	2	UF			805	Generic:ICPMS	CS				15			1.60	Data suspect
Test Well 3	Lead	8/11/1997	15	ug/L	3	UF			805	GENERIC ICPMS	CS				15			1.00	Data suspect
Test Well 3	Lead	9/29/2004	22.4	ug/L		UF			805	SW-846:6020	CS				15			1.49	Data suspect
Test Well 3	Lead	9/29/2004	21.8	ug/L		UF			805	SW-846:6020	DUP				15			1.45	Data suspect
Test Well 3	Strontium-90	6/2/1994	35.1	pCi/L	2.2	UF			805	LEGACY	CS			8			4.39		
Test Well 3	Strontium-90	5/27/1999	10.58	pCi/L	0.67	UF			805	Liquid Scintillation Counting	CS			8			1.32		Data questionable because of lab analytical error
Test Well 4	Aroclor-1260	8/11/1997	0.77	ug/L		UF			1195	Generic: PCB	CS				0.5			1.54	
Test Well 4	Aroclor-1260	5/2/2000	0.53	ug/L		UF			1195	Generic: PCB	CS				0.5			1.06	
Test Well 4	Aroclor-1260	5/2/2000	0.53	ug/L		UF			1195	PCBS CL	CS				0.5			1.06	
Test Well 4	Cadmium	6/20/1994	7	ug/L					1195	LEGACY	CS				5			1.40	
Test Well 4	Lead	5/19/1993	59.6	ug/L					1195	LEGACY	CS				15			3.97	Data suspect
Test Well 4	Lead	6/20/1994	52	ug/L					1195	LEGACY	CS				15			3.47	Data suspect
Test Well 4	Lead	6/20/1994	57	ug/L		UF			1195	LEGACY	CS				15			3.80	Data suspect
Test Well 4	Lead	7/19/1995	150	ug/L	20	UF			1195	Generic:ICPMS	CS				15			10.00	Data suspect
Test Well 4	Lead	9/27/1996	57	ug/L	3	UF			1195	SW-846:6020	CS				15			3.80	Data suspect
Test Well 4	Lead	8/11/1997	101	ug/L	3	UF			1195	GENERIC ICPMS	CS				15			6.73	Data suspect
Test Well 4	Lead	8/11/1997	140	ug/L		UF			1195	LEGACY	CS				15			9.33	Data suspect

Table A3-3. Test Well exceedances of EPA primary drinking water standards in LANL WQDB

Location Name	Analyte Desc	Sample Date	Result	Units	Uncertainty	Field Prep Code	Valid Flag Code	Lab Qualifier Code	Port Depth (ft)	Analytical Method Code	Lab Sample Type Code	Field QC Type Code	EPA Primary Drinking Water Standard: Screening Level mg/L	Screening Level pCi/L	Screening Level ug/L	Ratio (Result/ Screening Level) mg/L	Ratio pCi/L	Ratio ug/L	Comment
Test Well 4	Lead	9/1/1998	46	ug/L	3	UF			1195	GENERIC ICPMS	CS				15			3.07	Data suspect
Test Well 4	Lead	9/1/1998	19.4	ug/L		UF			1195	LEGACY	CS				15			1.29	Data suspect
Test Well 4	Lead	5/2/2000	40	ug/L	5	UF			1195	GENERIC ICPMS	CS				15			2.67	Data suspect
Test Well 4	Lead	6/4/2001	30.4	ug/L		UF			1195	SW-846:6020	CS				15			2.03	Data suspect
Test Well 4	Lead	5/17/2002	47.9	ug/L		UF			1195	SW-846:6020	CS				15			3.19	Data suspect
Test Well 4	Strontium-90	5/27/1999	18.59	pCi/L	1.07	UF			1195	Liquid Scintillation Counting	CS			8			2.32		Data questionable because of lab analytical error
Test Well 8	Antimony	9/2/1998	6	ug/L	3	UF			953	GENERIC ICPMS	CS				6			1.00	
Test Well 8	Lead	1/1/1988	60	ug/L		UF			953	LEGACY	CS				15			4.00	Data suspect
Test Well 8	Lead	9/23/1991	36	ug/L		UF			953	LEGACY	CS				15			2.40	Data suspect
Test Well 8	Lead	12/5/1993	19	ug/L					953	LEGACY	CS				15			1.27	Data suspect
Test Well 8	Strontium-90	4/12/1976	9.4	pCi/L	1.6	UF			953	LEGACY	CS			8			1.18		
Test Well DT-10	Cadmium	3/20/1978	8	ug/L	3	UF			1080	LEGACY	CS				5			1.60	
Test Well DT-10	Lead	3/30/1988	39	ug/L		UF			1080	LEGACY	CS				15			2.60	Data suspect
Test Well DT-10	Lead	9/23/1991	28	ug/L		UF			1080	LEGACY	CS				15			1.87	Data suspect
Test Well DT-10	Lead	2/24/1993	50	ug/L					1080	LEGACY	CS				15			3.33	Data suspect
Test Well DT-10	Lead	5/20/1993	75	ug/L					1080	LEGACY	CS				15			5.00	Data suspect
Test Well DT-10	Lead	9/8/1994	95	ug/L					1080	LEGACY	CS				15			6.33	Data suspect
Test Well DT-10	Lead	9/8/1994	27	ug/L		UF			1080	LEGACY	CS				15			1.80	Data suspect
Test Well DT-10	Tritium	11/1/1982	21000	pCi/L	1000	UF			1080	LEGACY	CS			20000			1.05		Suspected lab analytical error
Test Well DT-5A	Antimony	11/18/1992	36.5	ug/L		UF			1172	LEGACY	CS				6			6.08	
Test Well DT-5A	Antimony	5/20/1993	280	ug/L					1172	LEGACY	CS				6			46.67	
Test Well DT-5A	Antimony	11/21/1994	8.5	ug/L					1172	LEGACY	CS				6			1.42	
Test Well DT-5A	Cadmium	3/10/1978	6	ug/L	3	UF			1172	LEGACY	CS				5			1.20	
Test Well DT-5A	Chromium hexavalent ion	4/24/1974	3000	ug/L	3000	UF			1172	LEGACY	CS				100			30.00	
Test Well DT-5A	Lead	3/30/1988	48	ug/L		UF			1172	LEGACY	CS				15			3.20	Data suspect
Test Well DT-5A	Lead	9/23/1991	33	ug/L		UF			1172	LEGACY	CS				15			2.20	Data suspect
Test Well DT-5A	Lead	11/18/1992	209	ug/L		UF			1172	LEGACY	CS				15			13.93	Data suspect
Test Well DT-5A	Lead	5/20/1993	9000	ug/L					1172	LEGACY	CS				15			600.00	Data suspect
Test Well DT-5A	Lead	9/8/1994	26	ug/L		F			1172	LEGACY	CS				15			1.73	Data suspect
Test Well DT-5A	Lead	9/8/1994	270	ug/L		UF			1172	LEGACY					15			18.00	Data suspect
Test Well DT-5A	Lead	9/8/1994	290	ug/L		UF			1172	LEGACY					15			19.33	Data suspect
Test Well DT-5A	Lead	11/21/1994	56	ug/L		UF			1172	LEGACY	CS				15			3.73	Data suspect
Test Well DT-5A	Tritium	10/19/1973	51200	pCi/L	1700	UF			1172	LEGACY	CS			20000			2.56		Suspected lab analytical error
Test Well DT-9	Lead	3/30/1988	17	ug/L		UF			1040	LEGACY	CS				15			1.13	Data suspect
Test Well DT-9	Lead	9/23/1991	26	ug/L		UF			1040	LEGACY	CS				15			1.73	Data suspect
Test Well DT-9	Lead	2/24/1993	55	ug/L					1040	LEGACY	CS				15			3.67	Data suspect
Test Well DT-9	Lead	5/20/1993	53	ug/L					1040	LEGACY	CS				15			3.53	Data suspect
Test Well DT-9	Strontium-90	6/2/1999	10.18	pCi/L	0.64	UF			1040	Liquid Scintillation Counting	CS			8			1.27		Data questionable because of lab analytical error

Notes:

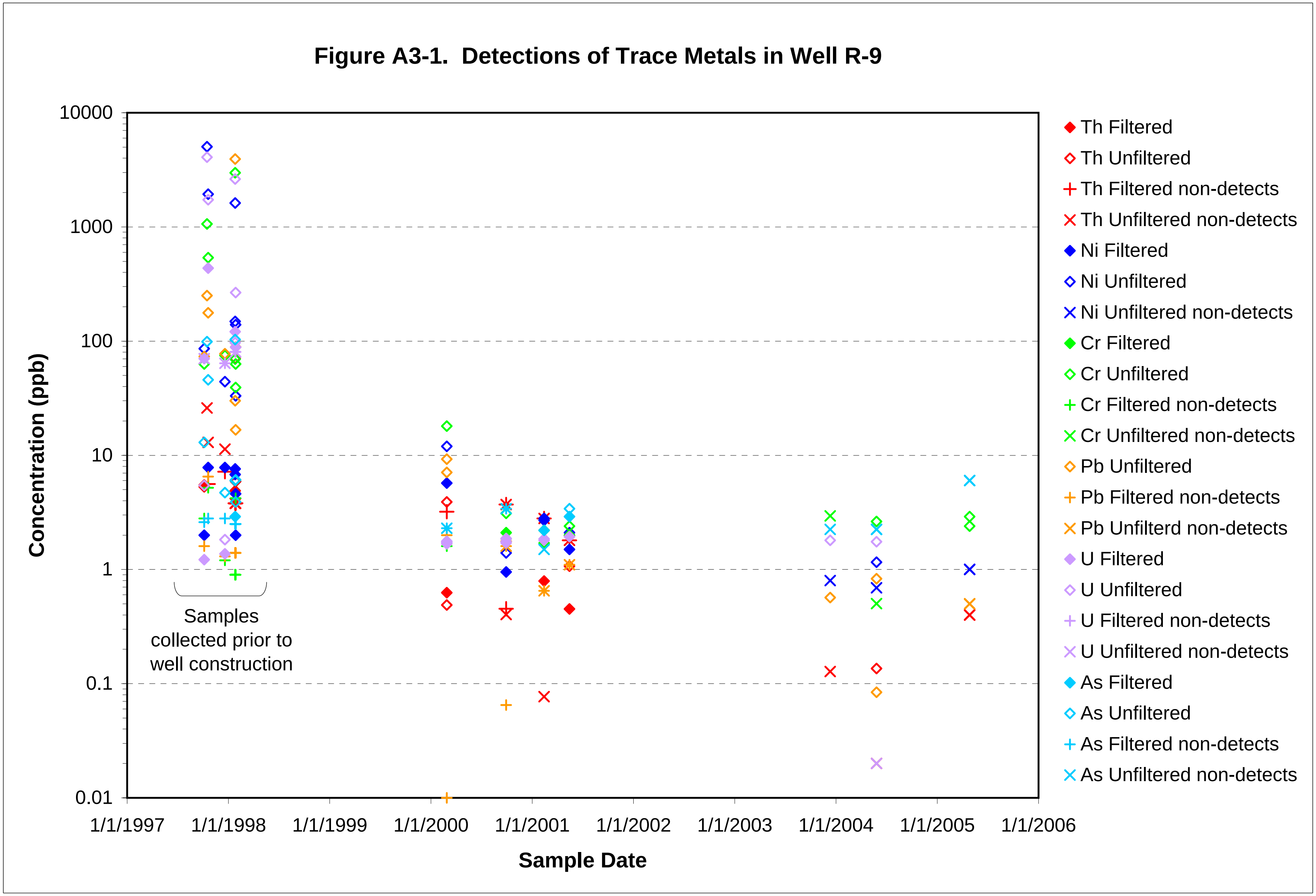
The LANL WQDB includes numerous apparent detections for cadmium, thallium, and beryllium in 1998 that were actually non-detects (the < sign was omiited from the database entry). Those data are omitted here.
1999 strontium-90 data quality issues are reported in *Environmental Surveillance at Los Alamos during 1999*, Los Alamos National Laboratory Report LA-13775-ENV, 2000, p. 161-162.
Laboratory analytical cross-contamination issues with tritium samples are reported in Rogers, D.B., 1998, *Impact of Tritium on Surface Water and Groundwater at Los Alamos National Laboratory Through 1997*, LANL Report LA-13465-SR, p. 8-9.
High metals levels in the test wells are supected to be caused by corrosion of +40 year old carbon steel well casings and galvanized steel fittings and likely do not represent regional aquifer water quality.
High lead levels appear to result from flaking of piping installed in the test wells. This issue is discussed in *Environmental Surveillance at Los Alamos during 1994*, Los Alamos National Laboratory Report LA-13047-ENV, 1996.
EPA = Environmental Protection Agency
ug/L = micrograms per liter
pCi/L = picoCuries per Liter
QC = Quality control
ICPMS = Inductively coupled mass spectrometry
ICPES = Inductively couple plasma emissions spectrometry
ETVAA = electrothermal vaporization atomic absorption
PCB = polychlorinated biphenyl
FIA = Flow injection analysis

Field Prep Codes:
UF = unfiltered sample
F = filtered sample

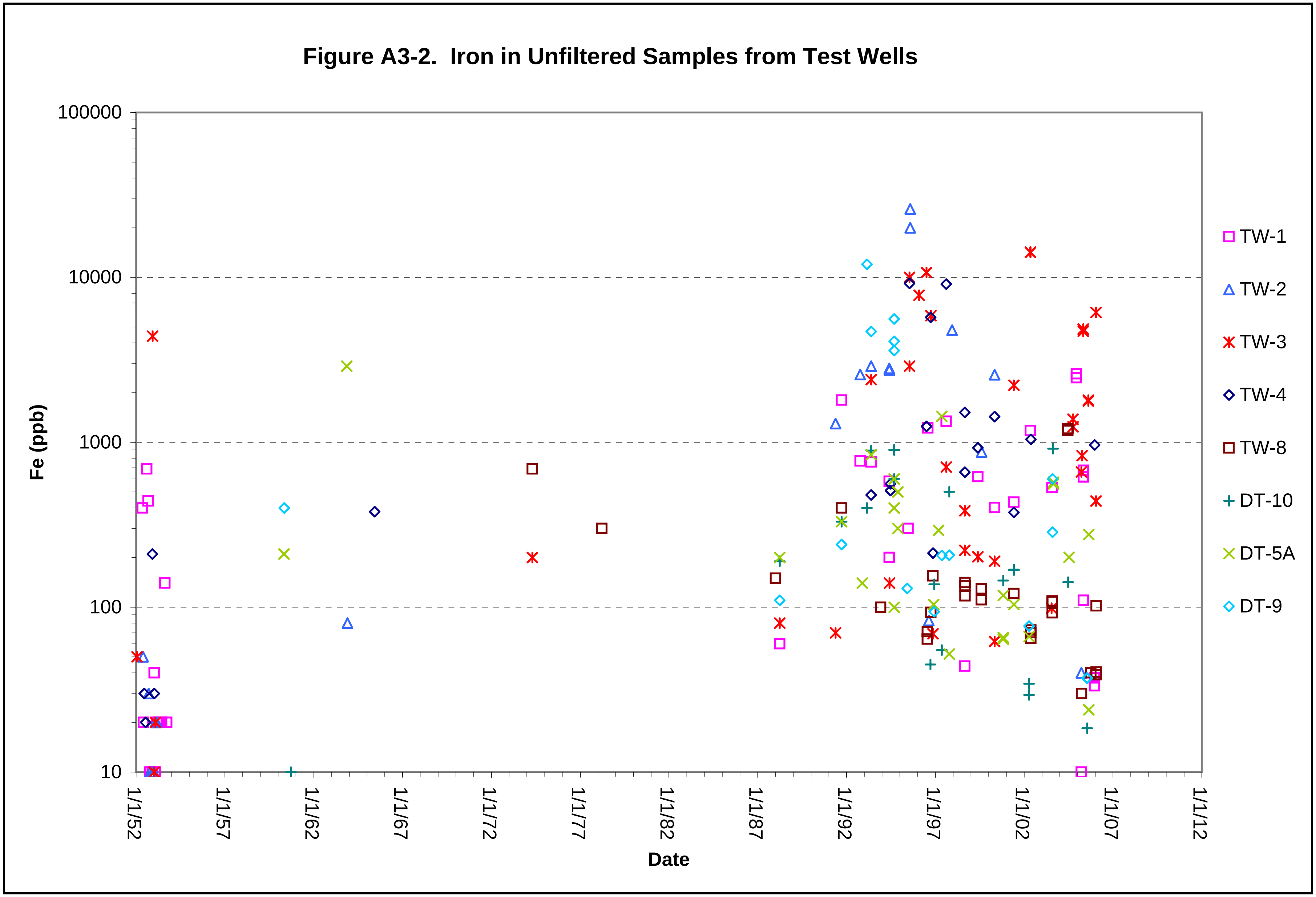
Lab Qualifier Codes:
E = Reported value is estimated because of the presence of interference

Lab Sample Type Codes:
CS = Customer sample
DUP = Duplicate

Valid Flag Codes:
J = Analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual

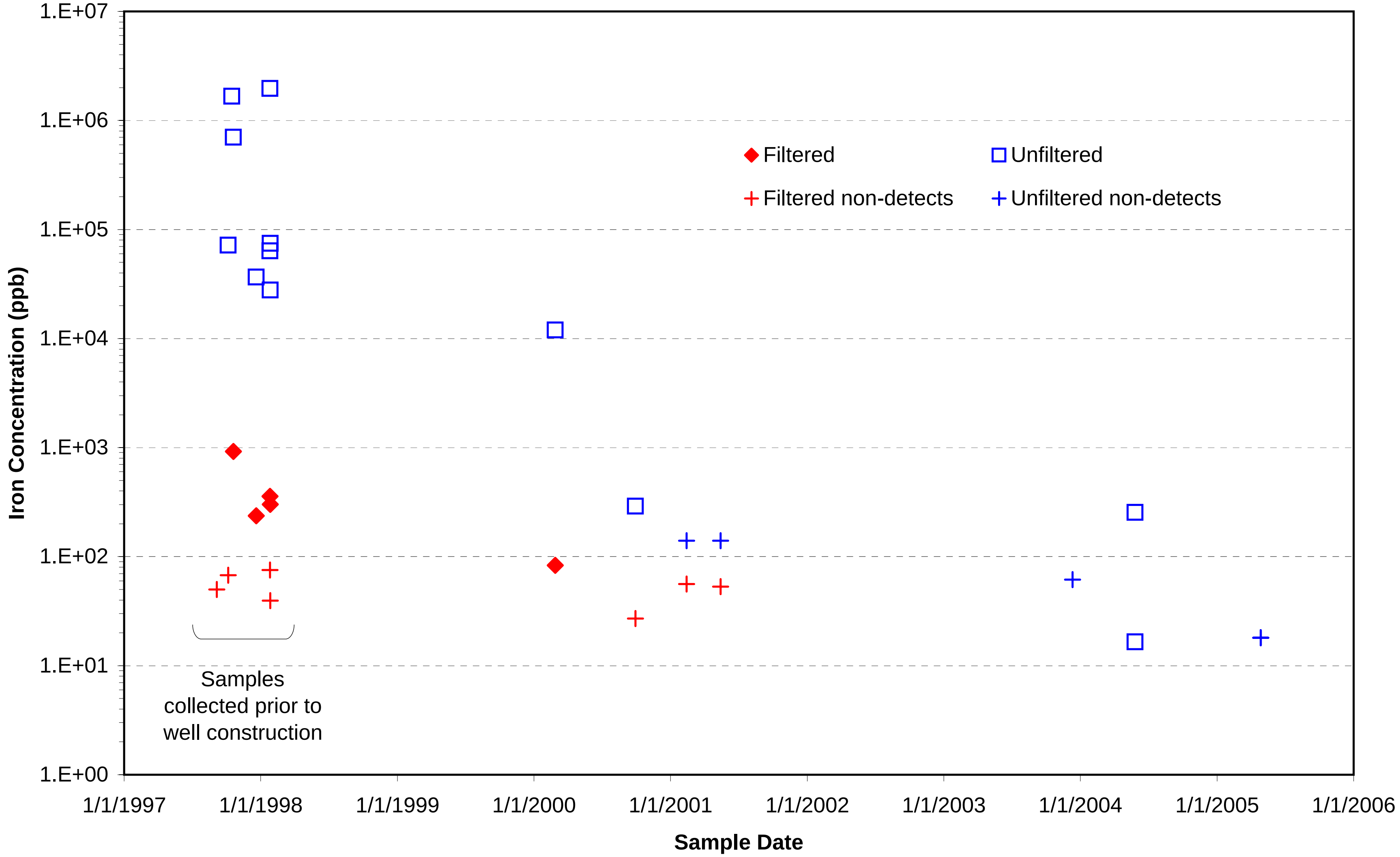


FA3-1_R-9 Metals Chart.xls [Figure 3.14]

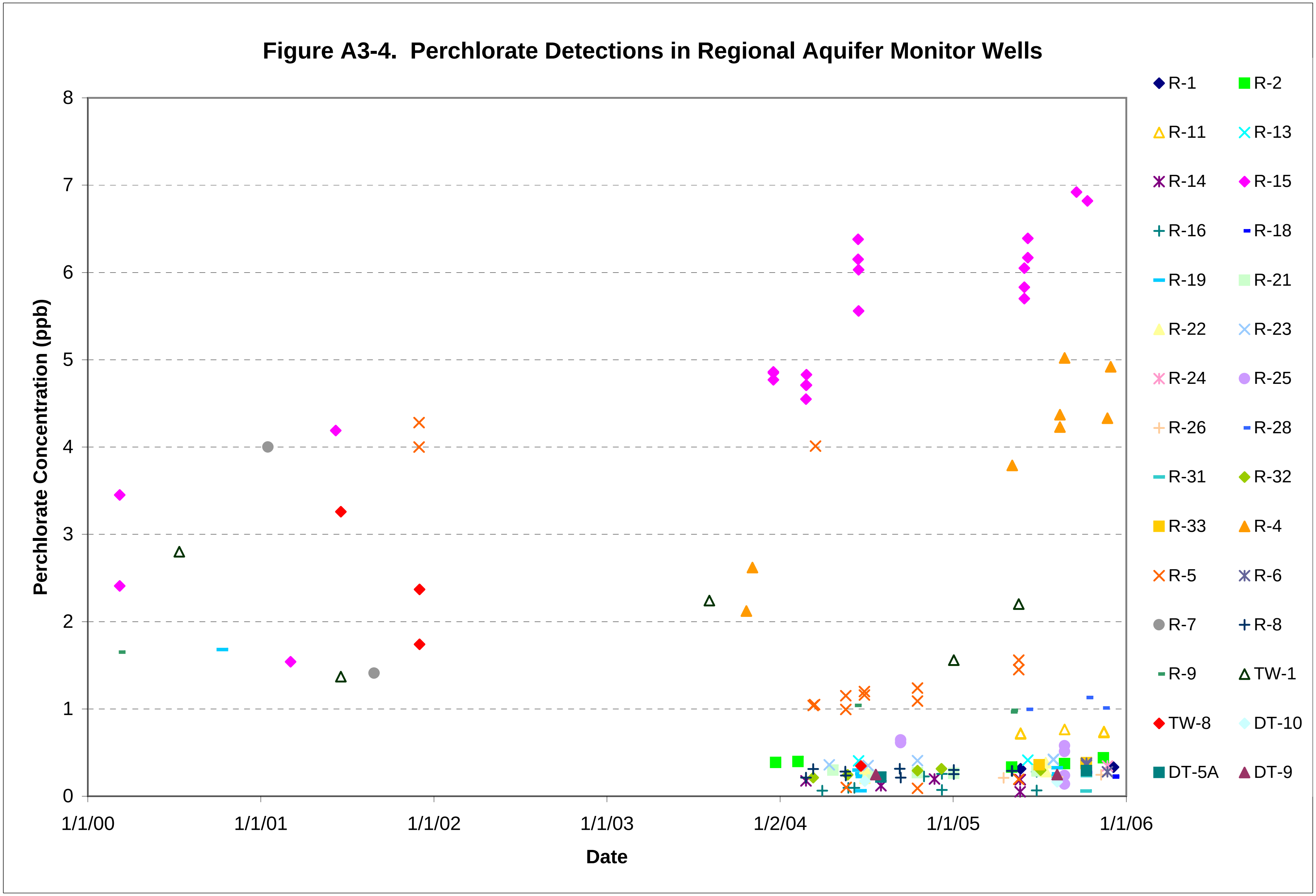


FA3-2_Test wells iron chart.xls [Fig. 3.15]

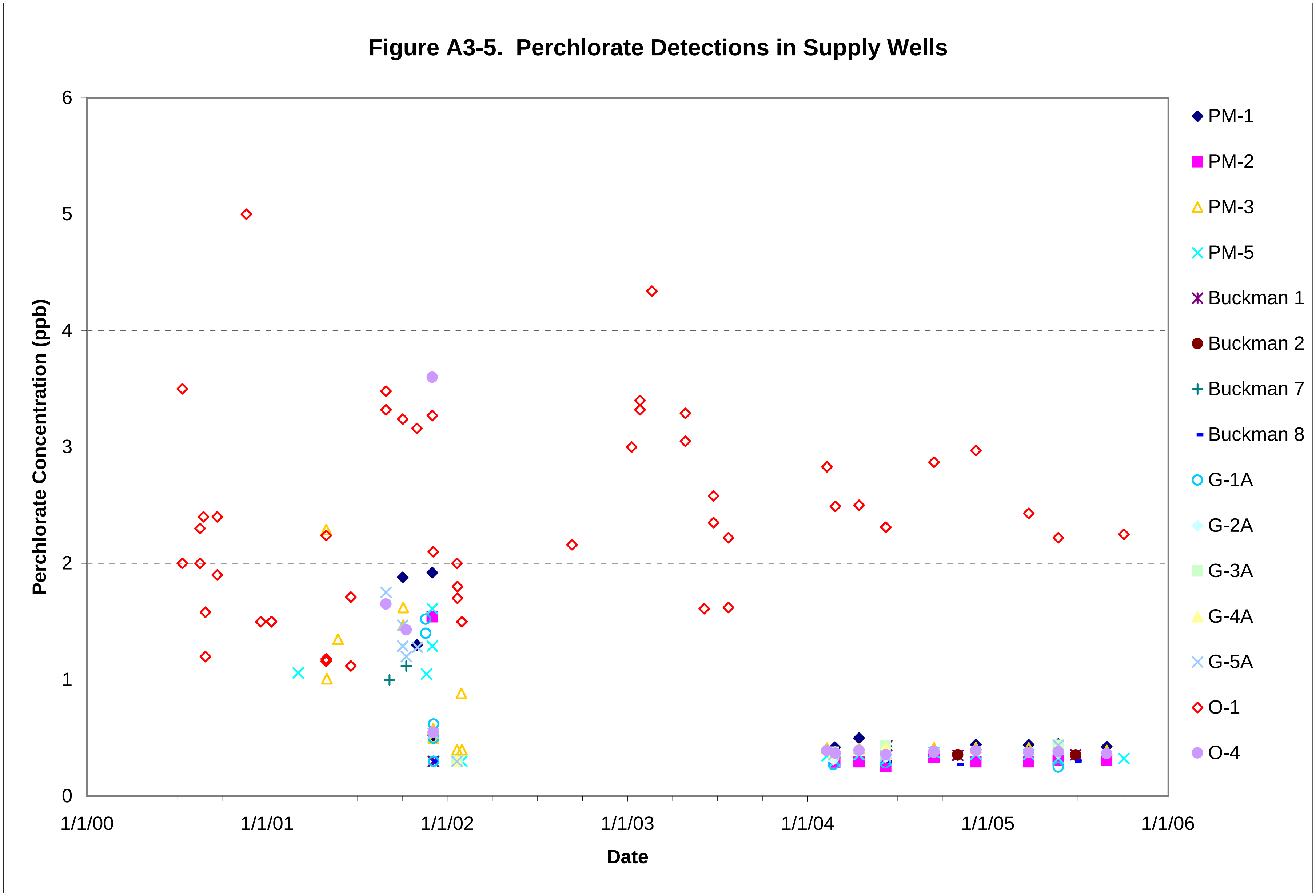
Figure A3-3. Measured iron concentrations in well R-9, showing diminishing influence of drilling fluids over time



FA3-3_R-9 iron chart.xls [Fig 3.16]

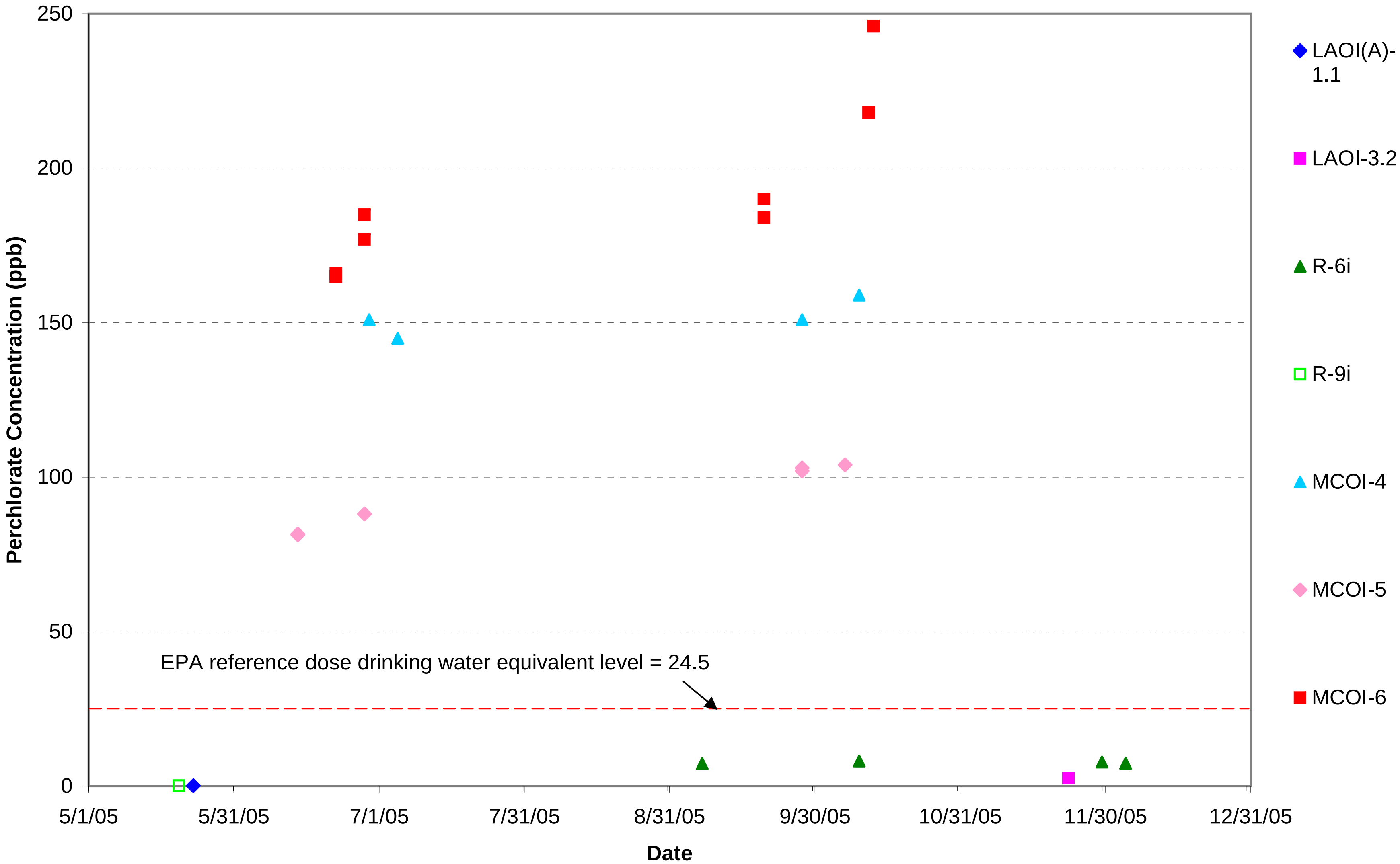


FA3-4_A3-6_Perchlorate charts.xls [R Wells ClO4 - Fig 3.22]

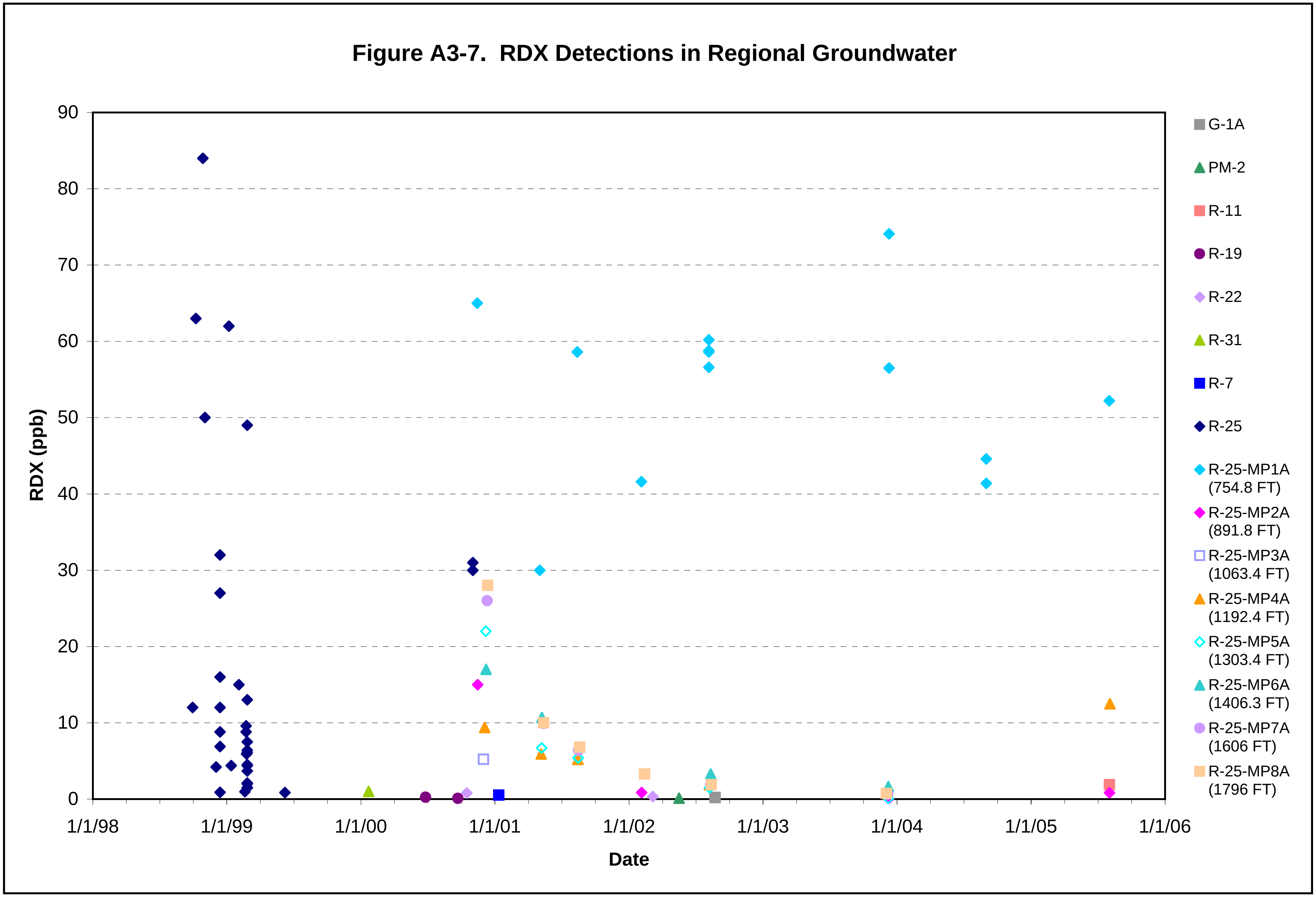


FA3-4_A3-6_Perchlorate charts.xls [Supply Wells ClO4 - Fig 3.24]

Figure A3-6. Perchlorate Detections in Intermediate Depth Perched Aquifer Wells



FA3-4_A3-6_Perchlorate charts.xls [I Wells ClO4 - Fig 3.25]



FA3-7_RDX charts.xls [RDX Chart - Fig 3.27]

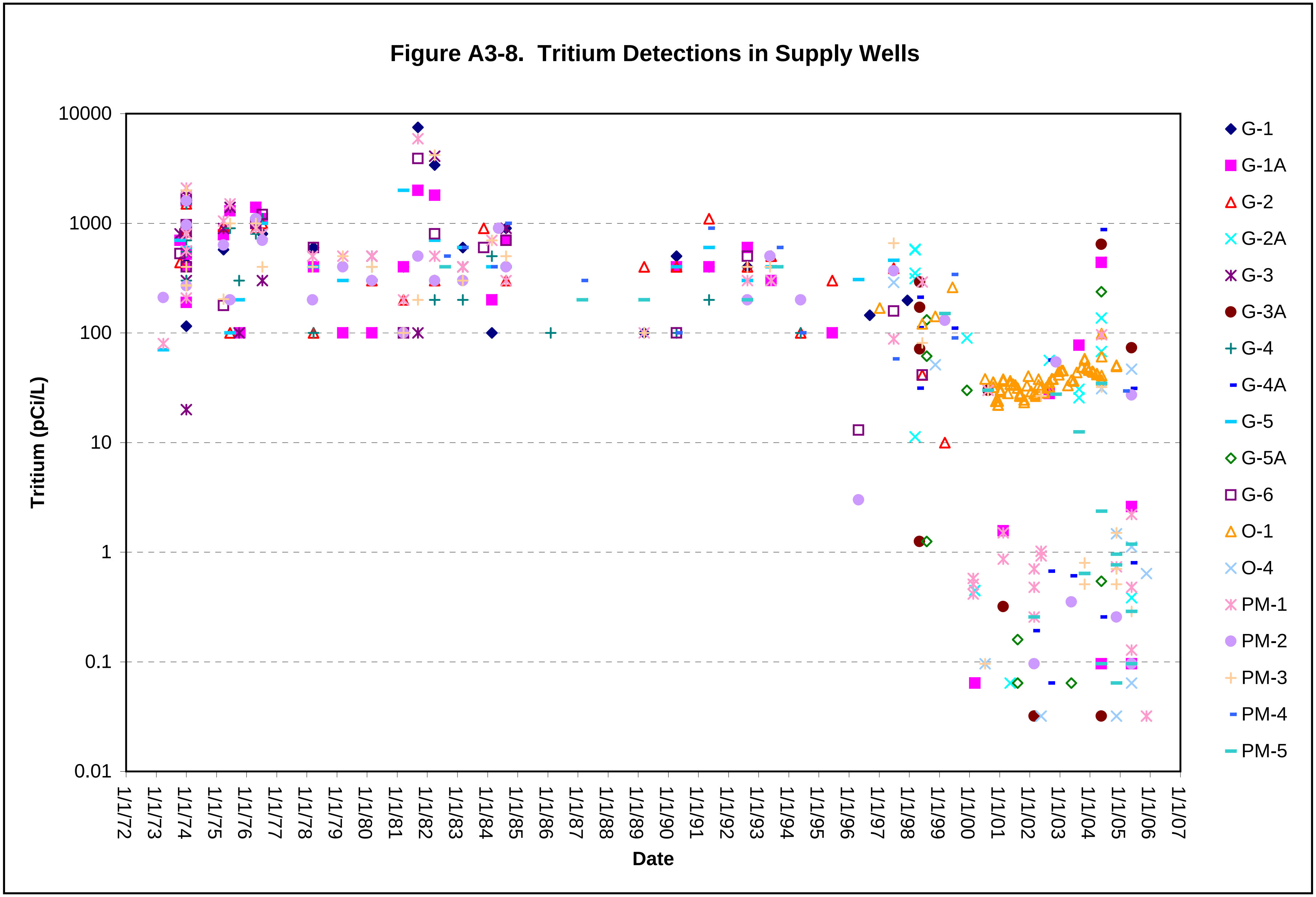


Figure A3-8. Tritium Detections in Supply Wells
Tritium (pCi/L)
10000
1000
100
10
1
0.1
0.01
1/1/72
1/1/73
1/1/74
1/1/75
1/1/76
1/1/77
1/1/78
1/1/79
1/1/80
1/1/81
1/1/82
1/1/83
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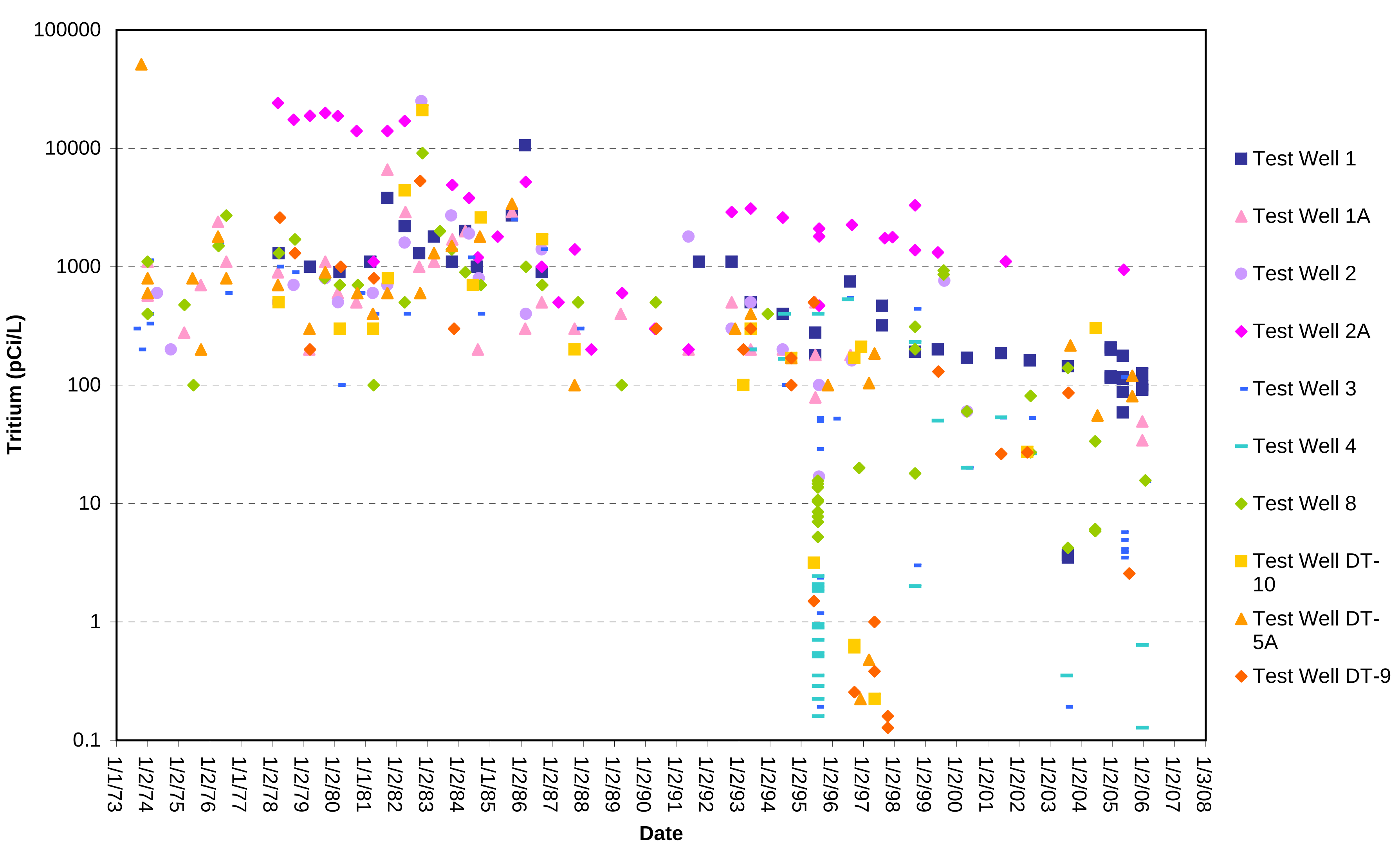
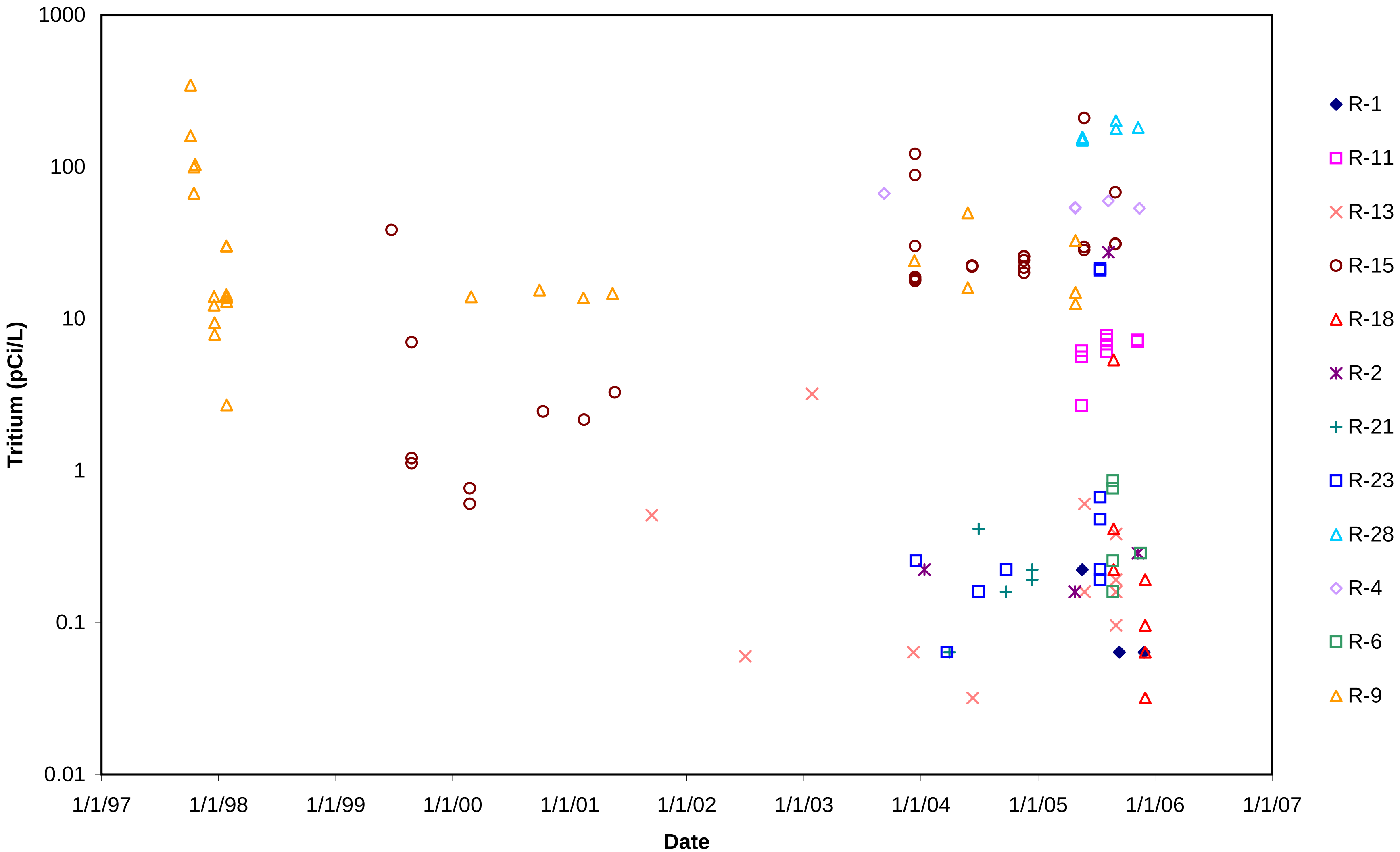
1/1/99
1/1/00
1/1/01
1/1/02
1/1/03
1/1/04
1/1/05
1/1/06
1/1/07
Date
G-1
G-1A
G-2
G-2A
G-3
G-3A
G-4
G-4A
G-5
G-5A
G-6
O-1
O-4
PM-1
PM-2
PM-3
PM-4
PM-5

Figure A3-9. Tritium Detections in the Regional Aquifer - Test Wells

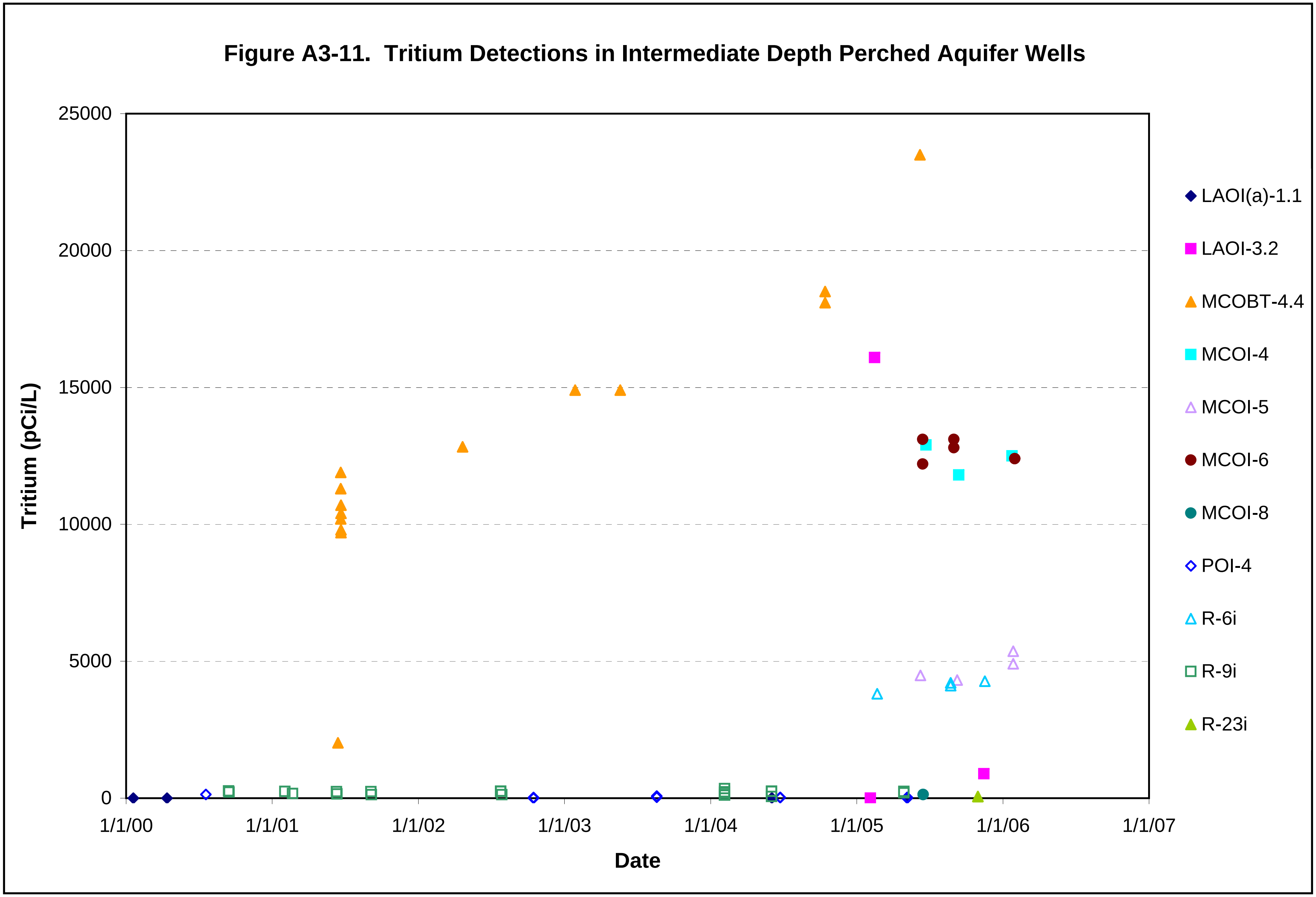


FA3-8_A3-11_H3 charts.xls [Test Wells Chart - Fig 3.29]

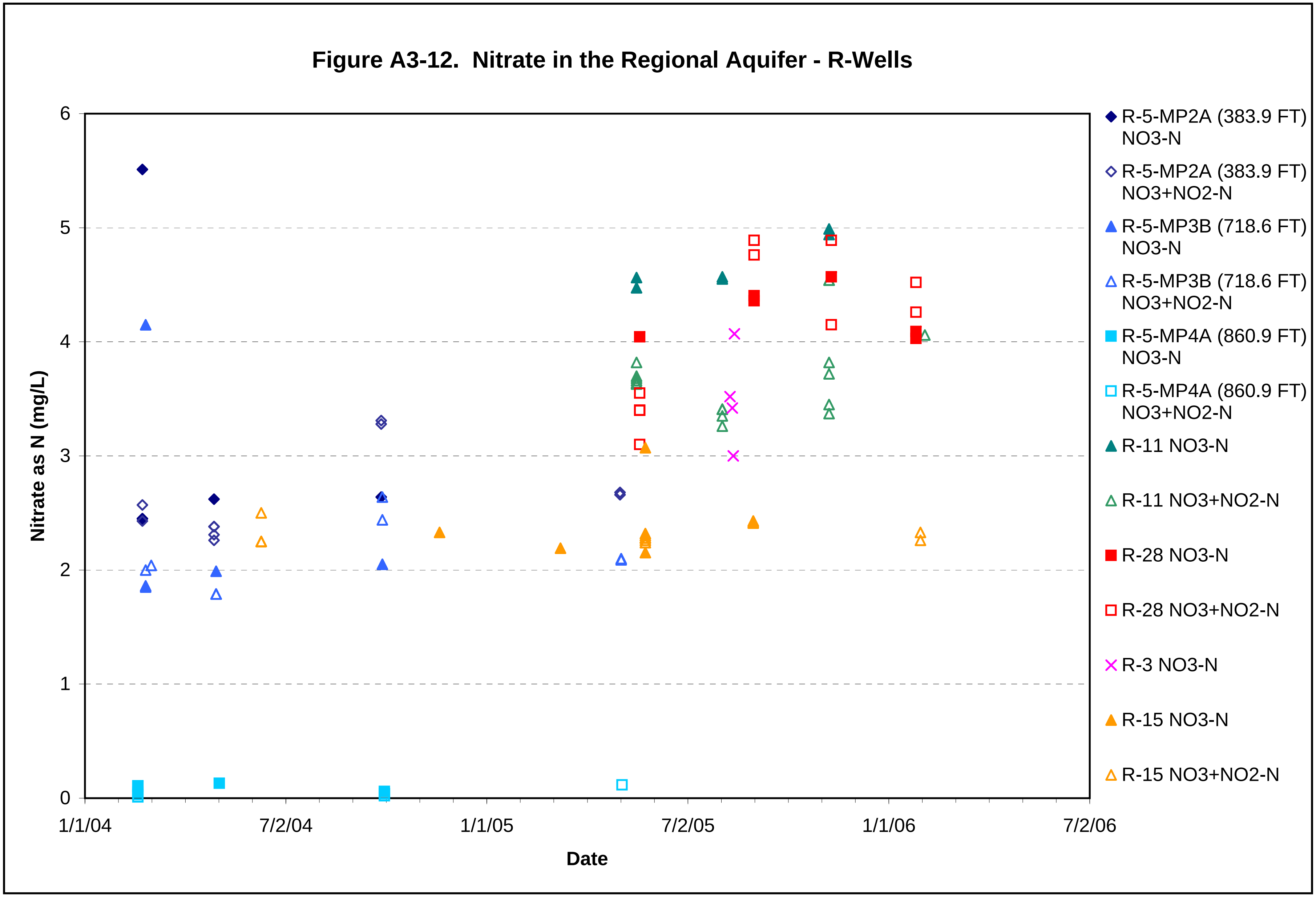
Figure A3-10. Tritium Detections in the Regional Aquifer - Single Screen R-Wells



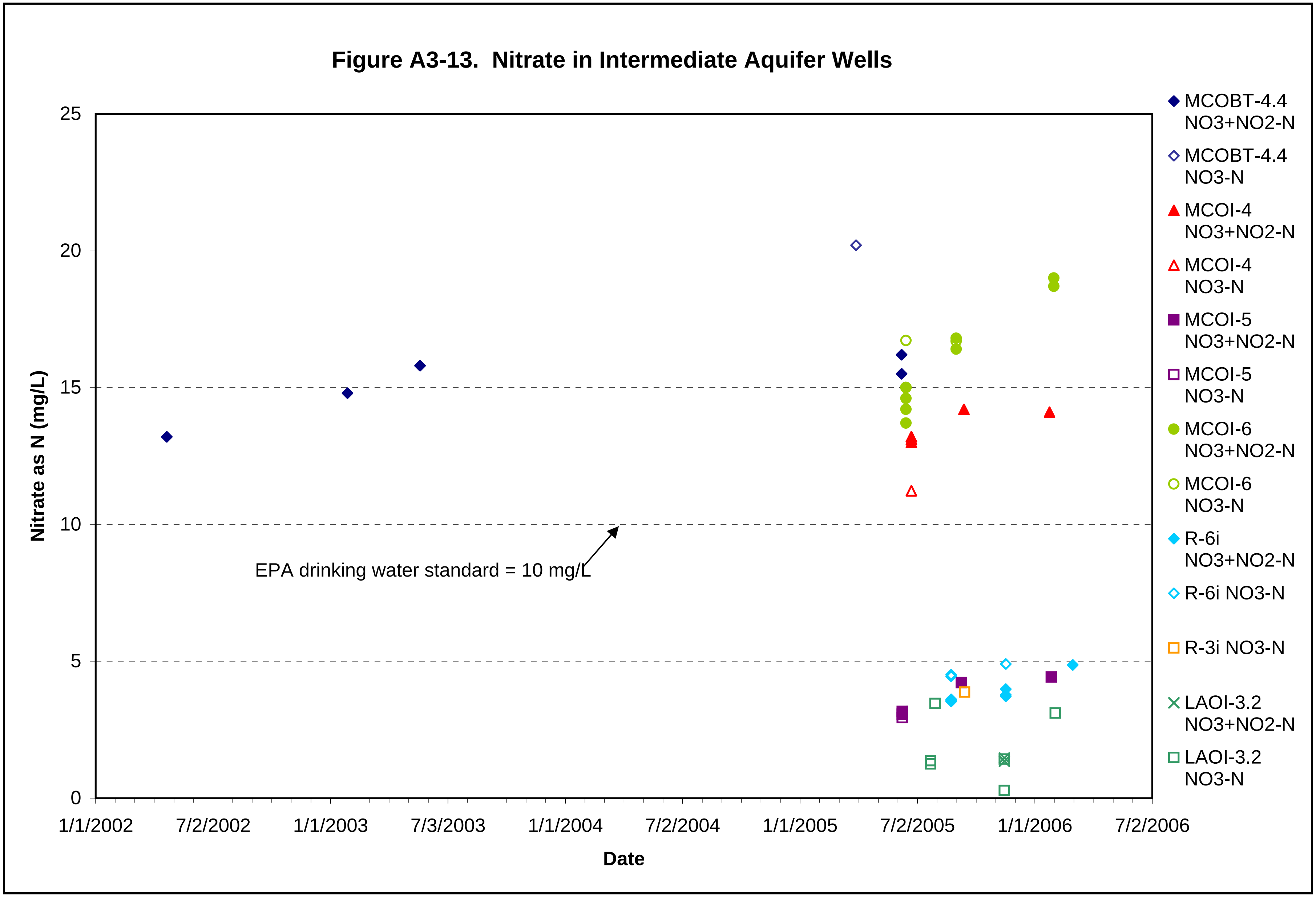
FA3-8_A3-11_H3 charts.xls [SingScrR-wells Chart - Fig 3.30]



FA3-8_A3-11_H3 charts.xls [I-Wells Chart - Fig 3.31]



FA3-12_NO3asN_R-wells charts.xls [R-well N Chart - Fig 3.32]



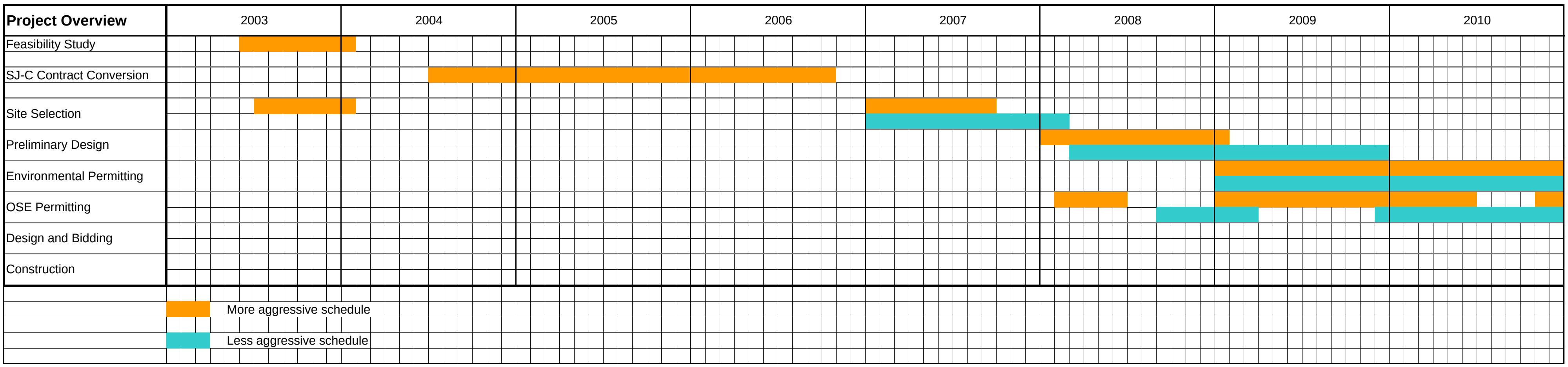
FA3-13_Copy of NO3asN_I-wells charts.xls [I-well N Chart - Fig 3.33]

Appendix B

San Juan-Chama Timeline

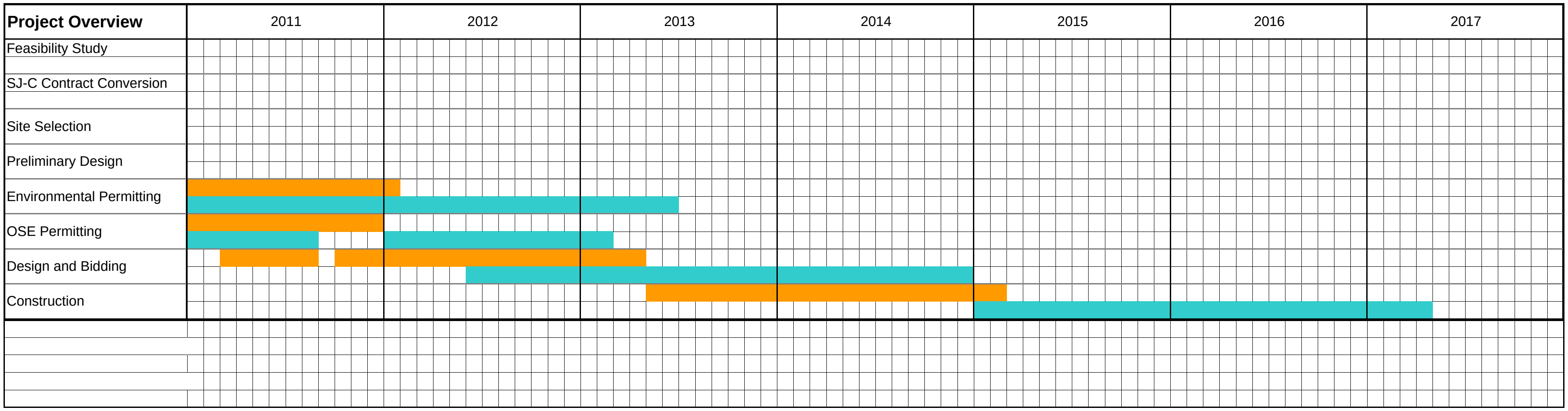
Los Alamos County

SJ-C Drinking Water Project Timeline



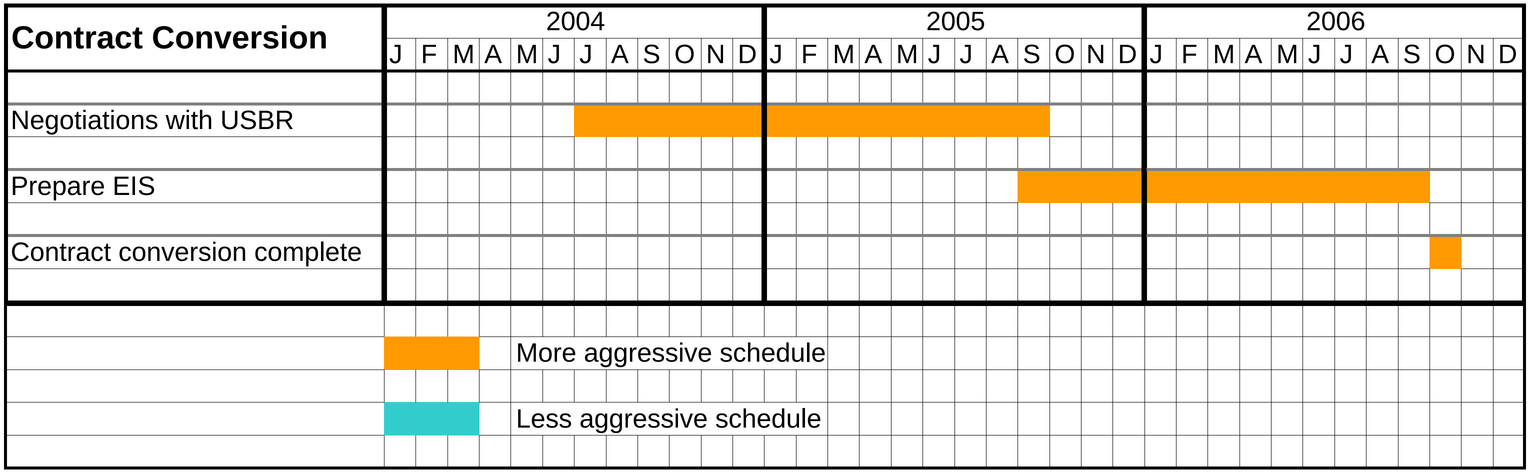
Los Alamos County

SJ-C Drinking Water Project Timeline



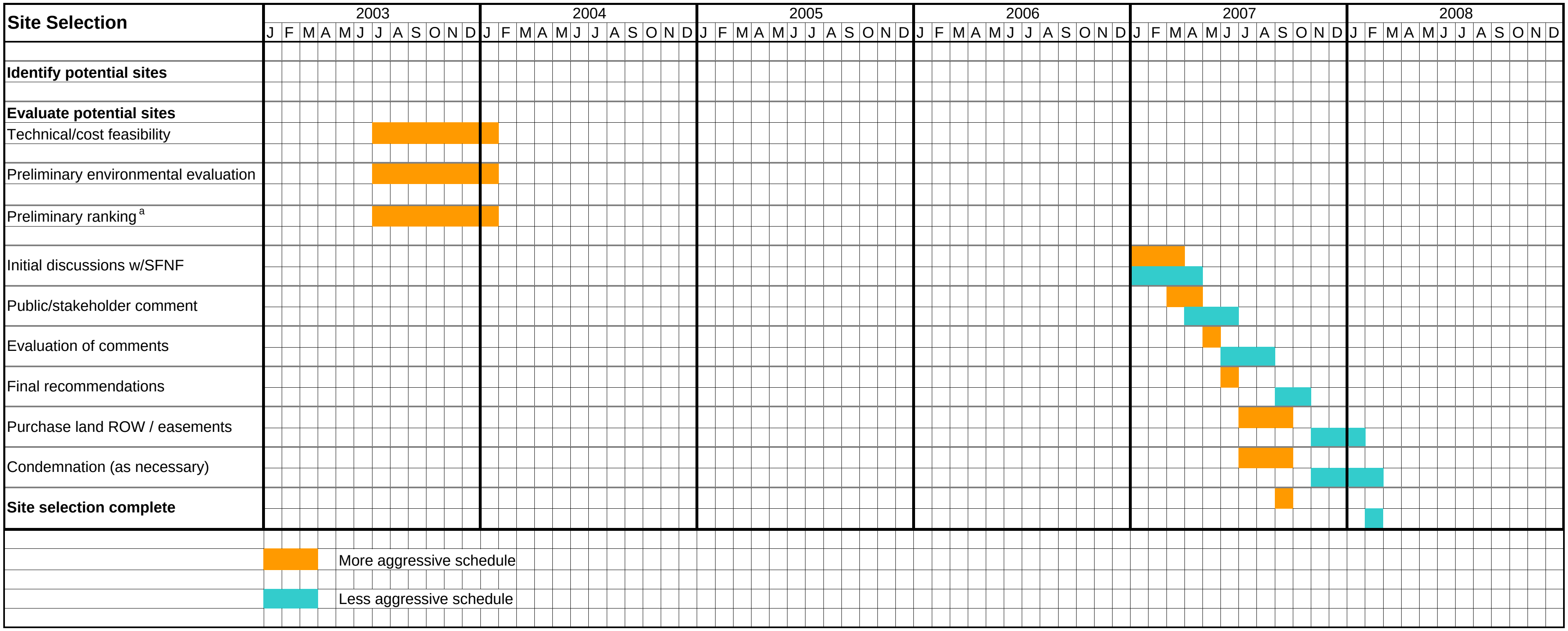
Los Alamos County

SJ-C Drinking Water Project Timeline



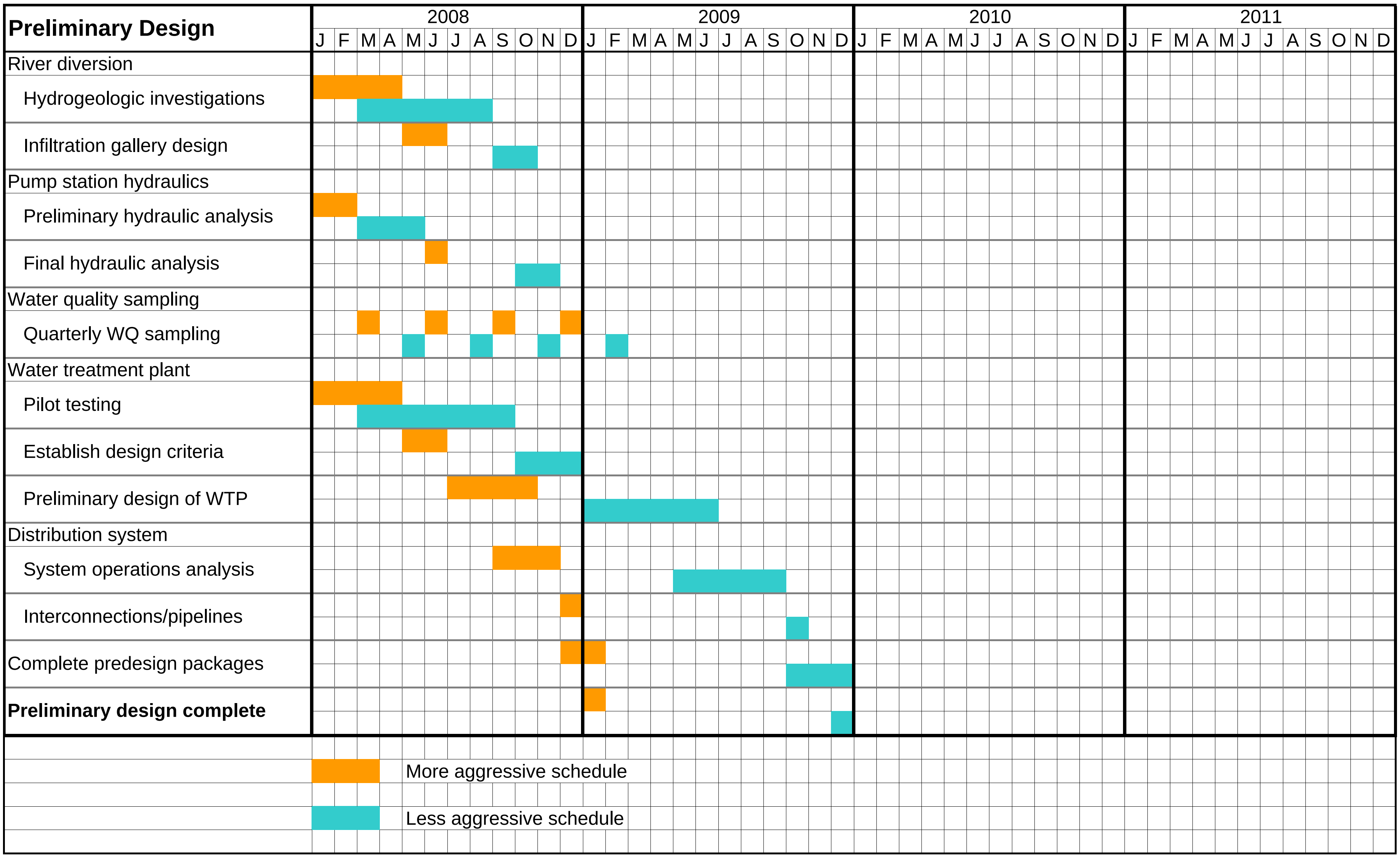
Los Alamos County

SJ-C Drinking Water Project Timeline



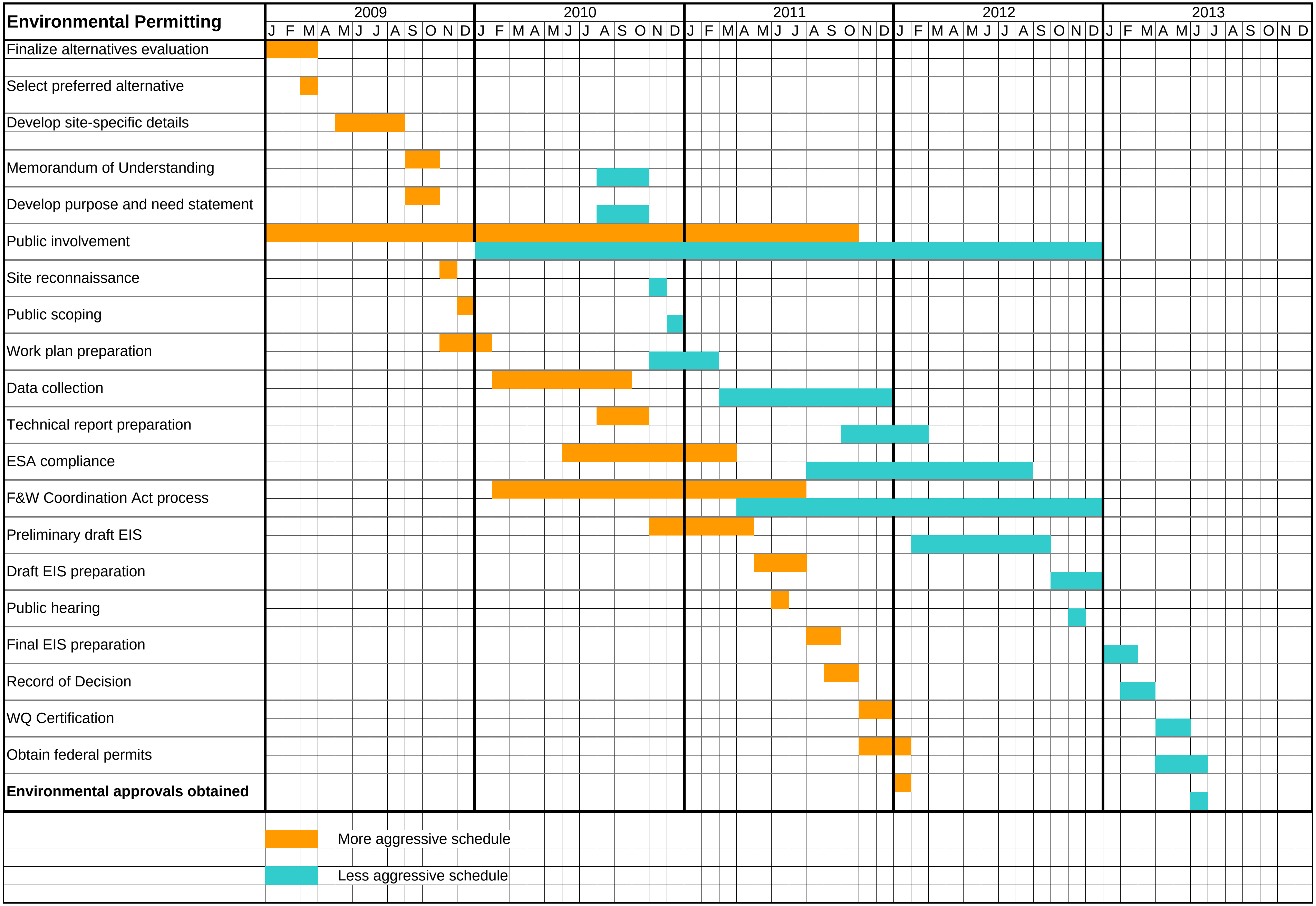
Los Alamos County

SJ-C Drinking Water Project Timeline



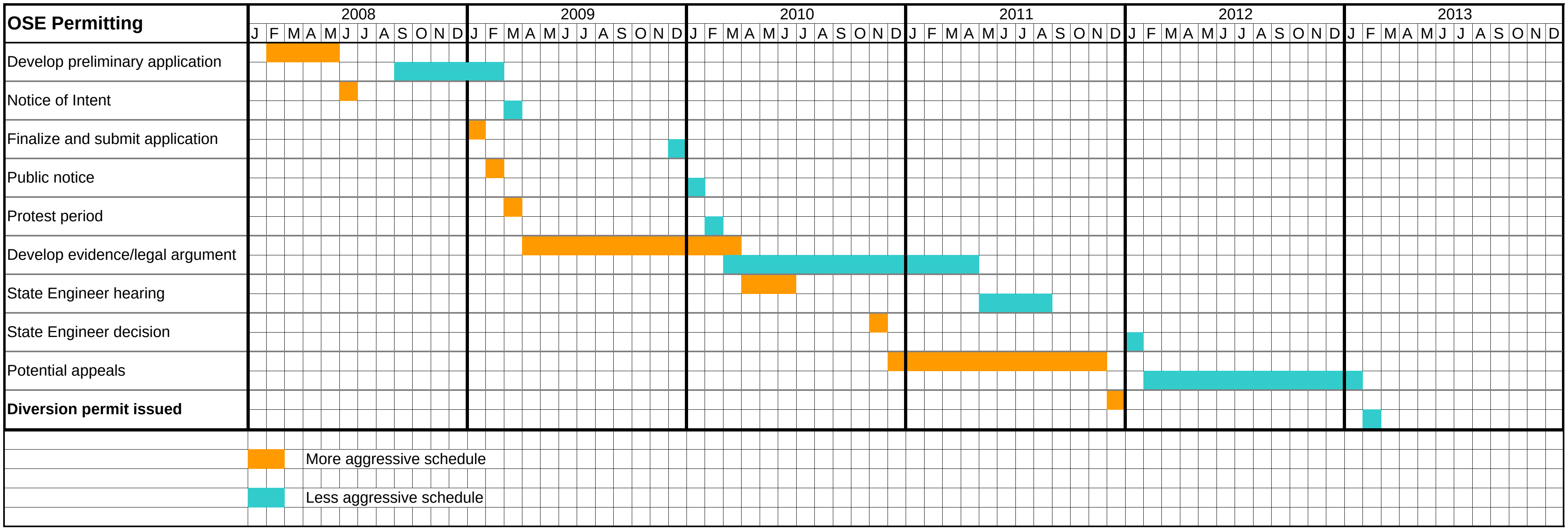
Los Alamos County

SJ-C Drinking Water Project Timeline



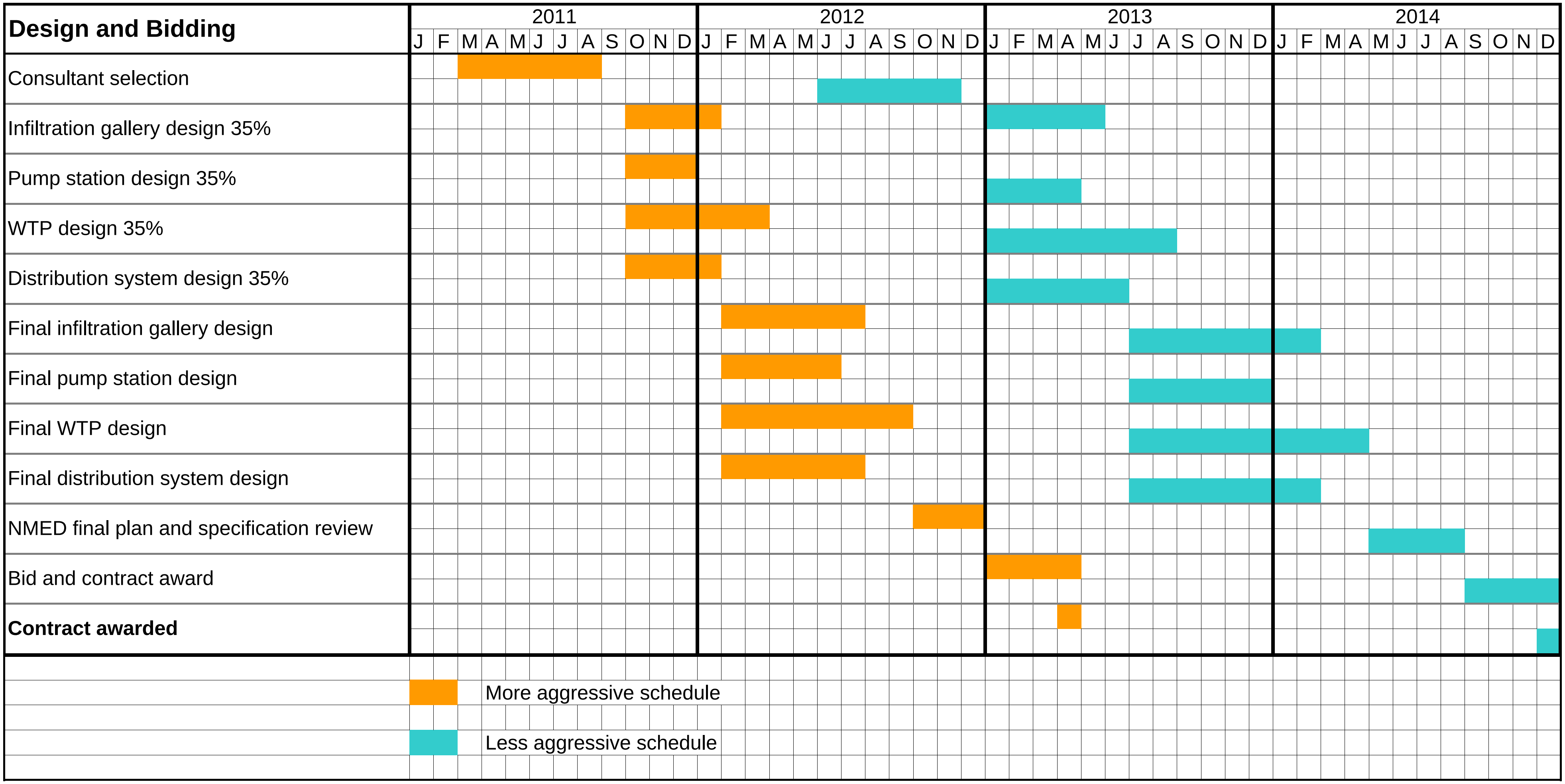
Los Alamos County

SJ-C Drinking Water Project Timeline



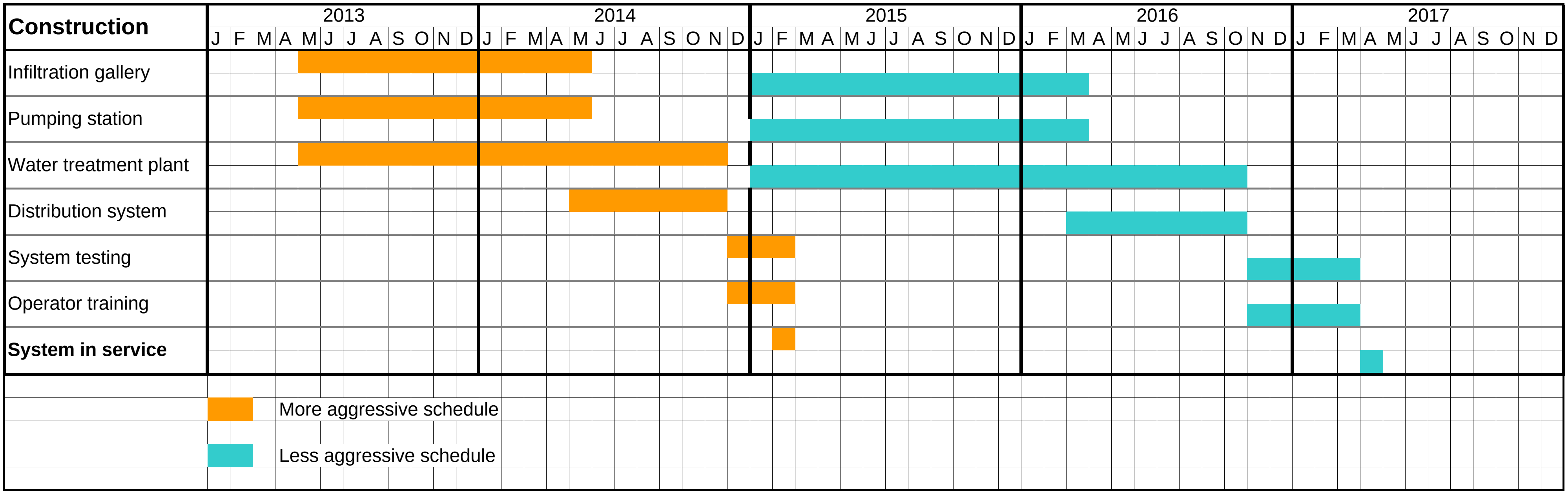
Los Alamos County

SJ-C Drinking Water Project Timeline



Los Alamos County

SJ-C Drinking Water Project Timeline



Appendix C

Facilities Assessment

Appendix C is not available.

Please contact Los Alamos County Utilities Department for further information.