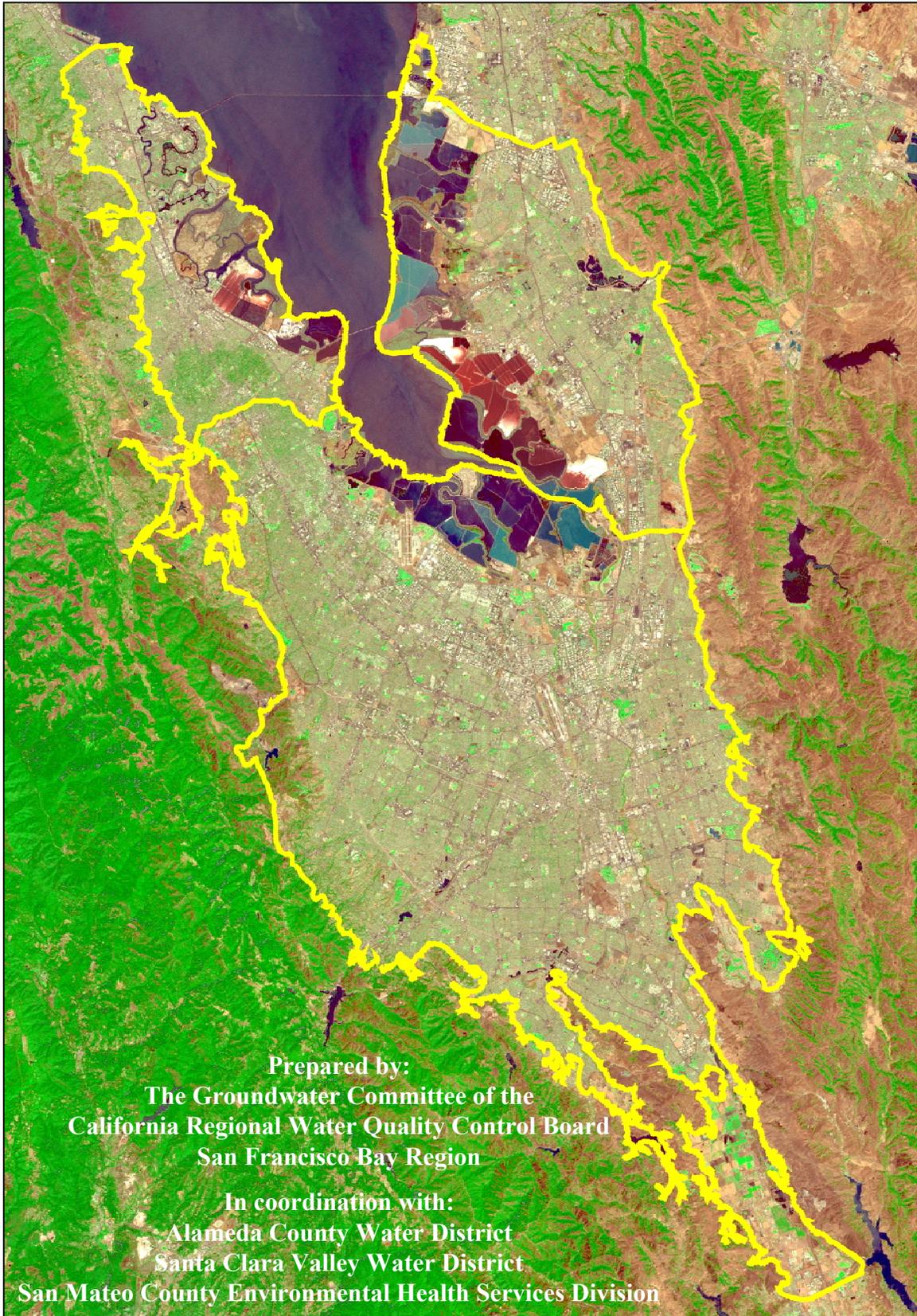


A Comprehensive Groundwater Protection Evaluation for the South San Francisco Bay Basins



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Report Availability

This report, including Figures, Tables, Plates, and Appendices, is available online at the S.F. Regional Board's website: <http://www.swrcb.ca.gov/rwqcb2/>. Look under "Available Documents". The report is available in MS Word and PDF formats, with and without the figures to facilitate downloading. The complete document is also available on CD from the S.F. Regional Board. Please contact the S.F. Regional Board at (510) 622-2300. Limited hard copies are available for purchase.

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EXECUTIVE SUMMARY

E.1 Purpose

Numerous local, state, and federal programs address groundwater protection to varying degrees in the San Francisco Bay region. Perhaps nowhere in this area are these programs as important as in the South San Francisco Bay area (South Bay), where 351 public water supply wells serve a population of 1.75 million people and provide up to half of the drinking water supply.

This report presents the results of a two-year, comprehensive effort by the Groundwater Committee of the San Francisco Bay Regional Water Quality Control Board (S.F. Regional Board), in conjunction with the Santa Clara Valley Water District (SCVWD), the Alameda County Water District (ACWD), and the San Mateo County Environmental Health Service Division (SMCEHSD). The purpose of this effort was to:

1. Document existing groundwater beneficial uses, ambient groundwater quality, and groundwater protection programs (i.e., prevention and cleanup) in three South Bay groundwater basins
2. Identify gaps and areas of overlap among groundwater protection programs and evaluate their effectiveness
3. Make recommendations for improvement

The three groundwater basins evaluated in this project include the Niles Cone, Santa Clara Valley, and San Mateo Plain, which include 27 cities and occupy large portions of Alameda, Santa Clara, and San Mateo Counties, respectively, (Figure 1).

Until this study began, no comprehensive overview of existing groundwater protection programs had been performed in the South Bay. Therefore, it has been difficult to identify areas where gaps in protection programs may exist, and ultimately where special attention and resources should be focused to optimize protection efforts. In light of these difficulties, and the high degree of reliance on groundwater in the South Bay, this project has focused on 1) evaluation of major threats to groundwater quality, 2) evaluation of existing groundwater protection programs in response to those threats, 3) review of new statewide initiatives for protection and data sharing, and 4) evaluation of special problem areas that are typically not addressed by groundwater protection programs. Several key findings and recommendations have been developed to identify regulatory gaps and help prioritize future protection efforts.

E.2 Groundwater Threats, Protection Programs, and Special Focus Areas

This report presents information in three areas beyond the traditional review of basin hydrogeology, groundwater beneficial uses, and ambient water quality. These areas include review and evaluation of 1) major threats to groundwater quality, 2) existing groundwater protection programs, and 3) special focus areas based on concerns of the Groundwater Committee and stakeholders. The following topics under each category are addressed in this report.

Major Threats to Groundwater Quality. Major groundwater quality threats addressed in this project are described in detail in Section 5 and include the following:

1. Fuel Leaks and methyl-tert-butyl ether (MTBE), including: leaking underground storage tanks (LUSTs) and petroleum aboveground tanks (AGTs)
2. Solvent Plumes including Solvent Stabilizers such as 1,4-Dioxane
3. Leaking Sewer Lines
4. Nitrates
5. Emerging Contaminants
6. Other Pollutants of Concern such as Perchlorate, Arsenic, and Hexavalent Chromium)
7. Salt-Water Intrusion

8. Municipal Landfills

Existing Groundwater Protection Programs. Existing local, state, and federal groundwater pollution prevention and cleanup programs were reviewed and summarized so that gaps and areas of overlap among programs could be identified. Groundwater protection programs addressed in this report are described in detail in Section 6 and include the following:

1. Fuel Leaks and methyl-tert-butyl ether (MTBE)
 - Leaking Underground Storage Tanks (SWRCB/Local)
 - Petroleum Aboveground Tanks (SWRCB/Local)
2. Solvent Plumes
 - Spills, Leaks, Investigations, and Cleanup (SLIC) (SWRCB/Local)
 - Multi-Site Cooperative Agreement (MSCA) (SWRCB)
 - State oversight/superfund (DTSC)
 - Federal oversight/superfund (EPA)
3. Leaking Sewer Lines
4. Nitrates
5. Emerging Contaminants
6. Other Pollutants of Concern
7. Saltwater Intrusion
8. Municipal Landfills
9. Statewide Groundwater Protection Initiatives

Special Groundwater Protection Focus Areas. Eight groundwater protection “focus areas” were identified for special attention based on the experience of Groundwater Committee members and concerns expressed at stakeholder meetings. Focus areas were selected because they represent common problems that are typically not addressed by protection programs, or because they represent recent efforts with the potential to enhance existing programs. These focus areas, which are described in detail in Section 7, include the following:

1. Identification and Sealing of Vertical Conduits
2. Leaking Sewer Lines
3. Drycleaner Cleanups
4. Electronic Reporting Program for Chlorinated Volatile Organic Compound (CVOC) Plumes
5. Coordination with the Department of Health Services’ Drinking Water Source Assessment and Protection (DWSAP) Program
6. Surface Water and Groundwater Interaction
7. Emphasis on Groundwater Protection in City and County General Plans
8. Regulatory Structure and Information Management

E.3 Key Findings and Recommendations

Overall Groundwater Quality. Groundwater quality varies throughout the South Bay Basins, but is generally of very high quality, particularly in deeper aquifer systems. In contrast, there is significant and widespread pollution of the shallow aquifers from a variety of sources, including leaking fuel and solvent tanks (underground and aboveground), historic drycleaner facilities, leaking sewer lines, agricultural fertilizers, and leaking landfills. Cleanups at these sites are regulated by six different agencies. Investigations are complete, and cleanup is underway at the majority of regulated sites. A wide range of pollutants and /or polluting activities has the potential to degrade water quality in the South Bay Basins, with the major chemical threats being MTBE, solvents, nitrates and salinity (via saltwater intrusion).

Fuel Leaks and MTBE. Leaking underground storage tanks (LUSTs) and the associated release of MTBE account for the largest number of groundwater pollution sites in the South Bay. As of September

2001, there were 947 open LUST sites and 2,109 closed LUST sites in the South Bay Basins (Figure 21 and Table 6). MTBE is scheduled to be banned as a fuel additive in California after December 31, 2003. Thus, while new releases continue to be regularly reported, future releases should become rare after the ban has been fully implemented. Largely due to vigorous oversight efforts by the responsible agencies, groundwater contaminants from these leaking fuel USTs have had minimal effects on municipal and domestic wells in the South Bay Basins. To date, only one well has been impacted by MTBE.

Using the State Water Resources Control Board's (SWRCB's) MTBE Prioritization Guidelines, there are 98 high priority (Class A) and 280 medium priority (Class B) sites in the South Bay Basins. All Class A and Class B priority sites have completed an investigation. Further, all Class A and approximately 50 percent of Class B sites have implemented corrective actions. None of the groundwater protection programs, other than LUST, contain prioritization and ranking strategies. Groundwater extraction is a typical remedy for all Class A plumes, or where the plume is migrating. A total of 209 South Bay LUST sites have implemented groundwater extraction, consisting of 52 in Niles Cone, 101 in Santa Clara Valley, and 56 in the San Mateo Plain.

Operating Gasoline Stations. As part of a Pilot Program by the SF Regional Board and SCVWD, monitoring of active service stations was conducted. Preliminary results indicate that MTBE and other gasoline constituents are detected at up to 60 percent of facilities. Furthermore, at more than 40 percent of the facilities MTBE is present at concentrations significant enough to threaten groundwater. All active service stations should be required to perform environmental monitoring program.

Solvent Plumes. The investigation and cleanup of chlorinated solvents is a significant issue in the South Bay Basins. The Groundwater Committee spent considerable effort in evaluating the status of such cleanups. Nearly 200 groundwater solvent plumes exist in the South Bay. Santa Clara County alone has more than 100 solvent plumes and the largest number of federal Superfund sites of any county in the United States. Intermittent trace levels of volatile organic compounds have been detected in public water supply wells at trace concentrations. However, only four wells have had consistent detections above drinking-water standards, and those wells have been destroyed.

Regulatory lead for South Bay solvent sites is shared. The S.F. Regional Board has the bulk of the sites, while ACWD, SMCEHSD, the Department of Toxic Substances Control (DTSC), and U.S. EPA (EPA) share the lead for the remaining sites. The SCVWD does not presently assume lead responsibility for any non-fuel sites.

In the South Bay, solvent plumes can be grouped into two main categories. First, there are large sources, which are generally related to underground solvent storage tank leaks from semiconductor manufacturing and chemical processing sites. These sites have resulted in moderate to large plumes averaging about 1,500 feet long, with five plumes approaching or exceeding one mile in length. Most regulatory efforts are focused on these sites. Many of these sites have commingled plumes, which complicate investigation and cleanup due to concerns about allocation of responsibility. Second, there are small to moderate sources, which are primarily associated with drycleaners, leaking sewer lines, or surface spills. None of the groundwater protection programs have focused specifically on historical solvent leaks from drycleaning facilities.

Electronic Reporting Project for Solvent Plumes. A total of 74 sites submitted electronic summary data describing the size and magnitude of solvent plumes and the progress of cleanup attempts. The sites include most of the major South Bay plumes and provide a snapshot of cleanup progress. The median plume length is 1,360 feet (range 110 to 14,623 feet), and the median depth of the pollution extends 50 feet below the ground surface (range 9 to 364 feet).

Cleanup data show impressive progress. A total of 382,000 pounds of solvents has been removed from the groundwater at these South Bay sites, and maximum concentrations have dropped by 93 percent over

an average 12-year cleanup period. Cleanup to low part-per-billion drinking water standards is still rare, and most sites are expected to take several more decades to reach these low levels. After more than a decade of active cleanup, several sites are reaching a point where groundwater extraction no longer removes significant mass. Accordingly, dischargers are proposing more passive cleanup methods and long-term monitoring. Ultimately, electronic reporting could allow for better long-term management and tracking of these sites.

In addition to statistical information, the Groundwater Committee also requested submittal of electronic maps of plume outlines. This is the first attempt in Northern California to compile a regional plume map using electronic data. The maps will allow the S.F. Regional Board to better coordinate and prioritize regulatory oversight (Figures 22 and 23). In addition, the maps will allow local well-permitting agencies and water suppliers to better understand the locations of these long-term pollution problems.

Solvent Stabilizers. An emerging issue at solvent cleanup sites is the presence of solvent stabilizers, such as 1,4-dioxane. Solvent stabilizers have thus far received little attention from a regulatory perspective. However, the recent detection of 1,4-dioxane at several South Bay sites that were previously believed to be fully characterized indicates that monitoring solvent stabilizers in groundwater and in discharges of treated extracted groundwater should become a standard requirement at solvent cleanup sites to determine whether stabilizers are present. For sites where the solvent stabilizer plume is larger than the primary solvent plume, additional cleanup may be required.

Drycleaner Cleanups. Historical solvent leaks from drycleaning facilities pose a significant but relatively unquantified threat to South Bay groundwater quality. In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances resulted in impacts to groundwater. Drycleaners can also cause groundwater contamination as a result of releases from sumps, leaking machines, and dumping. Investigation and cleanup of drycleaner sites has not been a major focus of any groundwater protection program, yet they are often located proximate to recharge areas or drinking water supply wells. As of 1998, there were about 350 drycleaners in the South Bay, while only 42 have been investigated, primarily as a result of impending property transactions.

As an outgrowth of this project, and in recognition of the need to better understand threats from drycleaners, the S.F. Regional Board recommended that the SCVWD receive a \$70,000 grant from the State Water Pollution Cleanup and Abatement Account. The grant would be used to conduct a detailed study of past and current drycleaner operations in northern Santa Clara County.

Leaking Sewer Lines. Using the city of Sunnyvale as an example, the Groundwater Committee conducted a qualitative evaluation of the potential for exfiltration from South Bay sewer lines to affect groundwater quality. We believe the primary potential for degradation of groundwater quality is from historic disposal of solvents, such as at drycleaners and electronics manufacturing facilities (wafer fabricators, plating shops, and printed circuit board shops). In the context of sewer lines affecting water quality, exfiltration (leakage from sewer lines to groundwater) is a major factor.

Solvents are detected at measurable levels in wastewater at publicly owned treatment works (POTWs). These levels correspond to several thousand pounds per year of solvents. Assuming that dense solvents leak out of sewer lines prior to wastewater arriving at the POTW, the solvent mass that actually ends up at the POTW may represent only a fraction of the original discharge.

Nitrates. A relatively small number (18 of 242, or 7 percent) of public water-supply wells in the Santa Clara Valley were reported to have nitrate concentrations greater than the maximum contaminant level (MCL) of 45 mg/l during the period from 1980 to 2000. Since 1996, nitrate in excess of the drinking water standard has only been detected in one well.

Emerging Contaminants. Emerging contaminants, including N-nitrosodimethylamine (NDMA), endocrine disruptors, and pharmaceutically active compounds, may be present in sanitary wastewater, recycled water, imported water, and any other water source that receives sanitary wastewater. Emerging contaminants may pose a threat to groundwater quality when such waters are used for artificial recharge or otherwise intentionally infiltrated. The SCVWD is developing a water quality standard for intentional infiltration with recycled water, imported water, local surface water, and storm water runoff. The SCVWD is also evaluating if and to what extent recycled water needs to be treated to meet groundwater protection concerns and users needs.

Other Pollutants of Concern. Beyond the major chemical threats discussed above, several other pollutants have been released from a small number of toxic sites. These pollutants include arsenic, hexavalent chromium, and perchlorate. None of these compounds has been detected in public drinking water wells above drinking water standards.

Saltwater Intrusion. Saltwater from San Francisco Bay and adjacent salt ponds has intruded freshwater-bearing aquifers in all three South Bay Basins. In both the Niles Cone and Santa Clara Valley basins, local agencies have implemented measures to prevent saltwater intrusion. The threat of saltwater intrusion in the Niles Cone is primarily due to the basin's proximity to San Francisco Bay and the large system of salt ponds that operates along the bay's margin. In Santa Clara County, land subsidence has caused the lower reaches of streams and rivers to be invaded by saline tidal waters, increasing salinity in shallow groundwater. Saline water has been introduced to isolated portions of deeper aquifers by abandoned wells adjacent to the tidal reaches of the Guadalupe River

Vertical Conduits. Vertical conduits can provide pathways for the migration of surface pollution or shallow groundwater pollution into deeper aquifers. Pollutants that enter groundwater through vertical conduits circumvent the natural percolation process, which protects groundwater by filtering and absorbing pollutants. Examples of problem pollutants include human or animal wastes, petroleum products, fertilizers, pesticides, and solvents. Once an aquifer has become contaminated, it can be very expensive and difficult to correct the damage, thus prevention is the key.

Rapid urban expansion has taken place in the South Bay study area. Unfortunately, many agricultural and domestic wells up to 100 years old have been built over with no record of proper destruction. These lost wells are likely to be screened across several water-bearing zones and to have rusted or otherwise-damaged steel casings.

The ACWD has developed a comprehensive well search program that could serve as a model to other local agencies. This program was developed in cooperation with the cities of Fremont, Newark, and Union City. When land-use changes are proposed for properties, the cities require the property owners or developers to obtain a letter from the ACWD indicating whether wells are located within the boundaries of the development. This requirement gives the ACWD the opportunity to conduct a search for wells before development takes place (Appendix E).

Although there is no standard requirement for S.F. Regional Board sites to conduct a vertical conduit study, these studies are required on a case-by-case basis. All Superfund sites in the region have been required to perform well searches.

Surface Water and Groundwater Interaction. Nearly all surface water features (streams, lakes, reservoirs, wetlands, and estuaries) interact with groundwater. Several issues have been identified, which simultaneously affect the quality and quantity of surface water and groundwater due to the dynamic relationship between the two. The affects of these issues on water quality and quantity must be understood in order to develop effective water resource management strategies. These issues include the effect of surface water diversion and groundwater withdrawal on creek and riparian habitat, water quality, surface water infiltration to groundwater (e.g., recharge and stormwater infiltration) groundwater

discharge to surface water (e.g., plume discharges), and changing land use (as it affects runoff and recharge).

Regulatory Structure and Information Management. The regulatory structure for groundwater protection is fairly complicated and has been characterized by overlapping authority, limited budgets, and differing priorities. Historically, there has been very little data sharing among the various state and local groundwater protection agencies mostly because they do not have good information sharing mechanisms. Notable exceptions include local agencies supplying well-permitting data to the Department of Water Resources (DWR) and LUST cleanup data to the Regional and State Boards. Likewise, the various state groundwater protection agencies do not have good mechanisms for making information accessible to the public.

The evaluation of local groundwater protection must be considered in light of the state’s own diversified and decentralized management of groundwater resources. California is unique in the nation in its multi-agency approach to groundwater protection. Responsibility for groundwater protection is shared among local agencies, the California State and Regional Water Boards, DWR, and DHS. Information sharing is hindered because each agency has historically used a unique database. Furthermore, groundwater protection, from a pollution prevention standpoint, has been a low priority. High-priority groundwater protection programs have generally focused on addressing problems that have already occurred (e.g., state Superfund Program, Leaking Underground Fuel Tank Program, Solid Waste Assessment Test, MTBE Program). A comparison of groundwater protection measures for various state and federal programs is shown in Table ES-1.

Table ES-1. Comparison of Groundwater Protection Measures for Various State and Federal Programs

Protection Measure	Fuel Leaks/MTBE	Non-Fuel Leak Groundwater Pollution (Typically solvent plumes)				Landfills	Above-ground Tanks	Dry Cleaners
	LUST	RWQCB SLIC	RWQCB Superfund	DTSC Site Mitigation	EPA Superfund			
Comprehensive list of regulated sites	Y	Y	Y	Y	Y	Y	N/A	N
Tracking system for site status	Y	N/A	N/A	N/A	N/A	N	N	N
Individual cleanup orders issued	N	Y	Y	Y	Y	Y	N	N
Prioritization system established	Y	N	N	N	Y	N	N/A	N
Site information available online	Y	N/A	N/A	N	N	N	N/A	N
Location information available online	Y	N	N	N	N	N	N/A	N

Y = Yes, protection measures implemented

N/A = Either not publicly available, available but not up to date, or under development

N = No, protection measures not implemented

The South Bay Groundwater Protection Evaluation has provided a unique opportunity to compare local approaches and see how state and federal programs are implemented in three basins. Local approaches range from the tightly managed Niles Cone Basin to the moderately managed Santa Clara Valley and the

unmanaged San Mateo Plain. The varying approaches reflect the authority of the local agency, the importance of groundwater as a local water supply, and the basin's sensitivity to pollution. Some programs are working exceptionally well and could serve as models to other agencies both within and outside the study area (Table ES-2). For example, the SCVWD's GIS Program and ACWD's Well Abandonment Program are both highly effective.

Table ES-2. Comparison of Local Agencies' Groundwater Management Programs

Program	Niles Cone	Santa Clara Valley	San Mateo Plain
Local Agency	ACWD	SCVWD	SMCEHSD
Ambient Water Quality Monitoring Wells	Yes	Yes	No
Annual Monitoring Reports	Yes	Yes	No
GIS Status	Initial development	Moderately developed	Initial development
Leaking Underground Storage Tank Oversight	Non-LOP ¹ Program	LOP ¹	LOP ¹
Control of Retail Pumping	Yes	Yes	No
Link Redevelopment Permits to Locating and Sealing Vertical Conduits	Yes	No	No

¹Local Oversight Program

Statewide Initiatives. Several new statewide groundwater protection programs are being developed that will address many of the data shortcomings discussed above. These programs are described in detail in Section 6 and include the following:

- SWRCB's System for Water Information Management (SWIM) and Water Information Network (WIN)
- SWRCB's GeoTracker project
- SWRCB's Comprehensive Groundwater Quality Monitoring Program
- SWRCB's Groundwater Ambient Monitoring and Assessment (GAMA) Program
- DHS' Drinking Water Source Assessment Protection (DWSAP) Program
- DWR's Bulletin 118 Update on Groundwater Basins of California

E.4 Recommendations

Based on the results of this project, the Groundwater Committee developed a set of recommendations to improve groundwater protection in the South Bay. The recommendations are grouped into those that require: 1) coordination among two or more agencies (Table ES-3), 2) action by a single agency (Table ES-4), and 3) legislative action (Table ES-5).

Table ES-3. Recommendations Requiring Coordination Among Agencies

Topic	Finding	Recommendation	Implementation
VOC Plumes	It is very difficult for local well permitting agencies to determine whether a proposed well or dewatering operation is located within or near a VOC plume.	The location of VOC plumes regulated by the EPA, S.F. Regional Board, DTSC, and local agencies should be accessible to local well permitting agencies.	On a biennial basis, the S.F. Regional Board, in coordination with local agencies, DTSC, and EPA, should produce a plume map for the South Bay Basins that is accessible online in both PDF and Arc/Info formats.
Vertical Conduits and Redevelopment Permits	An effective method for addressing abandoned wells is for the permitting city or county to require investigation and well sealing as a condition of any site redevelopment.	Cities and counties should make investigation and well sealing a condition of any development or redevelopment permit. Funding should be included in the redevelopment permit fee.	The success of the ACWD program should be documented and used as an example for other areas of the South Bay. The SCVWD and San Mateo County should initiate this effort locally. This may require legislative efforts.
City General Plans	Cities show a wide range in their efforts focused on groundwater protection. Most efforts are minimal.	Cities should put more emphasis on groundwater protection when updating their general plans (e.g., well-head protection, integration with DWSAP).	List the priority groundwater protection elements that a general plan should include. Encourage cities to include these elements when updating their general plans and work with local agencies.
Drycleaner Cleanups	As of 1998, there were about 350 drycleaners in the South Bay, while only 42 have been investigated, primarily as a result of impending property transactions. None of the existing groundwater protection programs focuses on drycleaners.	Inventory and rank current and historical drycleaners for water quality assessments based on potential threat.	Convene a multi-agency task force that includes representatives from the S.F. Regional Board, local agencies, CUPAs, BAAQMD, and city staff to develop and implement a pilot project in a selected city to determine the feasibility of inventorying and ranking current and historical drycleaners for water quality assessments based on potential threat.
San Mateo Plain Basin Boundaries	The basin boundary between the San Mateo Plain and Westside Basin should be slightly changed to reflect hydrogeology. In addition, new research shows that the San Mateo Plain can be subdivided into two sub-basins, defined in this report as the South San Mateo Plain Sub-basin and North San Mateo Plain Sub-basin.	The San Mateo Plain Basin boundaries should be adjusted to better reflect hydrogeology as shown in Figure 9.	The S.F. Regional Board, San Mateo County, and the DWR should incorporate the revised nomenclature shown in Figure 9 into their respective planning documents.
Leaking Sewer Lines	VOCs discharged to sewer lines may leak and can significantly impact groundwater.	POTW influent concentrations should be routinely monitored and reviewed and compared with discharge data for CVOCs to evaluate the need for further	The S.F. Regional Board should initiate a pilot study with a select group of POTWs to assess the significance of the problem.

Topic	Finding	Recommendation	Implementation
		investigation. Wastewater treatment plants should review current pretreatment standards for CVOCs to determine the degree of protection offered in light of potential sewer line leaks.	
Regulatory Maze	Eight different agencies regulate groundwater cleanup projects. No comprehensive list of non-fuel cleanups is available.	All groundwater cleanup sites should be listed on a common Web site or set of linked sites. Fuel cases are using Geotracker (formerly GEIMS). No current effort for non-fuel cases exists.	EPA, the DTSC, and the S.F. Regional Board should independently maintain Web sites with summary information about the non-fuel groundwater cleanup sites they regulate. The sites should be cross-referenced (i.e., linked to each of the other agencies).
Site Naming/ Numbering/ Tracking	Sites are often regulated by multiple agencies. Each agency maintains its own files and databases using unique naming protocols. Therefore, locating files for the same site at different agencies can be challenging.	Agencies should agree on consistent site naming/numbering/tracking nomenclature.	Encourage agencies to come to a consensus on naming/numbering/tracking nomenclature.
General Plan Implementation	Most cities do not take an active role in groundwater protection.	Cities should impose permit requirements for groundwater protection on development in sensitive groundwater areas.	The S.F. Regional Board, local groundwater management agencies, and local planners should work together to identify sensitive groundwater areas and appropriate groundwater protection strategies.
Groundwater - Surface Water Interaction	Withdrawal of surface water or groundwater connected to creeks can adversely affect riparian zones. Changes in land use can reduce natural groundwater recharge, which in turn can reduce base flow contributions to creeks and other surface water bodies.	The relationship between creek flows, diversions, and groundwater pumping must be better understood. Vulnerability of creeks and riparian corridors to diversions and groundwater withdrawals should be evaluated.	The S.F. Regional Board, local groundwater management agencies, local planners, and creek and watershed protection groups should work together to quantify creek flows, diversions, and wells that withdraw connected groundwater. Rough water budgets should be worked out to bound surface water and groundwater contributions to better understand creek vulnerability.

Table ES-4. Recommendations Requiring Action by a Single Agency

Topic	Finding	Recommendation	Implementation
Vertical Conduit Searches	Vertical conduits can transport contaminants to deeper aquifers.	Vertical conduit searches should be a standard requirement for all groundwater pollution cases	The S.F. Regional Board, DTSC, EPA, and local agencies should all require conduit searches at the time groundwater impacts are identified.
Institutional Controls	The S.F. Regional Board has approved institutional controls, such as deed restrictions and/or risk management plans, for at least 16 sites in the South Bay.	A comprehensive list of sites with institutional controls should be maintained and made available online.	The S.F. Regional Board should maintain an updated list of cases with institutional controls and make it accessible online.
Annual Groundwater Monitoring Reports	The ACWD and the SCVWD conduct ambient groundwater monitoring and reporting. The SMCEHSD does not conduct ambient groundwater monitoring in the San Mateo Plain due to lack of funding. The ACWD and SCVWD are the only local agencies in the South Bay that compile their ambient groundwater monitoring data into an annual report.	Annual monitoring reports should be prepared so that data and interpretations can be shared with other agencies and the public.	The SMCEHSD should seek funding to develop an ambient groundwater monitoring and reporting program.
San Mateo Plain Groundwater Management Plan	There is no groundwater management plan for the San Mateo Plain.	The SMCEHSD, in coordination with other local stakeholders, should develop a groundwater management plan for the San Mateo Basin.	The SMCEHSD should seek funding to develop a groundwater management plan in coordination with local water suppliers.
Groundwater - Surface Water Interaction	Impacted surface water can cause degradation of groundwater quality via stormwater infiltration.	Stormwater infiltration should be used appropriately with consideration to groundwater impacts.	The S.F. Regional Board should require stormwater permits that acknowledge appropriate use of infiltration treatment and groundwater protection.

Table ES-5. Recommendations Requiring Legislative Action

Topic	Finding	Recommendation	Implementation
Drycleaner Cleanups	There are no formal programs for locating and remediating leaking drycleaner sites.	California should join EPA's State Coalition for Remediation of Drycleaners and develop a statewide drycleaner monitoring and remediation program.	Legislative efforts should be directed at funding California's participation in EPA's State Coalition for Remediation of Drycleaners and eventual development of a statewide drycleaner remediation program.
Threat posed by Operating Gasoline Stations	Studies show that operating gasoline stations with UST's pose a threat to groundwater quality.	Environmental monitoring should be conducted at operating gasoline stations.	The SF Regional Board should begin to require monitoring of operating gasoline stations not currently performing groundwater monitoring. Legislative action is needed to make this a statewide requirement.

1.0 INTRODUCTION

1.1 Groundwater Committee Organization and Background

The S.F. Regional Board's Groundwater Committee recommends policy on groundwater issues, shares new information about groundwater pollution cleanup, and fosters internal consistency for groundwater policy implementation. The Groundwater Committee consists of S.F. Regional Board staff, supervisors, and managers from all five staff divisions. In addition, local groundwater agencies often provide the Groundwater Committee with a broader perspective of information and issues.

From 1995 to 1999, the Groundwater Committee focused on conducting basin-specific beneficial use evaluations in areas that were not used for drinking-water supplies. The results are discussed in two Groundwater Committee-authored reports: "San Francisco and Northern San Mateo County Pilot Beneficial Use Designation Project" (1996) and "The East Bay Plain Groundwater Basin Beneficial Use Evaluation Report" (1999). Both are posted on the S.F. Regional Board Web site at <http://www.swrcb.ca.gov/rwqcb2/>.

With this project, the Groundwater Committee has turned its attention to the Santa Clara Valley, Niles Cone, and San Mateo Plain groundwater basins (Figure 1), where groundwater is a major source of drinking water. This report presents the results of a comprehensive effort to compile groundwater quality and use information, and review existing groundwater protection programs in the South Bay. A major effort was made to compile data in a geographic information system, for better groundwater management decision-making and improved public access.

1.2 Purpose

In the South San Francisco Bay area (South Bay), there are 351 public water supply wells that serve a population of about 1.75 million people (Figure 2). Groundwater protection (i.e., pollution prevention and cleanup) historically has not been well coordinated among the numerous responsible agencies. Furthermore, until now, no comprehensive overview of existing groundwater protection programs had been performed in the South Bay. Therefore, it has been difficult to identify areas where gaps in protection programs may exist, and ultimately where special attention and resources should be focused to optimize protection efforts.

This report presents the results of a two-year, comprehensive effort by the Groundwater Committee of the San Francisco Bay Regional Water Quality Control Board (S.F. Regional Board), in conjunction with the Santa Clara Valley Water District (SCVWD), the Alameda County Water District (ACWD), and the San Mateo County Environmental Health Service Division (SMCEHSD). The purpose of this effort was to:

1. Document existing groundwater beneficial uses, ambient groundwater quality, and groundwater protection programs (i.e., prevention and cleanup) in three South Bay groundwater basins
2. Identify gaps and areas of overlap among groundwater protection programs and evaluate their effectiveness
3. Make recommendations for improvement

In light of the high degree of reliance on groundwater in the South Bay, this project has focused on 1) evaluation of major threats to groundwater quality, 2) evaluation of existing groundwater protection programs in response to those threats, 3) review of new statewide initiatives for protection and data sharing, and 4) evaluation of special problem areas that are typically not addressed by groundwater protection programs. Several key findings and recommendations have been developed to identify regulatory gaps and help prioritize future protection efforts.

1.3 Stakeholder Participation

The Groundwater Committee worked closely with several local agencies, including the Alameda County Water District (ACWD), Santa Clara Valley Water District (SCVWD), and San Mateo County Environmental Health Services Division (SMCEHSD), to develop this report. These agencies participated in Groundwater Committee meetings, helped determine the report focus, and contributed key sections of the report itself.

The Groundwater Committee also involved stakeholders throughout the development of this report. In the spring of 2000, more than 100 potential stakeholders were invited to three scope-setting meetings held in Fremont, San Jose, and Redwood City. A total of 74 stakeholders attended, including representatives of local agencies, water suppliers, and non-governmental organizations (see Appendix A). The purpose of these meetings was to explain the South Bay Groundwater Protection Evaluation Project to stakeholders and gain feedback to better define its scope and purpose.

1.4 Project Methods

The methods used for this project were similar to those used in the “San Francisco/San Mateo Beneficial Use Study” (S.F. Regional Board, 1996) and the “East Bay Plain Beneficial Use Evaluation” (S.F. Regional Board, 1999) and include the following:

1. Review and summarize the hydrogeology, water use (i.e, beneficial uses), and water quality in each of the South Bay groundwater basins
2. Develop geographic information system (GIS) data layers for groundwater basin boundaries, public water supply wells, fuel and solvent leak sites, municipal landfills, and abandoned and destroyed wells, which could be potential vertical conduits for pollution transport
3. Review and summarize major threats to groundwater quality from industrial/agricultural chemicals (e.g., fuels, solvents, nitrates) and land use/resource management activities (e.g., saltwater intrusion, municipal landfills)
4. Review and compare existing local, state, and federal protection programs and new statewide initiatives for groundwater protection and data sharing
5. Identify and summarize special groundwater protection “focus areas” that represent common problems not typically addressed by groundwater protection programs, or that represent opportunities to integrate and enhance existing programs

GIS Analysis. The staff of the S.F. Regional Board and SCVWD prepared this report using ESRI’s Arc/INFO 8.0.1 and Arcview 3.2 software. Data layers were collected and merged from a variety of agency sources, including the S.F. Regional Board, ACWD, SCVWD, SMCEHSD, Department of Conservation Division of Mines and Geology, Department of Water Resources (DWR), San Francisco Estuary Institute, and the U.S. Geological Survey. Additional data layers were derived from databases developed by the Department of Toxic Substances Control (DTSC). Database data layers (Spills, Leaks, Investigation, and Cleanup [SLIC program], Leaking Underground Storage Tank Program [LUST], and DTSC data) were geocoded by the S.F. Regional Board using ESRI’s Streetmap package, which is based on 1997 TIGER street data as modified by GDT, Inc. All the maps in this report, unless otherwise noted, are 1:200,000 scale in the Lambert Conformal Conic projection, North American 1983 Datum. A complete data dictionary for the data layers is available upon request from the S.F. Regional Board.

1.5 Report Organization

This report is organized into eight sections including this introduction. Sections 2, 3, and 4 present a review of the hydrogeology, existing groundwater beneficial uses, and ambient water quality for each of the three South Bay basins. Sections 5 and 6 present a summary of the major groundwater quality threats and the protection programs implemented in response to those threats, as described below. Section 7

presents a summary of eight groundwater “focus areas” that were identified for special attention based on the experience of Groundwater Committee members and concerns expressed at stakeholder meetings. Section 8 summarizes the key findings and recommendations developed based on review and evaluation of the information.

Section 5 Major Threats to Groundwater Quality. Major groundwater quality threats addressed in this project are described in detail in Section 5 and include the following:

1. Fuel Leaks and methyl-tert-butyl ether (MTBE), including leaking underground storage tanks (LUSTs) and petroleum aboveground tanks (AGTs)
2. Solvent Plumes, including Solvent Stabilizers such as 1,4-Dioxane
3. Leaking Sewer Lines
4. Nitrates
5. Emerging Contaminants
6. Other Pollutants of Concern such as Perchlorate, Arsenic, and Hexavalent Chromium)
7. SaltWater Intrusion
8. Municipal Landfills

Section 6 Existing Groundwater Protection Programs. Existing local, state, and federal groundwater pollution prevention and cleanup programs were reviewed and summarized so that gaps and areas of overlap among programs could be identified. Groundwater protection programs addressed in this project are described in detail in Section 6 and include the following:

1. Fuel Leaks and MTBE
 - Leaking Underground Storage Tanks (SWRCB/Local)
 - Petroleum Aboveground Tanks (SWRCB/Local)
2. Solvent Plumes
 - Spills, Leaks, Investigations, and Cleanup (SLIC) (SWRCB/Local)
 - Multi-Site Cooperative Agreement (MSCA) (SWRCB)
 - State oversight/superfund (DTSC)
 - Federal oversight/superfund (EPA)
3. Leaking Sewer Lines
4. Nitrates
5. Emerging Contaminants
6. Other Pollutants of Concern
7. Saltwater Intrusion
8. Municipal Landfills
9. Statewide Groundwater Protection Initiatives

Section 7 Special Groundwater Protection Focus Areas. Eight groundwater protection “focus areas” were identified for special attention based on the experience of Groundwater Committee members and concerns expressed at stakeholder meetings. Focus areas were selected because they represent common problems that are typically not addressed by protection programs, or because they represent recent efforts with the potential to enhance existing programs. These focus areas, which are described in detail in Section 7, include the following:

1. Identification and Sealing of Vertical Conduits
2. Leaking Sewer Lines
3. Drycleaner Cleanups
4. Electronic Reporting Program for Chlorinated Volatile Organic Compound (CVOC) Plumes
5. Coordination with the Department of Health Services’ Drinking Water Source Assessment and Protection (DWSAP) Program
6. Surface water and Groundwater Interaction

7. Emphasis on Groundwater Protection in City and County General Plans
8. Regulatory Structure and Information Management

2.0 HYDROGEOLOGY OF THE SOUTH BAY BASINS

The South Bay groundwater basins lie in an alluvial-filled trough within the Coast Range Province of California (Figure 3). The Santa Cruz Mountains are on the west side of the fault-bounded depositional trough, and the Diablo Range is on the east. San Francisco Bay fills the center of the depression between the mountain ranges, with the San Mateo Plain on the west and the Niles Cone area on the east. The Santa Clara Valley Basin occupies the remainder of the area on the west side of San Francisco Bay and wraps around the south end of San Francisco Bay. The Santa Clara Valley Basin converges to the south at Coyote Narrows, where Coyote Sub-basin groundwater moves northward into the Santa Clara Valley Basin. An expanded discussion of South Bay geology is presented in Appendix B. Principal streams and watershed boundaries in the South Bay are shown in Figure 4.

2.1 Groundwater Basin Boundaries

Groundwater basin boundaries, from a groundwater flow perspective, are generally drawn along barriers to groundwater flow. Most of the South Bay Basin boundaries are artificial and have been established for convenience rather than along “no-flow” boundaries. The only true boundaries that meet this definition in the South Bay are those between alluvium and bedrock. In a hydrogeologic sense, the three South Bay Basins are connected and are part of a larger alluvial-filled trough that extends on the west from the vicinity of the San Francisco Airport, south to the Santa Clara Valley, and north to the city of Richmond. This large trough has historically been subdivided for convenience at the county boundaries in the South Bay. The San Francisco Bay shoreline has been used as the bayward boundary for all the South Bay Basins. However, alluvial and marine deposits extend beneath San Francisco Bay and merge, so the San Francisco Bay shoreline is also an artificial boundary. For example, the Centerville Aquifer of the Niles Cone is believed to cross under San Francisco Bay and is used for water supply in Palo Alto.

2.2 Niles Cone Groundwater Basin

The Niles Cone Groundwater Basin (Niles Cone) is defined by the Department of Water Resources (DWR) as the southern portion of the East Bay area, bounded on the south by the Alameda-Santa Clara County boundary; on the north by the boundary of the Alameda County Water District (ACWD), including the southern portion of the city of Hayward and Hayward detachment areas (Figure 5). The Niles Cone is bounded on the east by the Diablo Range and on the west by San Francisco Bay. However, certain aquifers of the Niles Cone appear to extend substantially beyond the boundaries described above. The Newark and Centerville aquifers continue westward all the way to the San Mateo Plain Basin. In addition, the Deep Aquifer may join the East Bay Plain, an adjacent groundwater basin to the north. Figure 5 illustrates a map view of the Niles Cone Groundwater Basin.

2.2.1 Niles Cone Hydrogeology

Niles Cone is the alluvial fan formed by Alameda Creek as it exits the Diablo Range and flows toward San Francisco Bay and by marine deposits from San Francisco Bay. A few smaller alluvial fans and some foothill areas underlain by older sediments are also included in the basin. The majority of water-bearing materials are composed of Quaternary alluvium, consisting of unconsolidated gravel, sand, silt, and clay. The Santa Clara Formation underlies a portion of the groundwater basin along its eastern margin. A cross-section of the Niles Cone Groundwater Basin is shown in Figure 6.

The Hayward Fault, which cuts across the apex of the Niles Cone alluvial fan, impedes the westward flow of groundwater and separates the basin into two sub-basins: the Below Hayward Fault (BHF) and the Above Hayward Fault (AHF) sub-basins. Large differences in water levels on either side of the fault demonstrate its relatively impermeable nature.

Above Hayward Fault (AHF) Sub-basin. The AHF Sub-basin is located on the east side of the Hayward Fault, between the apex of the Niles Cone alluvial fan and the Hayward Fault, and is composed of relatively homogeneous sand and gravel that form one aquifer. This aquifer is both unconfined and confined due to the presence of local low-permeability layers.

Below Hayward Fault (BHF) Sub-basin. The BHF Sub-basin on the west side of the fault is composed of a series of gently westward-dipping aquifers separated by extensive clay aquicludes. The aquifers comprise gravels and sands deposited from ancestral Alameda Creek and other small creeks as fluvial or alluvial deposits. The aquicludes comprise silts and clays deposited from distal (low-energy) portions of the alluvial fans and from San Francisco Bay as marine and estuarine deposits. The grain size and thickness of the aquifers decrease westward, while the intervening aquicludes become thicker. The aquifers can be correlated among wells and have been delineated over a large area.

The aquicludes may actually be absent just west of the Hayward Fault in the hydrogeologic region called the forebay. In the forebay, gravel constitutes nearly the total thickness of the alluvium and groundwater is unconfined, allowing direct recharge to all the aquifers from Alameda Creek and recharge ponds. West of the forebay, the basin is subdivided into the following hydrostratigraphic units.

Newark Aquifer. This is the first aquifer west of the fault and is an extensive permeable gravel layer between 40 and 140 feet below ground surface, except in the forebay, where it begins near the surface. The Newark Aquifer underlies most of the Niles Cone alluvial fan, extending westward under San Francisco Bay. The thickness of the Newark Aquifer ranges from less than 20 feet at the western edge of the basin to more than 140 feet at the Hayward Fault (DWR, 1967, 1968). The Newark Aquifer is overlain in most of the sub-basin by a thick layer of silt and clay called the Newark Aquiclude. Within the Newark Aquiclude, discontinuous layers of sand and silt comprise a non-regional hydrogeologic unit commonly known as the shallow water-bearing zone.

Centerville Aquifer. This lies at an average depth of between 180 and 200 feet below ground surface and ranges in thickness between 10 and 100 feet (DWR, 1967, 1968). It underlies most of the Niles Cone alluvial fan west of the Hayward Fault and is composed of gravel and sand. Throughout most of the fan, the Centerville Aquifer is separated from the Newark Aquifer by a fairly impermeable aquiclude, which protects it from the saline water in the overlying Newark Aquifer. However, the two aquifers merge in the vicinity west of the Hayward Fault.

Fremont Aquifer. This exists primarily east of the Coyote Hills, varying in depth from 300 to 390 feet below ground surface (DWR, 1967, 1968). It too merges with the overlying aquifers in the vicinity west of the Hayward Fault. While the Fremont Aquifer is not as well defined as the overlying aquifers, it is also composed of gravel and sand. The aquiclude separating the Centerville and Fremont aquifers is generally absent or thin near the inner portions of the alluvial fan, and the aquifers are commonly referred to as the Centerville-Fremont Aquifer. Lithology and water-level data indicate that they are in hydrogeologic connection near the inner portions of the alluvial fan.

The Deep Aquifer. A series of deeper aquifers exists below the Fremont Aquifer. These aquifers are sometimes referred to as the 400-foot Aquifer and 500-foot Aquifer (DWR, 1967), corresponding to the approximate depth at which they occur, but are more commonly referred to as the Deep Aquifer. The Deep Aquifer is separated from the Fremont Aquifer by a competent regional aquiclude. Their lateral extent has not been well defined, but they are suspected to extend beyond the margins of the Niles Cone alluvial fan, and thus may be a conduit through which groundwater is exchanged with adjacent basins to the north and west. However, the quantity of water moving between these basins is not well understood (Fio and Layton, 1995).

2.2.2 Niles Cone Groundwater Basin Yield

The construction of facilities for artificial recharge or diversion, in conjunction with the availability of imported water, has increased the safe yield of the Niles Cone Groundwater Basin. The theoretical physical limit of safe yield can be considered to be equal to the annual natural amount of percolation from direct rain plus the percolation of the recharge facilities. Together, these amounts were estimated to equal approximately 50,000 acre-feet per year (ACWD, August 1995). This limit assumes that groundwater is pumped as necessary so that basin levels are regulated to preclude losses to San Francisco Bay and diminished recharge rates. It also assumes that a supply of water for artificial recharge is always present.

However, these assumptions are unrealistic with respect to the current management of supplies and production because ACWD's goal is to maintain groundwater levels above sea level in the Newark Aquifer to prevent saltwater intrusion. At the high end of the operating range, groundwater levels may approach or surpass an elevation of 20 feet mean sea level in the forebay region if water is available for recharge. Within this normal operating range of the Below Hayward Fault Sub-basin, ACWD's groundwater model indicates that groundwater discharges to San Francisco Bay occur when the groundwater elevation is above sea level in the forebay region.

From 1989, when Rubber Dam No. 3 was constructed in Alameda Creek, to 1995, the approximate average annual amount of water recharged to the groundwater basin minus natural losses (safe yield) was estimated to be 38,000 acre-feet per year (ACWD, August 1995). However, a major rehabilitation of the Quarry Lakes area was completed in 1997, and the safe yield of the basin may have increased. Total groundwater pumpage varies from year to year. Between 1990 and 2000, groundwater pumpage ranged between 26,000-38,000 acre-feet per year.

2.3 Santa Clara Valley Groundwater Basin

The Santa Clara Valley Groundwater Basin is located at the southern end of San Francisco Bay and lies within an alluvial-filled intermontane valley defined by the Coast Range on the west and the Diablo Range on the east (Figure 7). The basin fills the southern end of the structural trough filled by San Francisco Bay. The basin extends 25 miles to the southwest on the southern end of San Francisco Bay. At its southern end, the Santa Clara Valley Groundwater Basin narrows to a half-mile in width at Coyote Narrows, then extends seven miles farther south through Coyote Valley to the boundary with the Llagas Groundwater Basin at Morgan Hill. The boundary between the Llagas and Santa Clara Valley groundwater basins is formed by a topographic and groundwater divide of the Coyote Creek alluvial fan as it emerges from the eastern foothills. At its northern end, the basin is 15 miles wide. On its western edge, it continues north as the San Mateo Plain and baylands, and on its eastern edge, it continues north as the baylands and Alameda Plain to Niles Cone.

The boundary of the Santa Clara Valley Groundwater Basin is generally considered to be the contact of alluvial valley fill with consolidated bedrock formations at the surface and beneath the alluvium. One moderately water-bearing rock formation occurs in the valley: the Santa Clara Formation, which consists of interbedded sand, gravel, clayey gravel, silt, and clay. In some parts of the basin, the basin boundary occurs at the contact between the Santa Clara Formation and other bedrock formations, upslope from the contact between the flat valley floor and the foothills. In the subsurface, because young alluvial fill is not easily distinguished from the Santa Clara Formation, the two deposits are considered as one water-bearing unit. Figure 7. illustrates a map view of the Santa Clara Valley Groundwater Basin.

2.3.1 Santa Clara Valley Hydrogeology

The Santa Clara Valley Groundwater Basin and its tributary sub-basin, the Coyote Valley, is located in the north-central portion of Santa Clara County. It represents one of the significant alluvial-filled groundwater basins in California.

2.3.2 Santa Clara Valley Drainage Features

The principal drainage feature of the Santa Clara Valley Groundwater Basin is Coyote Creek, which originates in the Diablo Range, enters the Coyote Valley at its southeastern end, and flows northwesterly through Coyote Valley and Santa Clara Valley before entering San Francisco Bay. Other major drainages passing through the Santa Clara Valley Groundwater Basin include the Guadalupe River, Los Gatos Creek, San Tomas Creek, Saratoga Creek, Calabazas Creek, Stevens Creek, and Permanente Creek, all originating in the Santa Cruz Mountains. Drainages entering Santa Clara Valley from the east are generally smaller; the largest are Penitencia and Berryessa creeks. Fisher Creek flows north on the western side of the Coyote Valley.

2.3.3 Santa Clara Valley Hydrostratigraphy

Gently sloping alluvial fans emerging from the basin's tributaries have laterally merged to form an alluvial apron, descending to the basin interior. The upper fan areas along the elevated edges of the basin are predominantly made up of coarse deposits, represented by massive sections of highly permeable gravel and less permeable gravel and clay. Mid-fan deposits are characterized by finer-grained, but better-sorted, deposits, and include moderately stratified clean and highly permeable sands and gravels, with fine-grained and restrictively permeable to impermeable silt and clay beds more abundant farther down the fan.

As ancient levels of San Francisco Bay fluctuated in response to ice ages, and as the basin and shallow marine deposits consolidated, the coarse-grained deposits advanced onto fine-grained deposits, and were subsequently covered by fine-grained deposits as San Francisco Bay levels rose. The result is a subsurface merging of more permeable alluvial fan deposits and low permeability basin and marine deposits in a complex and random pattern of interfingering and interlayering. Essentially impermeable silt and clay beds are interbedded with sand and gravel beds, which often are sinuous individual buried ancient stream channels with limited lateral continuity. Where these impermeable deposits are sufficiently thick and laterally extensive, they create confining layers to deeper aquifers.

The well-sorted sands and gravels in the mid-fan region are highly permeable and have proven to be good aquifers. The massive gravel and clay aquifers in the upper fan regions are of moderate to low permeability and have also been used extensively for water supply. The increasing clay and silt content in the basin interior creates lower permeability conditions and constrains the utility of these deposits as aquifers due to the limited gravel deposits in the basin interior.

The aquifers of the Santa Clara Valley Groundwater Basin are grouped into the following hydrogeologic units (Figure 8a):

- Forebay or recharge zone
- Upper aquifer zone
- Lower aquifer zone

The upper and lower aquifer zones occur in the basin interior. The "upper aquifer zone" is generally considered to be aquifers that occur within the upper 150 feet from the surface, and the "lower aquifer zone" refers to aquifers that occur at depths below 150 feet. Within the basin interior, aquifers occurring deeper than 150 feet are generally under pressure, i.e., they are confined by clay aquitards that vary in thickness and lateral continuity. Most of the groundwater pumped from the basin is from the lower confined-zone aquifers. The forebay, where groundwater is generally unconfined, occurs along the elevated edges of the basin in the upper alluvial fan areas.

The forebay consists predominantly of aquifer materials with discontinuous or leaky aquitards. The Santa Clara Valley Groundwater Basin receives its principal recharge in the forebay area from deep infiltration

from streams, applied irrigation waters, rainfall, and percolation ponds as part of the Santa Clara Valley Water District's (SCVWD's) artificial recharge operations. Small amounts also recharge the Santa Clara Valley Basin via subsurface inflow from the Coyote Valley Sub-basin through the Coyote Narrows.

Groundwater in the Coyote Valley Sub-basin is essentially unconfined, occurring in alluvial fill deposits emanating from Coyote Creek (Figure 8b). The principal recharge to the sub-basin is infiltration of runoff along Coyote Creek and SCVWD-controlled releases of water to upper Coyote Creek during the summer.

2.3.4 Santa Clara Valley Groundwater Basin Yield

The annual draft from the Santa Clara Valley Groundwater Basin is approximately 110,000 acre-feet, with an additional 12,000 acre-feet per year from the Coyote Sub-basin. To prevent subsidence, the SCVWD has estimated pumping in any one year should not exceed 200,000 acre-feet.

A notable feature of the Santa Clara Valley Groundwater Basin is that the basin was overdrafted for decades, which induced land subsidence from Palo Alto to San Jose, as much as 13 feet in places. As a result, the lower reaches of streams and rivers reversed gradient such that tidal waters now invade inland as much as three miles upstream. Saline waters traveling up rivers and creeks have entered shallow aquifers and have, in turn, been drawn into the lower aquifers through pumping of irrigation wells screened in multiple zones and through abandoned wells. Abandoned wells and other vertical conduits are discussed later in this report (see Section 7.1).

The SCVWD took several decisive steps to counteract overdrafting and land subsidence. These included expanding supply by erecting 11 local dams and using the stored water for groundwater recharge; building the infrastructure and securing the rights to import water from state and federal projects, as well as the city of San Francisco's Hetch Hetchy water supply; operating numerous groundwater recharge ponds and in-stream recharge with spreader dams; and aggressively sealing abandoned wells. These measures have succeeded in curtailing land subsidence since 1968 and the advance of saltwater intrusion, primarily since 1985.

2.4 San Mateo Plain Groundwater Basin

2.4.1 San Mateo Plain Hydrogeology

The San Mateo Plain Groundwater Basin is located along the southeastern edge of San Mateo County, bordering San Francisco Bay. The basin covers approximately 40 square miles, with a depth ranging from 20 to more than 1,250 feet (Figure 9). The basin includes the flatlands between the Santa Cruz Mountains and San Francisco Bay, underlying the cities of Hillsborough, San Mateo, Foster City, Belmont, San Carlos, Redwood City, Atherton, Menlo Park, and East Palo Alto.

The basin is bounded to the north by a bedrock high separating it from the Westside Basin, and to the south by San Francisquito Creek, a political boundary between San Mateo and Santa Clara counties. The western boundary is roughly defined by the Santa Cruz Mountains, following the base of the foothills that parallel Alameda de Las Pulgas. The basin boundary to the east is defined as the shore of San Francisco Bay; however, it may correlate to the Niles Cone Groundwater Basin.

2.4.2 San Mateo Plain Hydrostratigraphy and Drainage Features

The basin is composed primarily of complex alluvial fan structures formed by tributaries to San Francisco Bay; the proximal edge of the fan structures rests along the northeastern extent of the Santa Cruz Mountains, while the distal (east) edge is interfingered with San Francisco Bay muds. Various studies have been performed on the alluvial fan of San Francisquito Creek, often referred to as the San Francisquito Cone (Killingsworth, et al., 1932; Lee, 1991; Charlton International, 1996), but little is

known about the alluvial fans of the other tributaries to the north of San Francisquito Creek. These other tributaries, shown on Figure 10, are San Mateo Creek, Laurel Creek, Belmont Creek, Pulgas Creek, Cordilleras Creek, Redwood Creek, and San Francisquito Creek.

The alluvial setting of the basin can best be understood in reference to Figure 10, which has been adapted by Erler & Kalinowski (1993) from the U.S. Geological Survey Professional Paper 943 (Helley, et al., 1979). Figure 10 is a schematic diagram of a stream channel on an alluvial fan. It shows a characteristic distribution of coarser-grained channel sediments giving way laterally to silty and then clay-rich sediments. It also shows that the channel is characteristically enclosed within natural levees, which are topographically higher than the marshy flood basin around the channel. This configuration is typical of streams in the San Mateo Plain. Over the course of geologic time, the creeks changed their direction several times, especially closer to San Francisco Bay, allowing gravels, sands, and clay layers to interfinger and become laterally discontinuous. This has been observed in various well and boring logs, even for those located very close to each other (Erler & Kalinowski, 1993; Poland and Garrett, 1943).

2.4.3 Regional Cross Sections and Identification of San Mateo Plain Sub-basins

To better understand the character of the San Mateo Plain as a whole, well core data was compiled into three schematic cross sections of the basin subsurface, Plates 1, 2, and 3. The cross sections run along El Camino Real (from Sanchez Creek in Burlingame to San Francisquito Creek), Bayshore Highway (from Coyote Point in San Mateo to Pulgas Avenue in East Palo Alto), Woodside Road (from Highway 280 to San Francisco Bay), and Highway 92 (from Highway 280 to San Francisco Bay). Well log information obtained from files of the San Mateo County Environmental Health Services Division (SMCEHSD) was used for this task. To allow a greater number of well logs to be used for the cross sections, a buffer zone of 1,500 feet in each direction from the trace of the cross section was used.

The sub-basins are here defined as the North San Mateo Plain Sub-basin and South San Mateo Plain Sub-basin and are described below. This new nomenclature is recommended for inclusion into the DWR update of the map of California groundwater basins (Bulletin 118 update). The cross sections show the presence of two sub-basins within the San Mateo Plain, one north of Ralston Avenue in Belmont, and one south of it.

The South San Mateo Plain Sub-basin consists of two main aquifers, an upper one corresponding to the Holocene and late Pleistocene alluvium, and a lower one corresponding to the Pleistocene alluvium. The upper aquifer is encountered at depths of up to 120 feet below the ground surface. The lower aquifer occurs from about 200 to 400 feet. The lower aquifer is thickest in the Atherton and Menlo Park areas and is probably composed of both the Pleistocene alluvium and the Santa Clara Formation. The lower aquifer becomes thinner to the north where the South San Mateo Plain Sub-basin thins. The El Camino cross section shows the bedrock almost touching the surface at Ralston Avenue in Belmont. The lower aquifer is not present, and the upper aquifer is very thin and contains more clays. In the Bayshore cross section, the lower aquifer is not confirmed in the Belmont area due to the absence of deep wells in the area. The upper aquifer is not very extensive and contains more clay.

The North San Mateo Plain Sub-basin comprises the area from Ralston Avenue in the south to Coyote Point in the north. The bedrock in this area builds a big valley, with its deepest expression approximately under Highway 92. The shape of this valley is especially clear in the El Camino cross section. Several discontinuous gravel, sand, and clay layers can be observed in the North San Mateo Plain Sub-basin, and a distinction between an upper and a lower aquifer as in the South San Mateo Plain Sub-basin is more complicated. This valley and its sediments were probably eroded and deposited by San Mateo Creek and its tributaries throughout the Quaternary.

3.0 GROUNDWATER BENEFICIAL USES

3.1 Niles Cone Existing Beneficial Uses

The current and potential beneficial uses of groundwater within the Alameda County Water District’s (ACWD’s) service area are municipal and domestic supply, industrial process and service water supply, water contact and non-contact water recreation, and agricultural supply. Groundwater quality objectives for these beneficial uses are met in the Above Hayward Fault Sub-basin. Groundwater quality objectives for these beneficial uses are also met in the Below Hayward Fault Sub-basin, except in portions of the aquifers that are still affected by historical saltwater intrusion. Groundwater production in the Niles Cone Groundwater Basin is summarized in Table 1 for fiscal year 1999-2000, is presented in Figure 11 for the periods between fiscal year 1969-1970 and 1999-2000, and is discussed below.

Table 1. Production of Groundwater – Fiscal Year 1999-2000
 (acre-feet)

Use of Groundwater	Above Hayward Fault	Below Hayward Fault	Total
Municipal	11,800	8,400	20,200
Industrial	0	1,700	1,700
Non-municipal Recreation	0	0	0
Agricultural	100	200	300
Municipal Recreation	800	300	1,100
Aquifer Reclamation	0	6,300	6,300
Total Production	12,700	16,900	29,600

The largest category of production denoted in Table 1 as “municipal” (68.2 percent) is groundwater supplied to the distribution system by ACWD’s Peralta-Tyson and Mowry well fields. Groundwater production supplied 36 percent of water delivered by ACWD’s distribution system in 1999-2000. Most of the production figures for municipal, industrial, and agricultural uses and for the Aquifer Reclamation Program were obtained from well meter readings. A small amount of unmetered groundwater production was estimated.

3.2 Niles Cone Planned Groundwater Beneficial Uses

Greater reliance on the groundwater basin is anticipated based on ACWD’s Integrated Resource Plan (ACWD, August 1995), which contains a long-range program for conservation, water supply, and water-quality management to meet the future demands within ACWD’s service area through the year 2030. Based on this plan, ACWD is proceeding with the design and construction of a five-million-gallon-per-day, and ultimately a 10-million-gallon-per-day, reverse-osmosis desalination facility in the city of Newark to produce a low total dissolved solids (TDS) potable water supply from high-TDS groundwater (an estimated 2,600 parts per million). ACWD’s existing Aquifer Reclamation Program (ARP) wells will be used to provide a composite feed-water source. The first phase of the facility is anticipated to be operational in mid-2003, with expansion to produce 10 million gallons per day anticipated by 2009.

The desalination facility will provide several net environmental benefits. The existing ARP operation is a salinity-reduction and groundwater-management program, and the facility has been designed for integration and consistency with the ARP. In addition to maintaining groundwater protection benefits, the desalination facility, by converting brackish unused water into potable supply, will reduce the need to export additional water out of the Delta.

3.3 Santa Clara Valley Current Groundwater Beneficial Uses

Current groundwater beneficial uses for Santa Clara Valley are municipal and domestic supply, industrial process supply, industrial service supply, and agricultural. Water quality objectives for these beneficial uses are, for the most part, met. As noted in Section 7, monitoring results suggest that groundwater quality is excellent to good in northern Santa Clara Valley. Mineral salt content is elevated in localized areas, and a few wells have been shut down due to contamination, but overall, water quality objectives are met. Groundwater quality in southern Santa Clara Valley is also good, although high nitrate concentrations have been noted in some wells. Groundwater production in the Santa Clara Valley during 1999 is discussed below and summarized in Table 2. The data are from the Santa Clara Valley Water District (SCVWD) Water Resources Information System.

**Table 2. 1999 Groundwater Use in Santa Clara Valley Groundwater Basin
 (acre-feet)**

Sub-basin	Agriculture	Domestic	Municipal and Industrial	Total Groundwater Use
Santa Clara Valley (Northern Santa Clara Valley)	1,087	231	106,130	107,448
Coyote Valley (Southern Santa Clara Valley)	4,324	220	3,158	7,702
Totals	5,411	451	109,288	115,150

Water use in the SCVWD Water Resources Information System is grouped by agriculture, municipal and industrial, and domestic. These groupings do not directly correspond to the beneficial uses designated in the Basin Plan. For instance, agricultural use only includes crop use. It does not include use at golf courses, cemeteries, parks, and schools. These uses are included in industrial use.

Agricultural Use. Approximately 5,410 acre-feet of groundwater was produced from 235 agricultural wells to irrigate crops in 1999. Cherries, sod, alfalfa, flowers, sweet corn, and peppers account for more than half (3,090 acre-feet) of the groundwater use for crops. Other crops that were irrigated using groundwater include cucumbers, broccoli, beans, prunes, mushrooms, wine grapes, pumpkins, and walnuts.

Domestic Use. Approximately 451 acre-feet of groundwater was produced from 706 domestic wells in 1999. Domestic wells are private drinking-water wells that have fewer than five connections.

Municipal and Industrial Use. Approximately 109,288 acre-feet of groundwater was produced from 1,493 wells for municipal and industrial uses in 1999. This production is summarized in Table 3. Ninety percent of the use was by public water systems and miscellaneous industrial uses.

Table 3. Santa Clara Valley 1999 Municipal and Industrial Use

Use Type	Production (acre-feet)	Use Type	Production (acre-feet)
Beverage Plants	16	Mobile Home Parks	185
Cemeteries	413	Motels and Hotels	12
Cogeneration	166	Office Buildings	23
Concrete Plants	41	Other Uses	99
Construction	15	Paper Processing	846
Fiberglass Manufacturing	175	Parks - Municipal (Gross)	108
Food Processing	551	Parks - Amusement	92
Golf Course (Gross)	2,512	Pasture	96
Groundwater Contamination	2,436	Restaurants	2
Hospitals	354	Retail Stores	1
Lakes and Ponds	79	Schools	879
Landscape Irrigation	42	Service Station	2
Manufacturing Plant	1,589	Sewage Treatment	16
Meeting Hall	3	Water System	44,691
Misc. Industrial	53,842		

3.4 Santa Clara Valley Planned Groundwater Beneficial Uses

Groundwater production changes are anticipated in southern Santa Clara Valley (Coyote Valley Groundwater Sub-basin). Two large industrial developments are planned for the area. Water supply needs for one of the developments, a power plant, may be met primarily through the use of recycled water. The source of water supply for the other development, a research park, will be local groundwater. Groundwater production associated with the two facilities is more than 4,000 acre-feet per year.

3.5 San Mateo Plain Existing Groundwater Beneficial Uses

Currently, groundwater in the San Mateo Plain is used for irrigation, public drinking water, and private drinking water. The majority of pumping for irrigation occurs in the South San Mateo Plain Sub-basin, where about 90 percent of the irrigation wells are located (Figure 9). Of the wells in the South San Mateo Plain Sub-basin, approximately 65 percent are located in Atherton. While the majority of the wells in Atherton and Menlo Park are screened in the deeper aquifer, the majority of the irrigation wells in other cities in the South San Mateo Plain Sub-basin are drilled and screened in the shallower aquifer.

Public drinking water wells are located in East Palo Alto (Palo Alto Park Mutual Water Company), Menlo Park (O'Connor Tract Corporation and Menlo College), and San Mateo (San Mateo High School). While Menlo College and San Mateo High School are small water systems that provide water for their campuses, O'Connor Tract Corporation and Palo Alto Park Mutual Water Company provide drinking water for the population of East Palo Alto and to the East Menlo neighborhood in Menlo Park. All public drinking water wells are screened in the deeper aquifer.

A few private drinking water wells are located in East Palo Alto. These wells were installed in the 1980s when Palo Alto Park Mutual Water Company had in place a moratorium on new water connections. The well installations were necessary to allow development on properties where the wells are located. The moratorium was lifted after the 1989 Loma Prieta earthquake, when the federal government provided funds for the upgrade of the company's water supply system. Most of the houses developed in the 1980s have since been connected to public drinking water, and their wells have either been destroyed or are currently used for irrigation only. These drinking water wells are screened in the shallow water-bearing zone.

Of the known wells in the San Mateo Plain, 74 percent are monitoring wells related to current site remediation activities. The majority of the monitoring wells, about 72 percent, are located in the South San Mateo Plain Sub-basin. The majority of the monitoring wells are drilled and screened in the shallow aquifer zone. Only 10 monitoring wells are deeper than 70 feet, of which five are in East Palo Alto, three in Menlo Park, and two in San Mateo.

3.6 San Mateo Plain Planned Groundwater Beneficial Uses

There are no known plans for significantly expanding groundwater uses in the San Mateo Plain.

4.0 AMBIENT GROUNDWATER QUALITY

Groundwater quality is controlled by the amount and type of matter present in solution, which result from interactions among the water, atmosphere, and rock minerals. The ultimate concentration of dissolved constituents can be further modified by reactions in the aquifer and by mixing between surface water and groundwater, as in the case of saltwater intrusion. Further, compounds released into the environment by human activities can contribute more dissolved constituents to the groundwater, such as nitrogen-based fertilizers and soil amendments used in agricultural operations.

4.1 Niles Cone Groundwater Basin Quality

The Alameda County Water District (ACWD) requires high-quality groundwater because it is used extensively for domestic supply. Table 4 lists some important dissolved constituents found in groundwater collected on February 26, 2001, from ACWD's production wells.

The water of highest quality is in areas receiving direct recharge (i.e., the forebay in the Below Hayward Fault [BHF] Sub-basin and the Above Hayward Fault [AHF] Sub-basin) and in areas outside of the entrapped brackish water in the deeper aquifers. The overall character of the groundwater is calcium bicarbonate, except in areas of saltwater intrusion where it is sodium chloride type (University of California, Berkeley, 1987).

Saltwater Intrusion. Saltwater from San Francisco Bay and adjacent salt ponds has intruded into freshwater-bearing aquifers in the Niles Cone Groundwater Basin. Intrusion of saltwater into the portion of the groundwater area north of the Coyote Hills was evident by 1924. Degradation continued, and groundwater in the Newark Aquifer became progressively more unsuitable for irrigation use.

Farmers, in their search for suitable irrigation supplies, drilled wells deeper into the next major aquifer, the Centerville Aquifer, which is separated from the Newark Aquifer by a nearly impermeable clay layer (DWR, 1973). Freshwater from deeper aquifers relieved the immediate water supply problems. Therefore, the extent of saltwater intrusion was not fully realized until the 1940s, when brackish water first began to appear in some of these deeper wells. Ultimately, the intrusion extended almost to the Hayward Fault, approximately five miles east of San Francisco Bay (DWR, 1975).

Table 4. Summary of Alameda County Water District Production Well Groundwater Data and Water Quality Objectives

Constituents^a	Concen. Range AHF Aquifer	Concen. Range BHF Newark Aquifer	Concen. Range BHF C-F Aquifer	Concen. BHF Deep Aquifer (1 Well)	Drinking Water Standard
Chloride (mg/l)	86 – 93	84 - 88	100 - 200	114	500 ^c
Sulfate (mg/l)	83 – 89	81 - 83	65 - 73	54	500 ^c
Nitrate (mg/l)	0.36 - 1.40	0.97 - 1.28	0.60 - 4.98	N/A	45 ^b
Dissolved Solids (mg/l)	408 – 502	472 - 506	490 - 688	466	1,000 ^c
Sodium Adsorption Ratio	N/A	N/A	N/A	N/A	-
Aluminum (ug/l)	<50	<50	<50	<50	1,000 ^b
Arsenic (ug/l)	<2	<2	<2	<2	50 ^b
Barium (ug/l)	207 – 222	29 - 201	226 - 396	262	1,000 ^b
Boron (ug/l)	N/A	N/A	N/A	N/A	-
Cadmium (ug/l)	<1 - 1.03	<1	<1	<1	5 ^b
Chromium (ug/l)	<10	<10	<10 - 11.5	<10	50 ^b
Copper (ug/l)	<50	<50	<50	<50	1,000
Fluoride (mg/l)	0.20 - 0.23	0.20	0.12 - 0.20	0.12	1.8 ^b
Iron (ug/l)	<100	<100	<100	<100	300 ^c
Lead (ug/l)	<5	<5	<5	<5	50 ^b
Manganese (ug/l)	<30	<30	<30	<30	50 ^c
Mercury (ug/l)	<1	<1	<1	<1	2 ^b
Nickel (ug/l)	<10	<10	<10	<10	100 ^b
Selenium (ug/l)	<5	<5	<5	<5	50 ^b
Silver (ug/l)	<10	<10	<10	<10	100 ^b
Zinc (ug/l)	<50	<50	<50	<50	500 ^c

^a For common inorganic water quality constituents

^b Maximum contaminant level as specified in Table 64431-A of Section 64431, Title 22, of the California Code of Regulations

^c Secondary maximum contaminant level as specified in Table 64449-B of Section 64449, Title 22, of the California Code of Regulations

The intrusion began when groundwater in the Newark Aquifer dropped below sea level as groundwater extractions began to exceed the basin recharge (DWR, 1973). This relative elevation difference between the groundwater in the basin and saltwater from San Francisco Bay caused a landward direction of groundwater flow through the Newark Aquifer and intrusion of saltwater into the groundwater basin. Several decades of saltwater intrusion occurred, and saline water migrated as far as the forebay. A DWR illustration of saline water movement into the basin during overdraft conditions is shown in Figure 6.

Since 1962, ACWD has purchased State Water Project water supplies to supplement local recharge and raise groundwater levels. This has brought the water table above sea level as of 1972 (BHF indicator well) and returned the flow direction to its natural bayward direction in the Newark Aquifer. Although there has been substantial improvement in the basin, a considerable volume of saline water remains in the aquifers.

ACWD has implemented three programs aimed at managing water supplies and addressing saltwater intrusion more effectively, increasing production, and improving water quality:

1. Artificial recharge to improve recharge capability by constructing inflatable dams in Alameda Creek and increasing percolation capacity in the abandoned gravel quarries
2. An aquifer reclamation program to pump entrapped saltwater from the basin into San Francisco Bay

3. A desalination facility (located in Newark and planned to be operational in 2003) to treat some of the brackish water from ARP wells and supplement ACWD's drinking-water supply

Chloride levels in groundwater are indicative of general water quality in the Niles Cone Groundwater Basin. Chloride is a surrogate for total dissolved solids (TDS) in water that is significantly influenced by seawater, both because chloride is a major portion of the TDS in seawater and because it is conserved in the environment due to its non-reactive nature. The Above Hayward Fault (AHF) Aquifer has never been affected by saltwater intrusion due to the low permeability of the Hayward Fault. Therefore, the chloride data for the AHF Aquifer is very similar each year, with chloride concentrations ranging between 70 and 90 mg/l.

The quality of water in the Newark Aquifer deteriorates rapidly from the groundwater recharge area to the edge of San Francisco Bay, with the concentrations of chlorides increasing from about 70 ppm to concentrations exceeding 2 percent (20,000 ppm). Newark Aquifer monitoring wells near the percolation ponds have shown an improvement in water quality over the last 15 years. Changes in chloride concentrations in the BHF Sub-basin can be approximated by comparing the 250 ppm contour lines constructed for Fall 1962 (when artificial recharge activities began) and Fall 2000. Chloride concentrations in the Newark Aquifer appear to have decreased significantly from the Hayward Fault to almost as far as U.S. Interstate 880 (Figure 12).

In the central portion of the basin beyond the recharge area, water quality in the Centerville-Fremont Aquifer has been affected, with chloride concentrations generally between 250 and 1,000 ppm. Small areas west of U.S. Interstate 880 have chloride concentrations ranging between 1,000 and 1,700 ppm.

A large area of the basin shows a significant increase in the salinity levels within the Centerville-Fremont Aquifer. A comparison between 250 ppm contour lines for the Fall 1962 versus Fall 2000 time period shows a significant increase in salinity in a large area surrounding the Fall 1962 250 ppm contour line (Figure 13). The cause of the salinity increase is not known with certainty. It may, however, be due to mixing between highly saline water (>250 ppm) with less saline water (<250 ppm), as infiltration from the recharge area dilutes and disperses the saline water. This map also shows a decrease in salinity in the percolation ponds area to about Fremont Boulevard.

In the central portion of the basin beyond the recharge area, the quality of water in the Deep Aquifer has been affected, with chloride concentrations generally between 250 and 500 ppm. One small area west of U.S. Interstate 880 has chloride concentrations ranging between 500 and 700 ppm. A comparison between Fall 1962 and Fall 2000 250 ppm contour lines in the Deep Aquifer shows a decrease in salinity in the percolation ponds area to about Fremont Boulevard, and an apparent significant increase in salinity in the area surrounding the Fall 1962 250 ppm contour line, except for small, isolated areas to the north and possibly south where the salinity appears to have decreased (Figure 14).

Similar to the Centerville-Fremont Aquifer, this increase in salinity may be due to mixing between highly saline water (>250 ppm) with less saline water (<250 ppm), as infiltration from the recharge area dilutes and disperses the saline water.

Total Dissolved Solids. In 1997, the range of total dissolved solids (TDS) in all of ACWD's groundwater production wells was between 430 and 764 ppm, with an average of 549 ppm. However, since ACWD's groundwater supply is blended with purchased San Francisco Hetch Hetchy water, the blended-water TDS range was between 340 to 446 ppm, with an average of 395 ppm. In 1999, the blended-water TDS range was between 288 to 454 ppm, with an average of 394 ppm. The secondary maximum contaminant level (MCL) for TDS is 500 ppm. Isoconcentration maps of TDS levels for each of the Niles Cone aquifers are shown in Figures 15, 16 and 17.

Hardness. ACWD's goal for blended water hardness is 150 ppm on average and 175 ppm during a summer day's demand. To meet this goal, groundwater extracted from the Mowry and Peralta-Tyson wells (typically from 235 to 640 ppm for each well) is blended with surface water purchased from the San Francisco Public Utilities Department and conveyed to ACWD via the Hetch Hetchy system (typically below 30 ppm). ACWD's future desalination facility will help meet the hardness goal during the summer.

Nitrate. In 1968, DWR reported that excessive amounts of nitrates were found southwest of Union City and south of the Niles district of Fremont. In these areas, the nitrate concentrations exceeded California's primary MCL of 45 ppm for drinking water (DWR, 1968). However, in 1997, the range of nitrates in all of ACWD's groundwater production wells was between 0.1 and 24.8 ppm, with an average of 7.7 ppm, well below the MCL (ACWD, March 1998).

Boron. DWR reports indicate that some wells in the vicinity of geologic faults had high concentrations of boron, with the highest observed concentration being 5.3 ppm (DWR, 1960, and DWR, 1963). However, based on DWR data collected between 1962 and 1967, boron concentrations were below 0.7 ppm in all Niles Cone aquifers (DWR, 1968). In addition, ACWD collected samples from two Above Hayward Fault monitoring wells (one well is adjacent to the Hayward Fault) in 1998, and boron concentrations were 0.57 and 0.67 ppm. A boron concentration of 2 ppm or less is considered suitable for agricultural use. In higher concentrations, it can damage certain crops.

Manganese. In 1996, 1997, and 2000, manganese was not detected in any of ACWD's groundwater production wells, except for one Above Hayward Fault production well in 2000, when a concentration of 0.0093 ppm was detected. Historically, ACWD's northernmost production well, at the border between ACWD and the city of Hayward (the Whipple Well, screened in the Deep Aquifer), consistently had detectable concentrations of manganese ranging from 0.13 ppm to 0.29 ppm. The well has not been used since 1991 due to these manganese concentrations and is now considered an emergency supply well. It appears that elevated concentrations are prevalent in this area, because manganese has also been detected in shallower zones at concentrations as high as 1.0 ppm. The secondary MCL for manganese is 0.050 ppm.

Radon. Radon is a radioactive gas produced from the decay of uranium. If it accumulates in high concentrations indoors, it can pose a risk for lung cancer. It enters homes and buildings from nearby soils, rocks, and groundwater supplies. Groundwater supplies are estimated to contribute about 2 percent of total indoor-air radon concentrations. Recently, the U.S. Environmental Protection Agency (EPA) proposed a drinking-water MCL of 300 pico-curies per liter (pCi/l) for radon. According to the proposed rule, an alternate MCL (AMCL) of 4,000 pCi/l would be allowed if a state develops an EPA-approved Multimedia Mitigation Program to address other sources of indoor-air radon concentrations.

Between 1989 and 1999, radon was detected in ACWD's production wells in the range of 200 to 600 pCi/l, with the majority of the results above the proposed MCL of 300 pCi/l. However, since ACWD's groundwater supply is blended with purchased San Francisco water, the blended water produced a radon level of only 230 pCi/l in 1999. None of the wells exceeded the proposed AMCL.

4.2 Santa Clara Valley Groundwater Basin Water Quality

Groundwater monitoring results for the Santa Clara Valley show that water quality is excellent to good for all major zones of the basin. Most waters are calcium-magnesium-bicarbonate type. Trace constituents, which are considered unwanted impurities when present in high concentrations, are generally not detected; however, some limited areas of the Santa Clara Valley Basin contain concentrations of mineral salts that adversely affect the use of the resource. Areas that harbor somewhat degraded waters due to total mineral salt content are identified below.

Areas of high mineral salt concentrations include: a deep connate water zone in the southeastern portion of the forebay, a small area of the lower aquifer zone underlying the Palo Alto area, and the upper aquifer zone of the baylands. The Coyote Sub-basin possesses elevated levels of nitrate, although limited data suggested levels are not increasing. Table 5 presents a statistical summary of important dissolved constituents found in natural groundwater, which, when present in high concentrations, could render it unfit for human consumption or for agricultural use.

Table 5. Summary of Santa Clara Valley Groundwater Data and Water Quality Objectives

Constituents ^a	Median Conc. Lower Aquifer	95% C.I. ^d Estimate of True Median	Median Conc. Upper Aquifer	95% C.I. ^d Estimate of True Median	Drinking Water Standard	Ag. Objective ^f
Chloride (mg/l)	43	39 – 47	110	92 – 117	500 ^{c,e}	355
Sulfate (mg/l)	46	44 – 49	161	106 – 237	500 ^{c,e}	-
Nitrate (mg/l)	11	9 – 12	0.03	0.002 – 4	45 ^b	30
Dissolved Solids (mg/l)	420	394 – 440	991	733 – 1,210	1,000 ^{c,e}	10,000
Sodium Adsorption Ratio	0.94	0.89 – 1.26	2.14	1.23 – 3.84	-	9
Aluminum (ug/l)	6	3 – 15	54	23 – 97	1,000 ^b	20,000
Arsenic (ug/l)	0.2	0.05 – 1	2	1.2 – 3.7	50 ^b	2,000
Barium (ug/l)	159	129 – 188	92	60 – 220	1,000 ^b	-
Boron (ug/l)	132	115 – 150	340	200 – 523	-	2,000
Cadmium (ug/l)	<1	-	<0.5	-	5 ^b	500
Chromium (ug/l)	1	0.8 – 1.7	1	0.5 – 1.8	50 ^b	1,000
Copper (ug/l)	2.7	2 – 4	0.6	0.3 – 1	1,000 ^b	-
Fluoride (mg/l)	0.12	0.11 – 0.14	0.2	0.15 – 0.3	1.8 ^b	15
Iron (ug/l)	11	6 – 21	115	40 – 160	300 ^c	20,000
Lead (ug/l)	0.6	0.2 – 3	<0.5	-	50 ^b	10,000
Manganese (ug/l)	4	2 – 8	430	120 – 769	50 ^c	10,000
Mercury (ug/l)	<1	-	<0.2	-	2 ^b	-
Nickel (ug/l)	2.3	2 – 3	6.3	4 – 10	100 ^b	2,000
Selenium (ug/l)	1.5	1.2 – 1.9	0.9	0.4 – 2	50 ^b	20
Silver (ug/l)	<1	-	<0.5	-	100 ^b	-
Zinc (ug/l)	4.3	2 – 8	6	3 – 13	500 ^c	10,000

^a For common inorganic water quality constituents

^b Maximum contaminant level as specified in Table 64431-A of Section 64431, Title 22, of the California Code of Regulations

^c Secondary maximum contaminant level as specified in Table 64449-B of Section 64449, Title 22, of the California Code of Regulations

^d 95 percent confidence interval estimate of the true population median

^e Upper limit of secondary drinking-water standard

^f S.F. Regional Board, Water Quality Control Plan for San Francisco Bay Basin, 1995

Total Dissolved Solids. The elevated margins of the basin, also known as the forebay, yield groundwater of relatively low dissolved solids content (200 to 500 mg/l). Calcium and magnesium constitute the principal cations, and bicarbonate is the most prevalent anion. One small area, however, located in the southeastern portion of the basin, produces groundwater of higher dissolved solids content (500 to 750 mg/l), and an increased concentration of the sodium cation. This groundwater chemistry may be associated with sediments that were deposited in a nearly level, poorly drained area. At times in the geologic past, this area was temporarily covered with water and subject to evaporation, which would tend to concentrate mineral salts.

The interior portion of the basin, or lowlands, generally produces water of low dissolved solids content (200 to 500 mg/l), with an ionic composition dominated by calcium and magnesium cations and bicarbonate anions. However, samples drawn from wells near the southern shore of San Francisco Bay

produce water with increased sodium concentrations. This condition results from interactions between the groundwater and clay minerals in the aquifer. Calcium and magnesium dissolved in the groundwater exchange with sodium ions contained in the clays, resulting in a natural water-softening condition.

The northwest portion of the basin underlying the Palo Alto area produces groundwater of relatively high dissolved solids content (900 to 1,000 mg/l). Sodium is the dominant cation, and chloride the dominant anion. This condition may be indicative of estuarine deposition during previous high stands of San Francisco Bay. The Santa Clara Valley Water District (SCVWD) has special well construction requirements for this area to prevent groundwater quality degradation through the aquifer.

Saltwater Intrusion. Some aquifers adjacent to San Francisco Bay, especially the shallower ones, have been affected by saltwater intrusion. A chloride ion concentration of 100 mg/l has been used to define the leading edge of the zone affected. On the basis of this criterion, it is believed that an area encompassing about 18 square miles has been affected (Figure 18). The lower principal water-supply aquifers have only been minimally affected. Groundwater quality in the affected area is quite variable, depending on proximity to San Francisco Bay. In a thin band proximal to San Francisco Bay and salt-evaporation ponds, very high dissolved solid content is noted (3,000 to 4,000 mg/l). Sodium constitutes the principal cation, and chloride the principal anion.

More distant localities, near the leading edge of the affected zone, produce water of mixed ionic composition and a dissolved solid content of about 1,000 mg/l. The sulfate ion in many wells appears to have been enriched upon intrusion by seawater; however, this condition may be coincidental and could be attributed to the application of soil amendments and fertilizers at many now-defunct farming operations.

Nitrate. A relatively small number (18 of 242, or 7 percent) of public water-supply wells in the Santa Clara Valley were reported to have nitrate concentrations greater than California's primary maximum contaminant level (MCL) of 45 mg/l during the period from 1980 to 2000. These wells are located in the western alluvial apron, as shown in Figure 19. Several other wells, some more centrally located in the basin, were reported to contain nitrate in the 10 to 30 mg/l range. While not exceeding the MCL, these levels are much higher than would occur under natural conditions. Identification of nitrate sources is beyond the scope of the SCVWD's monitoring program; however, a special study to investigate these high nitrate concentrations is underway.

Nitrate concentrations in the Coyote Valley are generally elevated, with a median concentration of 25.5 mg/l. The concentrations have not significantly changed over the last 10 years.

Boron. Boron concentrations were generally below 1 mg/l in all areas except the shallow aquifers in the northern portion of the basin. A maximum concentration of 2.1 mg/l was noted in a shallow monitoring well near north San Jose. A boron concentration of 2 mg/l or less is considered suitable for agricultural use. In higher concentrations, it can damage certain crops.

Hardness. Hardness values range from 100 to 870 mg/l as CaCO₃, but typically hardness is high and these waters are classified as hard.

Manganese. A total of 47 wells, all of them located in the Santa Clara Valley, produced water that contained manganese above the drinking-water standard of 50 micrograms per liter (ug/l). Most of these wells are screened in the shallow aquifer zones and have been taken out of regular service or destroyed. As shown in Figure 20, elevated manganese concentrations are most prevalent in the eastern alluvial apron, the northwest portion of the basin, and coincident with those areas that have been affected by saltwater intrusion. Manganese is of concern because in high concentrations, it can cause staining of laundry and household fixtures. Other metallic and nonmetallic compounds, which are considered toxic impurities when present in high concentrations, were generally undetectable or within acceptable limits.

Sodium Adsorption Ratio. Sodium adsorption ratio (SAR), a measure of the likelihood that groundwater would alter drainage characteristics of soil in irrigated areas, was also determined. A maximum ratio of 9.1 was calculated from measurements from a shallow monitoring well in a region of severe saltwater intrusion near San Francisco Bay. This water would not be considered suitable for irrigation based upon this SAR. All other wells for which SAR was calculated produced water of low damage potential and that was considered suitable for irrigation.

Radon. Radon is a radioactive gas produced from the decay of uranium. If it accumulates in high concentrations indoors, it can pose a risk for lung cancer. It enters homes and buildings from nearby soils, rocks, and groundwater supplies. Groundwater supplies are estimated to contribute about 2 percent of the total indoor-air radon concentrations. Recently, EPA proposed a drinking-water MCL of 300 pico-curies per liter (pCi/l) for radon. According to the proposed rule, an alternate MCL (AMCL) of 4,000 pCi/l would be allowed if a state develops an EPA-approved Multimedia Mitigation Program to address other sources of indoor-air radon concentrations.

A survey indicated that about 32 percent of the wells tested contained radon above the proposed MCL of 300 pCi/l. Of community water systems tested, 27 percent contained radon concentrations above the proposed MCL. None of the wells tested exceeded the proposed AMCL. The average concentration was 263 pCi/l, and the maximum concentration was 568 pCi/l.

Volatile Organic Compounds. Volatile organic compounds (VOCs) in groundwater are typically associated with releases from industrial facilities, gasoline stations, and drycleaners. Public water suppliers are required to monitor VOC concentrations in their source waters, including wells. According to Department of Health Services (DHS) database records, since 1984 only two public water supply wells in the Santa Clara Valley Groundwater Basin have had confirmed VOC concentrations above drinking-water standards. One of these wells was destroyed after carbon tetrachloride was detected in concentrations up to 13 ug/l, well above the drinking-water standard of 0.5 ug/l. The other well is still in service. The contaminant found in the second well, trichloroethylene, was only detected above the drinking-water standard of 5 ug/l once, in 1992, and has not been detected since 1994. SCVWD records indicate that three additional wells have had VOC concentrations above drinking-water standards, but they were destroyed in the early 1980s, prior to implementation of the DHS database.

VOC contamination in Santa Clara Valley public water supply wells is not severe. However, VOCs are intermittently detected in wells throughout the basin. There are 259,206 VOC analytical results in the DHS database record for the period between 1984 and 2000, inclusive. Of these 259,206 analyses, VOCs were detected below drinking-water standards in 122 wells a total of 1,590 times. The most commonly detected VOCs are 1,1,1-trichloroethane, dichloromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, tetrachloroethylene, dichlorodifluoromethane, and trihalomethanes. Additional investigation is necessary to identify the causes of these detections and evaluate their long-term impact on groundwater resource sustainability.

4.3 San Mateo Plain Groundwater Basin Water Quality

Very little information is available on groundwater quality in the San Mateo Plain. Killingsworth and Hyde (1932) reported that high saline concentration problems in East Palo Alto started in 1925. They explained that the high saline concentration found in wells there was due to contamination caused by the more than 30 old Spring Valley Water Company wells drilled off Cooley Landing. These wells were drilled in 1904 and showed artesian conditions at that time. As the water levels in the area started to drop, saltwater from San Francisco Bay started to flow down into the wells and contaminated the upper and lower aquifers. These wells were plugged in 1931, and Killingsworth and Hyde (1932) assumed the high saline concentrations in the wells should go down over the years.

Poland and Garrett (1943) mentioned that many wells in the area from San Mateo to Palo Alto had poor water quality, with chloride concentrations up to 2,000 ppm. In the area near the mouth of Redwood Creek, the upper aquifer was contaminated with saltwater, but the water quality in the deep zone (Pleistocene alluvium) was reported as good.

Erler & Kalinowski (1993) reported brackish water in the area close to Willow Road and Bayfront Expressway in Menlo Park. They found conductivity values of up to 2.62 millimhos/cm. This area of high conductivity coincides with the trough-like depression in water level, with groundwater gradient to the southwest following along the line of Willow Road, observed by Killingsworth and Hyde in 1932.

Deep wells drilled in Atherton close to Alameda de las Pulgas are known to contain high saline concentrations. Killingsworth and Hyde (1932) proposed that the high saline concentrations were coming from water derived from the Whisky Hill Formation, which underlies the Santa Clara Formation. They suggested that the problem could be solved if the bottoms of the wells placed into the Whisky Hill Formation were sealed off. Similar observations have recently been made for some wells in Hillsborough. These wells penetrate Franciscan sheared rock and show higher calcium sulfate, TDS, and chloride concentrations.

In East Palo Alto, wells that penetrate the deeper aquifer showed chloride and TDS above secondary MCLs and hardness above 350 ppm. Boron concentrations were below 0.4 ppm, well below the 2 ppm maximum concentration that is considered suitable for agricultural purposes. The iron concentration in these wells was also very high and could be related to well construction materials (steel casings, for example). Manganese concentrations were either not detected or very low.

5.0 MAJOR THREATS TO GROUNDWATER QUALITY

A wide range of pollutants and polluting activities has degraded local groundwater in the South Bay Basins. Some degradation results from historical practices, while other degradation continues today. This section summarizes major threats to groundwater quality. Most threats affect shallow groundwater, and water supply wells are tested regularly to confirm that the water is safe for drinking. Section 6 describes numerous groundwater protection programs in place to address these threats and recommends areas for improvement. Vertical conduits pose a particular threat to water quality because they can provide a migration pathway between shallow contamination and deeper drinking water aquifers. The problems associated with vertical conduits are discussed in more detail in Section 7.

5.1 Fuel Leaks and MTBE

5.1.1 Leaking Underground Storage Tanks (LUSTs)

Leaking underground storage tanks (LUSTs) and the associated release of MTBE account for the largest number of groundwater pollution sites in the South Bay. As of September 2001, there were 947 open LUST sites and 2,109 closed LUST sites in the South Bay Basins (Figure 21 and Table 6). MTBE is scheduled to be banned as a fuel additive in California after December 31, 2003. Thus, while new releases continue to be regularly reported, future releases should become rare after the ban has been fully implemented.

Groundwater contaminants from these LUSTs have had minimal effects on municipal and domestic wells in the South Bay Basins. To date, only one well, located in South San Jose, has been impacted by MTBE, and only at concentrations less than both the primary and secondary MCLs. Three factors appear to account for the fact that few wells have been impacted by MTBE. First, vigorous oversight efforts by the responsible agencies have resulted in aggressive remediation of LUST sites located near drinking water wells. Second, most LUST sites are located in low permeability aquifers where groundwater flow rates are slow. Third, most drinking water wells have long well screen zones and large capture zones, with the result that a shallow MTBE plume would likely be diluted to below-detection levels.

5.1.2 Petroleum Aboveground Tanks (AGTs)

There are 184 aboveground petroleum storage facilities within the South Bay. Releases of petroleum hydrocarbons have been confirmed, and cleanup and abatement of these releases is occurring at six of these facilities. None of the releases has contaminated drinking water wells. Release of MTBE from AGTs is a concern, particularly at terminal facilities where gasoline is stored or where a common pipeline transfers products including gasoline and fuel additives.

5.2 Solvent Plumes

The Groundwater Committee spent considerable time and effort evaluating the status of solvent plume cleanups. Nearly 200 groundwater solvent plumes exist in the South Bay. Santa Clara County alone has more than 100 solvent plumes and the largest number of federal Superfund sites of any county in the United States. Intermittent trace levels of volatile organic compounds (VOCs) have been detected in public water supply wells. However, only four wells have had consistent detections above drinking water standards, and these wells have been destroyed.

In the South Bay, solvent plumes can be grouped into two main categories. First, there are large sources, which are generally related to underground solvent storage tank leaks from semiconductor manufacturing and chemical processing sites. These sites have resulted in moderate to large plumes averaging about 1,500 feet long, with five exceeding one mile in length. Most regulatory efforts are focused on these sites. Many of these sites have commingled plumes, which complicate investigation and cleanup due to

concerns about allocation of responsibility. Section 7.3 of this report discusses the current cleanup status of 72 South Bay solvent plumes.

Second, there are small to moderate sources, which are primarily associated with drycleaners, leaking sewer lines, or surface spills. In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances resulted in impacts to groundwater. Drycleaning equipment made prior to 1986 commonly used the gravity separation method, in which wastewater was separated from the heavier PCE and then discharged into the sewer system. Although local sewer districts permitted these releases in most cases, pipe leakage of dissolved and pure-phase solvents from this potentially persistent source could have resulted in soil and groundwater contamination. This groundwater pollution pathway has been observed at numerous drycleaner sites in the Central Valley and is well documented. Investigation and cleanup of drycleaner sites has not been a major focus of the S.F. Regional Board. Section 7.2 of this report discusses the potential for groundwater contamination from solvents discharged to leaking sewer lines.

Almost all the known solvent leaks related to the semiconductor manufacturing industry and associated solvent chemical suppliers are under control. However, as discussed in Sections 7.2 and 7.3, solvent plumes associated with drycleaners and leaking sanitary sewers have not been adequately addressed under existing groundwater protection programs.

A major work product is the compilation of a regional solvent plume map (Figures 22 and 23) based on a pilot project in which solvent plume data was reported electronically.

An emerging issue at solvent cleanup sites is the presence of solvent stabilizers, such as 1,4-dioxane. Solvent stabilizers have thus far received little attention from a regulatory perspective. However, the recent detection of 1,4-dioxane at several South Bay sites, which were thought to be fully characterized, indicates that monitoring solvent stabilizers in groundwater and in discharges of treated extracted groundwater should become a standard requirement at solvent cleanup sites to determine whether stabilizers are present. For sites where the solvent stabilizer plume is larger than the primary solvent plume, additional cleanup may be required.

5.3 Leaking Sewer Lines

The potential for exfiltration of solvents from sewer lines exists and may pose a significant threat to groundwater quality in the South Bay (see Section 7.2). The limited scope of this evaluation has not revealed direct evidence of any known releases or imminent threats to groundwater quality specifically resulting from sewer exfiltration. However, VOC groundwater contamination occurs in locations where no obvious source can be found, except for nearby sewer lines. In locations such as Gilroy, Santa Rosa, Merced, Modesto, Davis, and Stockton, it is believed that sewer lines have played a major role in conveying and releasing solvents to groundwater, particularly when historic drycleaners, which may have discharged solvents to sewer lines, were located nearby (Izzo, 1991).

The potential impacts from solvent leakage from sewer lines, whether historic or ongoing, are probably small compared to the numerous solvent plumes emanating from tanks, sumps, and spills. Nonetheless, where solvents are discovered in groundwater without an obvious source, investigators should take note of nearby historic and existing sewer lines, as they may be the source.

5.4 Nitrates

Historically in the Niles Cone, nitrate levels were detected above California's primary maximum contaminant level (MCL) of 45 mg/l southwest of Union City and south of the Niles district of Fremont. In 1997, however, the range of nitrates in all ACWD's groundwater production wells was between 0.1 and 24.8 mg/l, with an average of 7.7 mg/l, well below the MCL.

Nitrates have exceeded drinking water standards in a small number (18 of 242, or 7 percent) of public water supply wells in the Santa Clara Valley. Most of these wells are located in the western alluvial apron. One well is located in San Jose, and two wells are located in Morgan Hill, at the southern boundary of the Coyote Sub-basin. Since 1996, nitrate in excess of the drinking water standard has only been detected in one well. The median concentration of nitrate in the lower aquifer zone of the Santa Clara Valley is about 11 mg/L nitrate measured as nitrate.

Little information is available for nitrates in the San Mateo Plain. From the few water samples collected in Hillsborough, San Mateo, Menlo Park and East Palo Alto in 2000 and 2001 none of the samples showed nitrate concentrations of concern or that would require ongoing monitoring. Nitrate concentrations in all analyzed wells ranged from non-detect to 45 percent of the MCL. The lowest concentrations were found in East Palo Alto and the highest in San Mateo.

5.5 Emerging Contaminants

Emerging contaminants, including N-nitrosodimethylamine (NDMA), endocrine disruptors, and pharmaceutically active compounds, may be present in sanitary wastewater, recycled water, imported water, and any other water source that receives sanitary wastewater. Emerging contaminants may pose a threat to groundwater quality when such waters are used for artificial recharge or otherwise intentionally infiltrated. Studies are underway around the world to better understand the occurrence, fate and transport, and health effects of emerging contaminants. SCVWD studies that are either underway or planned include analyzing imported surface water, local surface water, recycled water, and groundwater for emerging contaminants; evaluating the impact of artificial recharge on groundwater quality; studying the fate and transport of NDMA in recycled water; and evaluating potential impacts of streamflow augmentation with recycled water on groundwater quality and stream ecological health.

5.6 Other Pollutants of Concern

Beyond the major chemical threats to South Bay groundwater quality discussed above, there are several other pollutants that have been released at a small number of toxic sites. These pollutants include arsenic, PCBs, hexavalent chromium, and perchlorate. Hexavalent chromium has received increased media and public attention following the recent DHS announcement of a public health goal of 2.5 ug/l for total chromium. An inventory of S.F. Regional Board sites shows that only one chromium contamination site is located in the South Bay Basins. Arsenic and hexavalent chromium have been detected in public drinking water wells at concentrations below drinking water standards. They are believed to be associated with natural sources.

5.7 Saltwater Intrusion

Saltwater from San Francisco Bay and adjacent salt ponds has intruded freshwater-bearing aquifers in all three South Bay Basins. In the Niles Cone Basin, historical overpumping caused saltwater intrusion to extend almost to the Hayward Fault, approximately five miles east of the San Francisco Bay shoreline. Saline water appears to be entering the Newark Aquifer through natural gaps in the overlying aquitards and along abandoned or unsealed wells. Sources of saltwater intrusion are San Francisco Bay and a large system of salt ponds that operates above the groundwater basin. The salt pond system is still in operation today and appears to be a current threat to the basin's water quality.

In the Santa Clara Valley Basin, some aquifers (especially the shallower ones) adjacent to San Francisco Bay have been affected by saltwater intrusion due to historical subsidence. Subsidence has increased the distance that San Francisco Bay water migrated upstream in creeks during high tide and has recharged adjacent shallow aquifers with brackish water. Using a chloride ion concentration of 100 mg/l, it is believed that an area encompassing about 18 square miles has been affected. Groundwater quality in the

affected area is quite variable depending on proximity to San Francisco Bay. In a thin band proximal to San Francisco Bay and salt evaporation ponds, very high dissolved solid content is noted (3,000 to 4,000 mg/L). The lower, principal water supply aquifers have been only minimally affected.

There is no ongoing monitoring program in the San Mateo Plain and, therefore, there is minimal data on the extent of saltwater intrusion. A groundwater study conducted at the Raychem facility in Menlo Park, indicates that brackish (total dissolved solids > 10,000 mg/L) to hypersaline (total dissolved solids > 25,000 mg/L) conditions predominate in the shallow aquifers in the area of and immediately adjacent to salt evaporators. Hypersaline conditions can, locally, be found up to 1,000 feet inland from the salt evaporators (Hydrofocus, 2002). Nevertheless, the conditions in the deep aquifers are, overall, unknown. Chloride:bromide and chloride:boron ratios for water samples collected from wells screened in the deep aquifers and located close to the bay in East Palo Alto are substantially lower than those of sea water. However, there have been reports that saltwater from San Francisco Bay has migrated into deeper aquifers as a result of piles being driven into the subsurface for construction of the Dumbarton Bridge. Furthermore, a U.S. Geological Survey study in the Atherton area (Metzger and Fio, 1997), where more than one hundred residential wells were installed during the 1987-1992 drought, found slightly saline groundwater near San Francisco Bay. However, these levels were not directly linked to over-pumping in Atherton.

5.8 Municipal Landfills

There are a total of nine (9) active and twenty-two (22) closed S.F. Regional Board-regulated landfills in the South Bay (see Figure 24). These landfills generally contain municipal solid waste. Other types of waste that may be discharged to some municipal landfills include construction and demolition debris, household hazardous waste, treated medical waste, petroleum-impacted soil, and biosolids. These wastes pose a threat to water quality because they can leach pollutants upon contact with water and other residual landfill liquids. Furthermore, municipal landfills can cause erosion and sedimentation damage to streams if surface water runoff is not managed properly, and must therefore operate under the SWRCB's general industrial stormwater permit. Landfills operate under S.F. Regional Board-issued permits, known as waste discharge requirements, that require control and containment systems, monitoring, and interim and final landfill covers (see Section 6.1.8).

None of the South Bay landfills is known to have contaminated drinking water wells. However, several have leaked and have been required to install groundwater or leachate extraction systems to control the leakage. For example, two active landfills (Guadalupe and Kirby Canyon), which are located upstream of recharge facilities in the Santa Clara Valley, have leaked in the past. As a result, both sites installed groundwater collection trenches to intercept pollutants and protect downstream beneficial uses. Neither site caused any off-site impacts. Current monitoring data indicates that the leaks have stopped.

6.0 GROUNDWATER PROTECTION PROGRAMS

The regulatory structure for groundwater protection is fairly complicated and has been characterized by overlapping authority, limited budgets, and differing priorities. Numerous federal, state, and local entities are implementing groundwater protection programs in the South Bay Basins. This section inventories these programs and the agencies that implement them, provides a qualitative summary of their effectiveness, and identifies areas for improvement. Groundwater protection programs described in this report are summarized by 1) water quality threat and 2) regulatory agency implementing the program. In addition, information management systems for each program and statewide initiatives are described in this section.

Groundwater protection programs generally have one of two aims:

1. To protect an aquifer from contamination (i.e., pollution prevention)
2. To remediate impacts that have already occurred, referred to as groundwater cleanup programs

Some programs focus only on pollution prevention (e.g., the Source Water Assessment Protection Program and state and local well-permitting standards). Other programs focus only on groundwater cleanup (e.g., Superfund or Spills, Leaks, Investigation, and Cleanup [SLIC]). In some cases, programs may address both protection and cleanup (e.g., California's Leaking Underground Fuel Tanks Program and the U.S. Environmental Protection Agency's Resource Conservation Recovery Act Program). Table 7 summarizes the various groundwater protection programs reviewed in this project. Groundwater protection programs are further described in Appendix D.

6.1 Groundwater Protection Programs by Threat to Groundwater Quality

6.1.1 Fuel Leaks and MTBE

Leaking Underground Storage Tanks (LUSTs)

The State Water Resources Control Board's (SWRCB's) LUST Cleanup Program manages oversight of these sites. This unique program gives local agencies independent authority to require and oversee investigation and cleanup of LUST sites. The S.F. Regional Board retains its Water Code authority to approve case closure.

Within the South Bay, four agencies oversee LUST cleanup: the S.F. Regional Board, the San Mateo County Environmental Health Services Division (SMCEHSD), the Santa Clara Valley Water District (SCVWD), and the Alameda County Water District (ACWD). Their oversight is driven by the SWRCB's March 2000 "Guidelines for Investigation and Cleanup of MTBE and Other Ether-Based Oxygenates," prepared in response to Executive Order D-5-99 and Senate Bill 989 (Sher, Chapter 812, Statutes of 1999). The local agencies have developed additional requirements that supplement the SWRCB's guidelines.

This prioritization strategy is one of the most advanced aspects of the MTBE guidelines relative to other protection programs (Figure 21). Using conservative assumptions, the SWRCB developed a prioritization strategy based on distance to drinking water wells. Based on this strategy, there are 98 high-priority (Class A) and 280 medium-priority (Class B) sites in the South Bay Basins. All Class A and Class B priority sites have completed an investigation. Further, all Class A and approximately 50 percent of Class B sites have implemented corrective actions. None of the groundwater protection programs, other than LUST, contain prioritization and ranking strategies.

Groundwater extraction is a typical remedy for all Class A plumes, or where the plume is migrating. A total of 208 South Bay LUST sites have implemented groundwater extraction, consisting of 52 in Niles Cone, 101 in Santa Clara Valley, and 56 in the San Mateo Plain.

Table 6. Inventory of South Bay SLIC and LUST Sites as of September 2001

	Santa Clara Valley	Niles Cone	San Mateo Plain	Total
Open SLIC Sites	491	61	66	618
Closed SLIC Sites	210	38	5	253
Percent Closed	42%	38%	7%	29%
Open LUST Sites	543	164	240	947
Closed LUST Sites	1599	156	351	2109
Percent Closed	75%	49%	59%	69%
Open LUST Sites w/ MTBE *	292	113	82	487
Open LUST Sites w/MTBE and Remediation Underway *	283	107	69	459
Percent w/ Remediation Underway*	97%	95%	84%	94%

*High-threat sites only

Several new initiatives and programs currently underway directly affect the South Bay Basins. These programs have come about as the LUST Cleanup Program has matured, evolving from an approach of individual case management to one of identifying high-risk sites and marshalling each regulatory agency's efforts to see how they can best protect the South Bay's groundwater resource. The most significant of these programs are described below.

Geographic Information System (GIS) Integration. The use of a geographic information system (GIS) is a major element of implementing the state's MTBE guidelines. The existing GeoTracker (<http://geotracker.swrcb.ca.gov/>) provides a Web-based tool that the public and local agencies can use to conduct case-by-case review of information about LUSTs and drinking water wells. GeoTracker is currently undergoing pilot testing in Central California. Routine updating of GeoTracker is expected to begin in late 2001 within the S.F Bay Region, including the South Bay Basins.

Reopening Closed Sites. Many LUST sites that were closed before 1998 were not analyzed for MTBE because MTBE was not understood to be a chemical of concern until the mid-1990s. These sites are now being reexamined to determine whether they were inappropriately closed. The concern is that MTBE may be present at a subset of these sites.

Monitoring Active Service Stations. The S.F. Regional Board has instituted a pilot test with the SCVWD to perform environmental monitoring at operating service stations that are not currently in the LUST Cleanup Program. SCVWD investigations indicate that undetected MTBE releases are occurring at currently upgraded operating LUST facilities. The trend of undetected releases was found to be consistent across a larger spectrum of 50 sites. Previous studies and the preliminary results of the Pilot Program indicate that undetected MTBE releases from operating and upgraded LUST facilities are a greater threat to groundwater resources than earlier believed. Preliminary results from the pilot program based upon investigation at 30 active stations indicate that more than 40 percent have concentrations significant enough to threaten groundwater quality such that additional investigation and cleanup are necessary.

The methods employed for dealing with petroleum releases over the past decade will not suffice for MTBE. Unlike traditional petroleum constituents, such as benzene, MTBE moves quickly to pollute

water and is slow to degrade in the subsurface environment. Therefore, for MTBE, a quick response time is critical, greatly increasing the ability to check MTBE's spread and clean up the release mass. Accordingly, regulators must prioritize their sites and give first attention to those that pose the greatest risk to groundwater.

Petroleum Aboveground Tanks (AGTs)

The Aboveground Petroleum Storage Act (APSA) provides the regulatory basis for the Aboveground Tank (AGT) Program, which was enacted in 1990 in response to petroleum spills and releases from aboveground tanks and associated piping. APSA was enacted in direct response to the 1988 spill of 400,000 gallons from the Shell Oil Refinery in Martinez. The program's goal is to protect vegetation, wildlife, surface water, human health, and groundwater from the damaging effects of petroleum releases by ensuring safe operation of aboveground petroleum storage facilities. The program applies to aboveground storage tanks and containers with a cumulative capacity greater than 1,320 gallons.

Covered facilities are subject to S.F. Regional Board inspection. Facilities must file "Storage Statements" with the state every two years. Releases from petroleum AGTs are investigated by the S.F. Regional Board under authority of APSA and the Water Code. The S.F. Regional Board maintains internal lists of aboveground tanks, but this list is not available online. Site-specific information and water quality data for petroleum AGT release sites are not maintained in any database. The AGT Program Web site is at: http://www.swrcb.ca.gov/rwqcb2/Aboveground_Tanks/aboveground_tanks.html.

6.1.2 Solvent Plumes

In contrast to the single unified and coordinated program that regulates LUST sites, solvent plumes are regulated by three different agencies, with each agency overseeing sites under different regulatory programs. There is little coordination among the three agency programs.

SWRCB's Spills, Leaks, Investigations, and Cleanup (SLIC) Program. The SWRCB and the Regional Boards use the term "SLIC Program" to define those sites with groundwater polluted by chemicals other than petroleum hydrocarbon fuels. In the South Bay, most SLIC sites are solvent plumes. A smaller number are contaminated with PCBs, metals, and pesticides.

The SLIC Program involves the S.F. Regional Board and some local agencies that have elected to participate, including the ACWD and the SMCEHSD. The SLIC Program encompasses all unauthorized releases of pollutants to soil and groundwater that are not regulated by other programs, such as LUST. Board policy for the SLIC Program can be found in SWRCB Resolution 92-49 and in the S.F. Regional Board's Basin Plan. There are no implementing regulations.

Relevant Web site addresses include:

- S.F. Regional Board Groundwater Policy
- <http://www.swrcb.ca.gov/rwqcb2/gdwtrdef/gdwtrdef.htm>
- SLIC staff contacts at the S.F. Regional Board
<http://www.swrcb.ca.gov/rwqcb2/gdwtrdef/SLICPage97/slicpage97.htm>

There are 618 open and 253 closed SLIC sites in the South Bay Basins. As discussed above, not all SLIC sites are solvent plumes. However, the majority of South Bay SLIC sites are associated with solvent releases. The S.F. Regional Board maintains a database of SLIC sites that is available online at <http://www.swrcb.ca.gov/rwqcb2>. This database is not regularly updated, however, and data is on average eight years old. Notable South Bay SLIC sites include FMC (Newark), Ashland Chemical (Newark), Hewlett-Packard (Mountain View), Velcon Filters (San Jose), Mohawk Labs (Sunnyvale), and the Purex

site (Belmont). The S.F. Regional Board has required active groundwater remediation at most significant SLIC sites.

S.F. Regional Board's Multi-site Cooperative Agreement (MSCA). Since 1987, the S.F. Regional Board has managed the investigation and development of cleanup plans for 21 U.S. Environmental Protection Agency (EPA) Superfund sites in the Santa Clara Valley. Under MSCA, the S.F. Regional Board agreed to regulate the sites according to federal Superfund procedures, as well as appropriate California laws and regulations. In exchange, EPA would use the state Remedial Action Plan as part of the federal record of decision under CERCLA, or Superfund. All 21 sites have had final records of decisions in place for at least five years.

Department of Toxic Substances Control (DTSC). The DTSC is responsible for regulating hazardous waste facilities and overseeing the cleanup of hazardous waste sites. It is also responsible for investigating and cleaning up, or overseeing the investigation and cleanup of, properties contaminated by the release of toxic substances. DTSC can issue imminent and/or substantial endangerment orders to force owners to investigate and remediate contamination on their property, or it can negotiate consent agreements. In many cases, such as when property owners wish to clean up sites for redevelopment, DTSC will enter into a voluntary cleanup agreement with the owner of the site or development proponent to conduct investigation and remedial activities. Other voluntary mechanisms for DTSC oversight of remedial actions are also available, such as prospective purchaser agreements, the new brownfields loan program, and the expedited removal action program.

For sites where there has been a release of hazardous substances to soil, and this represents a threat to public health but not to groundwater, DTSC is typically the lead regulatory agency. At sites where soil and groundwater and/or surface waters are contaminated, or where there is a significant threat of water contamination, DTSC and the S.F. Regional Board have separate but overlapping regulatory authority. In the past, for South Bay sites, overlapping regulatory oversight has been minimal. Notable South Bay solvent sites regulated by DTSC are the Hillview Porter site in Palo Alto and the Mansion Grove site in Santa Clara.

DTSC maintains the CALSITES database, which lists all sites known or suspected to have had releases of hazardous substances. For the South Bay, approximately 350 sites are listed (Figure 25), of which approximately 31 are being investigated, remediated, or monitored. Thirty-five have been closed. The remaining sites have been referred to other agencies. This list is not available online. Files on each site, identified by address or business name, can be reviewed by appointment at the DTSC regional office in Berkeley.

EPA's Superfund Program. EPA is the lead agency for 11 sites in the South Bay, all in the Santa Clara Valley, under the federal Superfund program (Figure 25). EPA's involvement has typically been in cases where the S.F. Regional Board or DTSC needed assistance because of one of the following factors: federal funds were needed for cleanup, responsible parties were not cooperative, or sites were complex with multiple responsible parties. Notable EPA-lead sites include Lorentz Barrel & Drum and the Middlefield-Ellis-Whiseman (MEW) site.

Moffett Field Naval Air Station is a closing military base and EPA is the lead agency for environmental restoration. Based on 2001 data, Moffett Field has 96 Active LUSTs, 13 Closed LUSTs, 27 MTBE sites, 1 solvent plume, 2 groundwater pump and treat systems, and 3 former landfills.

6.1.3 Leaking Sewer Lines

There are no specific programs that cover leaking sewer lines. However, wastewater treatment plants set limits on the levels of pollutants that can be discharged to sanitary sewers. Meeting specific discharge

limits can protect groundwater in the event of sewer line leaks. Section 7.2 of this report discusses this problem in more detail and includes recommendations for better understanding the issues.

6.1.4 Nitrates

The SCVWD is working with local farmers and land owners by conducting outreach and education on reducing nitrate loading. Nitrate is not a current groundwater problem in the Niles Cone. In the San Mateo Plain, it is not known if nitrate is a significant issue.

6.1.5 Emerging Contaminants

The SCVWD, in addition to performing the studies listed above, is developing a water quality standard for intentional infiltration with recycled water, imported water, local surface water, and storm water runoff. The SCVWD is also evaluating if and to what extent recycled water needs to be treated to meet groundwater protection concerns and users needs for different uses. The water quality standard and the treatment requirements evaluation will address emerging contaminants, as well as more traditional contaminants like salts and nitrate.

6.1.6 Saltwater Intrusion

The SCVWD and the ACWD oversee saltwater intrusion problems in the Santa Clara Valley and the Niles Cone, respectively. There is no formal oversight program in the San Mateo Plain, although the SMCEHSD is participating in a basin-wide monitoring program in the Westside Basin to the north of the San Mateo Plain. The S.F. Regional Board has authority to enforce against current pumping that degrades aquifers due to saltwater intrusion, but rarely exerts such powers.

ACWD. Since 1962, the ACWD has used imported surface water supplies to supplement local recharge and raise groundwater levels. This has brought the water table above sea level as of 1972 and returned the hydraulic gradient to its natural bayward direction in the Newark Aquifer. Although there has been substantial improvement in the basin, a considerable volume of saline water still remains in the aquifers. Current programs in place to restore and monitor the saltwater-contaminated aquifers are:

- **Expanded Artificial Recharge Program.** ACWD utilizes sections of the Alameda Creek Flood Control Channel behind three inflatable rubber dams and recharge ponds (abandoned quarry pits) to store and percolate water into the aquifers of the Niles Cone. The artificial recharge program serves two major roles: (1) replenishment of groundwater extracted as part of the Aquifer Reclamation Program and (2) maintenance of groundwater flow toward San Francisco Bay, in order to prevent future saline water intrusion from the bay and to displace brackish water remaining from historic saline water intrusion. A major portion of the recharge ponds below (i.e., west of) the Hayward Fault were rehabilitated in 1997 and 1998, resulting in greater surface water storage capacity within the ponds and increasing the rate at which water can be recharged to replace water pumped from the groundwater basin.
- **Aquifer Reclamation Program.** ACWD pumps entrapped saltwater from degraded portions of aquifers in the Niles Cone in order to increase usable basin storage, to improve overall water quality, and to prevent the movement of saltwater toward production wells. Pumped water from a combination of nine Aquifer Reclamation Program wells is discharged to flood control channels which flow into San Francisco Bay in accordance with a NPDES permit issued by the Regional Board. Operation of this program depends on the annual availability of water supplies to replace the water that is pumped out of the aquifers. A desalination facility, which will use reverse osmosis to convert brackish groundwater to freshwater, is scheduled to begin producing 5.5 million gallons per day of potable water in the Spring of 2003.

- **Basin Monitoring Program.** ACWD performs weekly water level measurements of representative wells in each major aquifer to monitor changes in groundwater levels. A more comprehensive monitoring program consisting of measuring and sampling water levels is performed in the spring and fall of each year to assess the extent of brackish groundwater and to determine the direction of groundwater flow. Water levels were measured in 235 wells and water samples were collected for chloride, total dissolved solids, and hardness analyses from 136 wells during the Fall 2001 program. ACWD annually produces a Groundwater Monitoring Report to document the results of the spring and fall monitoring programs. In order to maintain an adequate network of monitoring wells for this program, ACWD has constructed 52 monitoring wells since 1995 to replace privately owned wells utilized in the past that have been destroyed due to development.

SCVWD. Since the early 1960's, the SCVWD has used imported water to supplement local recharge, raise groundwater levels, and curb subsidence. In addition, from 1980 through 1984, the SCVWD completed a comprehensive effort aimed at locating and destroying wells fronting San Francisco Bay that were thought to allow seawater to invade deeper freshwater aquifers. Of the 39 potential conduit wells identified, 10 were not located and were presumed destroyed without a permit. The remaining wells were all properly destroyed. The SCVWD continues to monitor the extent and severity of saltwater intrusion. The current saltwater intrusion monitoring program consists of 21 monitoring wells that are sampled quarterly.

6.1.7 Other Pollutants of Concern

In the South Bay, there are about 25 regulated groundwater cleanup sites with arsenic, PCBs, hexavalent chromium, or perchlorate. These sites are regulated under a mix of the programs listed in Section 6.1.2. Notable examples of these sites are United Technologies (San Jose), Rohne Poulenc (East Palo Alto), and Westinghouse (Sunnyvale). No comprehensive, cross-agency list of these sites exists.

6.1.8 Municipal Landfills

In California, municipal landfills are regulated jointly by the SWRCB and the California Integrated Waste Management Board (CIWMB). In general, the SWRCB takes responsibility for water-quality protection and cleanup, while the CIWMB takes responsibility for public health and day-to-day landfill operations. Implementing regulations are found in the California Code of Regulations, Division 2, Title 27.

Title 27 regulations establish a classification system for landfills and include requirements for siting, construction, operation, monitoring, cleanup, and closure. Title 27 regulations are equivalent to the federal municipal solid waste requirements known as "Subtitle D" (Subpart 257 and 258, Title 40, Code of Federal Regulations). Subtitle D establishes minimum standards for design, operation, location, closure, and post-closure at public and private landfills. S.F. Regional Board permits for municipal landfills are called waste discharge requirements (WDRs) and may be issued to active, inactive, public, or private landfills, depending on the severity of the threat to water quality. WDRs typically require control and containment systems, monitoring programs for surface water, groundwater, and leachate, and interim and final covers.

The S.F. Regional Board maintains internal lists of regulated closed and active landfills, but this list is not available online. Site-specific information and water quality data are not currently maintained in any database, however, the California Integrated Waste Management Board has recently initiated compilation of a Landfill Facility Compliance Study database. Local enforcement agencies maintain lists of smaller, closed landfills that are not regulated by the S.F. Regional Board.

6.2 Groundwater Protection Programs by Regulatory Agency

Tables 7 and 8 summarize groundwater protection and cleanup programs for the various regulatory agencies in the South Bay.

6.2.1 State and Federal Programs

A summary of the various state and federal groundwater programs is presented in Table 7. California is unique in the nation in its multi-agency approach to groundwater protection. Responsibility for groundwater protection is shared among local agencies, the California State and Regional Water Boards, Department of Water Resources (DWR), and Department of Health Services (DHS). Information sharing is hindered because each agency has historically used a unique database. Furthermore, groundwater protection, from a pollution prevention standpoint, has been a low priority. Indeed, California has just begun development of a wellhead protection program nearly 15 years after the federal Clean Water Act required such a program. High-priority groundwater protection programs have generally been focused on addressing problems that have already occurred (e.g., state Superfund Program, Leaking Underground Fuel Tank Program, Solid Waste Assessment Test, MTBE Program). State and federal programs are described in Appendices D and E.

6.2.2 Local Programs

In the South Bay, the Alameda County Water District (ACWD), the Santa Clara Valley Water District (SCVWD), and the San Mateo County Environmental Health Services Division (SMCEHSD) take an active role in groundwater protection, tailoring programs to meet the needs of local residents. Local programs are discussed briefly below and summarized in Table 9, and described in more detail in Appendix E.

Alameda County Water District (ACWD)

The ACWD serves as both the wholesale and retail water supplier to the cities of Newark, Fremont, and Union City located within the Niles Cone Basin. The ACWD has several sources of water supply, including water purchased from the State Water Project (via the South Bay Aqueduct) and the San Francisco Public Utilities Commission (via the Hetch Hetchy aqueduct system). Groundwater remains an important component of its supply, currently furnishing 35 percent of the water the ACWD distributes. In dry years, groundwater has contributed more than 60 percent of the supply.

The ACWD takes an aggressive role in ensuring protection of the groundwater basin. It helps regulatory agencies and industry by identifying sources of potential groundwater contamination, implementing monitoring systems at hazardous materials storage sites, and providing technical oversight for the investigation and cleanup operations at Leaking Underground Fuel Tank (LUFT) and Spills, Leaks, Investigation, and Cleanup (SLIC) sites. Other groundwater protection programs include: Well Permitting Program, Well Records, Well Destruction Program, Weekly Groundwater Monitoring Program, Spring/Fall Groundwater Monitoring Program, Monitoring Well Construction Project, Aquifer Reclamation Program, Wellhead Protection Program, and the American Water Works Association Research Foundation Project.

The ACWD can be contacted via its Web site: <http://www.acwd.org>, or by phone: (510) 659-1970. For more information on the ACWD's programs, see Appendix E of this report.

Table 7. Summary of Groundwater Protection Programs in the South Bay Basins

Program¹	Agency¹	Pollution Prevention Component	Groundwater Cleanup Component
CERCLA/ Superfund	EPA, S.F. Regional Board, DTSC	None	Focuses on cleanup of highest-risk sites
RCRA	EPA, DTSC	Storage requirements for hazardous chemicals and wastes	Sets investigation and cleanup requirements in the event of a release at a RCRA site
SLIC	S.F. Regional Board and some local agencies	None	Focuses on investigation and cleanup of sites not covered in the federal Superfund or leaking LUST program
LUST	S.F. Regional Board and some local agencies	Storage requirements for fuel hydrocarbons	Sets investigation and cleanup requirements in the event of a fuel release
DWSAP	DHS and some local agencies	Development of a wellhead protection program for all public water supply wells	None
Landfills (CCR Title 27)	EPA, S.F. Regional Board, CIWMB, and some local agencies	Sets standards for the design and operation of municipal solid-waste landfills and nonhazardous liquid waste impoundments	Establishes requirements for cleanup in the event of a release
AGT	S.F. Regional Board and Certified Unified Program Agencies	Requires registration, development of a release detection program, and Spill Prevention, Control, and Countermeasure Plans	Requires investigation and cleanup in the event of a release
Well Standards	DWR and some local agencies	Sets uniform minimum well construction and destruction standards to prevent cross-contamination of aquifers	None
Well Destruction Programs	Some local agencies	Identification and sealing of improperly constructed or abandoned wells	None
Ambient Groundwater Monitoring	DWR and some local agencies	Periodic monitoring of aquifers to assess general water quality unrelated to a specific pollution source, e.g., saltwater intrusion, nitrates, etc.	None
Certified Unified Program Agencies	See below for agencies ²	Permit and inspect underground tank installations, aboveground tank installations, and hazardous-materials storage; may require groundwater monitoring of regulated facilities	Refers leaking LUSTs and AGTs to Regional Boards and/or local agencies

¹Programs/Agencies

AGT (Aboveground Tank)

CERCLA/Superfund (Comprehensive Environmental Response, Compensation, and Liability Act)

CIWMB (California Integrated Waste Management Board)

DHS (Department of Health Services)

DTSC (Department of Toxic Substances Control)

DWSAP (Drinking Water Source Assessment and Protection Program)

LUST (Leaking Underground Fuel Tanks)

RCRA (Resource Conservation and Recovery Act)

S.F. Regional Board (San Francisco Bay Regional Water Quality Control Board)

SLIC (Spills, Leaks, Investigation, and Cleanup)

EPA (U.S. Environmental Protection Agency)

² Certified Unified Program Agencies (CUPAs) in the South Bay are Fremont Fire Department, Newark Fire Department, City of Union City Environmental Programs Division, San Mateo County Environmental Health Department, Santa Clara County Hazardous Materials Compliance Division, Santa Clara County Central Fire Protection District (Campbell, Cupertino, Los Gatos, Morgan Hill), Milpitas Fire Department, Mountain View Fire Department, Palo Alto Fire Department, San Jose Fire Department, Santa Clara Fire Department, and Sunnyvale Department of Public Safety

Table 8. Summary of Groundwater Cleanup Regulatory Agencies in the South Bay Basins

Agency	Types of Groundwater Pollution Sites Regulated	Number of Active Sites in South Bay	Number of Closed Sites in South Bay Basins
EPA	Superfund sites, DoD sites/emergency response	11	0
DTSC	VOCs, metals, RCRA, state lead for DoD sites	8 preliminary assessments 16 voluntary cleanup programs 7 annual workplan sites	35 closed
S.F. Regional Board	VOCs, metals, coordinates LUST Program, landfills, consults on DoD sites	947 open LUST ² 618 open SLIC 6 active landfills 18 MSCA sites	2,109 closed LUST 253 closed SLIC 24 closed landfills All 18 MSCA sites have reached records of decisions
Alameda County Water District	Non-local Oversight Program for Fuels, also active in SLIC sites	164 active LUST 61 active SLIC (49 ACWD lead)	159 closed LUST 38 closed SLIC
Santa Clara Valley Water District	Local Oversight Program for Fuels	546 active LUST	1,556 closed LUST
San Mateo County Environmental Health Services Division	Local Oversight Program for Fuels, also active in SLIC sites	240 active LUST 66 active SLIC	351 closed LUST 5 closed SLIC

¹From CalSites database

²Includes non-S.F. Regional Board sites

Groundwater protection programs are described in detail in Appendix D

Santa Clara Valley Water District (SCVWD)

The SCVWD provides wholesale water supply and flood management for all of Santa Clara County. This responsibility includes managing the Santa Clara Valley Groundwater Basin for quality and quantity. In a typical year, groundwater provides nearly half the water used in the county, and the SCVWD relies on the groundwater basin to meet water supply needs in dry years. Thus, groundwater protection and conservation continue to be high-priority programs for the SCVWD.

The SCVWD takes an aggressive role in working with local cities and the county to identify and locate sources of contamination; evaluate potential and existing threats to groundwater quality; and implement programs to protect and enhance groundwater quality. Specific SCVWD groundwater protection programs include: Well Ordinance Program, Dry Well Program, Abandoned Well Destruction Assistance Program, Leaking Underground Storage Tank Oversight Program, Solvents and Toxic Cleanup Liaison Program, Saltwater Intrusion Prevention Program, Saltwater Intrusion Monitoring Program, Groundwater Quality and Depth-to-Water Monitoring Program, Nitrate Management Program, and Land Use and Development Review Program.

The SCVWD can be contacted via its Web site: <http://www.scvwd.dst.ca.us>, or by phone: (408) 265-2600. For more information on the SCVWD's programs, see Appendix E of this report.

San Mateo County Environmental Health Services Division (SMCEHSD)

Unlike the ACWD and the SCVWD, the SMCEHSD is not a water district. However, it is the regulatory authority for permitting all environmental health programs within the county, including small water systems, septic systems, water wells, underground storage tanks, contaminant site remediation, hazardous waste generators, hazardous material business plans, stormwater discharge compliance, and solid waste. All these programs involve some component of protection of surface or groundwater resources.

The SMCEHSD has no formal authority for groundwater management within San Mateo County, but does protect groundwater resources through various programs as outlined above. The SMCEHSD groundwater protection program (remedial oversight), under a contract with the State Water Resources Control Board (SWRCB), is the Local Oversight Program (LOP) providing regulatory oversight for the investigation and remediation of leaking underground storage tank sites. Groundwater protection program (GPP) staff also oversees SLIC and other soil- or groundwater-impacted sites based on verbal agreements with the S.F. Regional Board and Department of Toxic Substances Control (DTSC).

The SMCEHSD Land Use Program is the permitting element for both installation and destruction of all agricultural, domestic, water supply, and cathodic protection wells within the county, with the exception of the city of Daly City. The SMCEHSD GPP is the permitting element for all geotechnical drilling and environmental investigation drilling (borings and monitoring well installation and destruction) within the San Mateo Plain.

The SMCEHSD can be contacted via its Web site: <http://www.smhealth.org/enviro/index.shtml>, or by phone (650) 363-4305. For more information on the SMCEHSD's programs, see Appendix E of this report.

Table 9. Comparison of Local Agencies' Groundwater Protection Programs

Program	Niles Cone	Santa Clara Valley	San Mateo Plain
Local Agency	ACWD	SCVWD	SMCEHSD
Ambient Water Quality Monitoring Wells	Yes	Yes	No
Annual Monitoring Reports	Yes	Yes	No
GIS Status	Initial development	Moderately developed	Initial development
Leaking Underground Storage Tank Oversight	Non-LOP ¹ Program	LOP ¹	LOP ¹
Control of Retail Pumping	Yes	Yes	No
Links Redevelopment Permits to Locating and Sealing Vertical Conduits	Yes	No	No

¹Local Oversight Program

6.3 Information Management

While there do not appear to be any major gaps in the oversight of regulated cleanup sites, the lack of any up-to-date list on the status of these sites does not allow for full committee review of all programs. Historically, there has been very little sharing of data, except as local agencies supply well-permitting data to the Department of Water Resources (DWR) and LUST cleanup data to the Regional and State Boards. The various state groundwater protection agencies do not have a good mechanism for sharing information. There is little coordination among the S.F. Regional Board, DTSC, and EPA for tracking the progress of solvent cleanup sites. Basin-wide maps showing the location of the various solvent and landfill cleanups do not exist. Fortunately, there are several statewide initiatives currently underway that should help address these information management problems (see Section 6.4). A summary of the key information management areas the Groundwater Committee reviewed is below.

Leaking Underground Storage Tanks. Information on LUST sites is generally available and complete. A prioritization list exists, and there is workable coordination among the regulatory agencies. Programs for addressing major threats to groundwater from MTBE releases are being administered, with local agencies acting as lead for nearly all fuel leak sites.

Active Gasoline Service Stations. Information on the location of active service stations with UST's is generally available and up to date. The Geotracker system incorporates data from all of the CUPA's and local agencies in one location accessible by the public. Studies are underway to identify the threats posed by the storage of gasoline at these facilities and which sites should be put into the LUST program. In addition, changes in leak prevention and monitoring requirements specify enhanced leak detection for UST's located within 1000 feet of public water supply wells.

Other Groundwater Pollution Sites. Information on non-fuel leak sites, landfills, and aboveground tanks is either not generally available, incomplete, or out of date. Large amounts of water quality data are not accessible electronically. The S.F. Regional Board maintains internal lists of regulated closed and active landfills and of aboveground tank sites. However, no site-specific information or water quality data is collected electronically. Additionally, local enforcement agencies maintain lists of smaller closed landfills that are not regulated by the S.F. Regional Board. The S.F. Regional Board posts a copy of the SLIC database online, including a list of the non-fuel sites it regulates. However, the SLIC database was updated, on average, eight years ago, making this information of questionable utility to other agencies and the public.

DTSC, under its voluntary cleanup program, and EPA, under the Superfund program, have also invested significant efforts in overseeing solvent plume investigations and cleanups. Both agencies have regulated solvent cleanups in the South Bay since the late 1980s. Neither DTSC nor EPA maintains an online list of the groundwater pollution sites they regulate.

Regulatory lead for South Bay solvent sites is shared. The S.F. Regional Board has the bulk of the sites, and local agencies, DTSC, and EPA share the lead for the remaining sites (see Table 8). The ACWD and the SMCEHSD each act as lead agency for a number of cleanups. The SCVWD does not assume lead responsibility for any non-fuel sites. Investigation and cleanup of these sites has been a high priority at the S.F. Regional Board since the late 1980s, when EPA contracted with the S.F. Regional Board for it to be the lead for 21 federal Superfund sites. Records of decisions have been signed for all these Superfund sites. Board orders have been adopted for an additional 80 solvent plumes in the South Bay. For smaller solvent pollution sites, the S.F. Regional Board uses its authority under Water Code 13267 to regulate approximately 80 more sites. These non-Superfund sites are overseen under the SLIC Program.

Access to EPA-maintained information is available online through a single tool known as Envirofacts at http://www.epa.gov/enviro/index_java.html. Information available regarding groundwater quality is limited to select information collected under a variety of federal regulations, such as RCRA, SARA, and SDWA. Some information relating to groundwater contamination is available for NPL (Superfund) sites, but this is generally limited to abstracts of documents submitted as part of the CERCLA remedial process. These documents, such as remedial investigations, feasibility studies, and records of decisions, may contain some site characterization data, but the information is not available in a GIS format. Individual sites may be plotted using the Envirofacts Web interface, but plume maps or other groundwater quality information are not available.

The Groundwater Committee's review of information available online from DTSC's Web site (<http://www.dtsc.ca.gov>) indicated that no geographically coded contamination information is available on the Internet. Available documents include a subset of DTSC guidance on site investigation and fact sheets for a small number of contaminated sites under DTSC oversight. No geographic information system (GIS) mapping tools are provided to plot the locations of sites or plumes. DTSC maintains an in-house database containing site-specific information for sites where DTSC is the lead regulatory agency. Currently, the database is accessible only to DTSC staff, although the public may obtain the information secondhand from DTSC staff or project managers.

Drinking Water Wells. Information on the location of public water supply wells is generally available. Local agencies have done an excellent job of collecting location information for public water supply wells. However, data on well depth, well construction, and pumpage rates are not currently publicly available. The primary barrier to the compilation of this information is the DWR's well privacy law.

Information on the location of domestic water supply wells is generally not readily available. Current resources are insufficient on both the state and federal levels to protect the thousands of private domestic wells from groundwater pollution. Indeed, current resources are stretched thin at the state and local levels to adequately protect just the hundreds of public water supply wells. DWR has records on wells installed after about 1950. State law prohibits distributing well completion reports to anyone but the landowner, his or her designee, or a government agency without the owner's permission. Thus, while state and local agencies have access to this information, the sharing of this information on a wide scale (e.g., online) is not permissible. No records exist for wells drilled before 1950; however, local agencies are beginning to collect location information on these wells as they become aware of them.

6.4 Statewide Groundwater Protection Initiatives

Several new statewide groundwater protection programs are being developed that will address many of the data shortcomings discussed above. These programs are summarized below.

6.4.1 SWRCB's System for Water Information Management

The SWRCB has recognized that the existing information management system provides incomplete and inaccurate data, which makes it difficult for the SWRCB to carry out its mission. The inadequacy of the current system has impacted the State and Regional Boards' ability to achieve their objectives and to comply with legislative mandates relating to inspection, monitoring, enforcement, and reporting. To address this problem, the SWRCB is developing a System for Water Information Management (SWIM), which is scheduled to be fully implemented in 2003. SWIM will accept self-monitoring report data in electronic and standardized formats, thus reducing the manual effort now required to capture data and decreasing the elapsed time between data receipt and capture.

6.4.2 SWRCB's GeoTracker Project

GeoTracker is a GIS program that provides online access to environmental data. GeoTracker is the interface to the Geographic Environmental Information Management System (GEIMS), a data warehouse that tracks regulatory data about underground fuel tanks, fuel pipelines, and public drinking water supplies (<http://geotracker.swrcb.ca.gov/>). GeoTracker and GEIMS were developed pursuant to a mandate by the California State Legislature (AB 592, SB 1189) to investigate the feasibility of establishing a statewide GIS for LUFT sites. GeoTracker contains well, tank, and pipeline data from all of California, making it an important resource both to regulators and the public. Currently, GeoTracker is undergoing pilot testing in Central California. Routine updating of GeoTracker began in late 2001 within the San Francisco Bay Region, including the South Bay Basins.

6.4.3 SWRCB's Groundwater Ambient Monitoring and Assessment Program

The SWRCB, in coordination with the DHS and the DWR, is implementing the Groundwater Ambient Monitoring and Assessment Program (GAMA) to determine the water quality and relative susceptibility of groundwater that serves as a source for public water supplies to potentially contaminating activities. The primary element of GAMA is the California Aquifer Susceptibility (CAS) program, which is using groundwater age-dating techniques and low-level analyses for volatile organic compounds (VOCs). The fundamental premise of this assessment is that groundwater age can be used as a guide for assessing aquifers in terms of susceptibility. The age of groundwater may be defined as the time since the water was recharged and isolated from the atmosphere. Tritium/helium-3 techniques will be used to determine the mean integrated age of groundwater samples. Widespread use of regulated chemicals has occurred during the past 50 to 60 years (following World War II). Therefore, groundwater that has recharged during the past 50 years will be considered more susceptible to contamination from various land-use activities. In addition, low-level VOC analysis will be used to identify those public supply wells already impacted by certain contaminating activities, but which are still below action levels. The assessment is designed to sample the approximately 16,000 public supply wells statewide. Sampling began in September 2000 and will continue for the next several years over the entire state, depending on the availability of funding. In the South Bay, sampling has been completed in the Niles Cone and Santa Clara Basin.

6.4.4 SWRCB's Comprehensive Groundwater Quality Monitoring Program

The SWRCB, in coordination with an inter-agency task force and public advisory committee has been tasked with preparing a Comprehensive Groundwater Quality Monitoring Program as described in the Groundwater Monitoring Act of 2001 (AB 599). The goal of this program is to improve comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public. The SWRCB will integrate existing monitoring programs and design new program elements to establish a statewide program. The draft report to the legislature will be submitted in May 2003.

6.4.5 Department of Health Services' Wellhead Protection Program

The Drinking Water Source Assessment and Protection (DWSAP) program will satisfy the mandates of the 1986 Federal Safe Drinking Water Act, which required states to develop a wellhead protection program. The DWSAP program will include an assessment of every public drinking water well in California. The assessment will have the following components:

- Determine the location of groundwater wells using a global positioning system
- Identify recharge area boundaries to determine the source area
- Delineate protection zones based on two-year, five-year, and 10-year travel times for groundwater to travel from a point in the aquifer to a pumping well
- Evaluate physical barrier effectiveness in preventing contaminants from reaching the well
- Inventory potentially contaminating activities in the source area
- Prepare an assessment map that shows the well location, source area, and protection zones
- Notify the public in the Public Water Supplier's annual Consumer Confidence Report about the assessment results

Although DHS is responsible for performing these assessments, some public water systems may also choose to perform more complex drinking-water source assessments. The water purveyors in the Niles Cone and Santa Clara Valley basins are working in coordination with DHS to complete their DWSAP requirements. DHS is the local primacy agency in the San Mateo Plain Basin and will be completing the DWSAP requirements for the water purveyors in that basin. All assessments must be completed by May 2003. Further information on DHS' DWSAP program is available online at: <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>.

6.4.6 Department of Water Resources' Update on Groundwater Basins of California

DWR is updating its report titled, "California's Ground Water - Bulletin 118," first published in 1975. The draft report will be released in April 2003. The update will consist of a summary of regional and statewide data available on groundwater basins, as well as detailed information on individual groundwater basins. The funding and time allotted did not allow for the collection of new data, so the update focuses on compiling and summarizing existing information on groundwater basins. The update will also be available online at <http://www.waterplan.water.ca.gov/groundwater/updatemain.htm>

6.5 Recommendations

The primary areas where groundwater protection programs could be improved are information management and prioritization.

As discussed above and in Section 5.0, access to site information is severely limited in all areas except the LUST Program. The LUST Program utilizes GeoTracker as an interface to the GEIMS, a data warehouse that tracks regulatory data about underground fuel tanks, fuel pipelines, and public drinking water supplies. The addition of SLIC sites, Federal facilities, landfills, and above ground tanks to the GeoTracker system would greatly improve access to site data and allow for better site management and tracking. GeoTracker, in its current form, cannot be used to create custom reports or lists (e.g., sites with institutional controls, sites with MTBE above a particular concentration, or sites that have not initiated groundwater remediation). This capability should be added to GeoTracker.

A prioritization strategy should be developed for landfills, SLIC sites, and aboveground tanks. Currently, the only groundwater protection program with a prioritization strategy is the LUST Program, which is based on recharge areas, distance to drinking water wells, and MTBE concentrations. The SCVWD has developed a sensitivity map for the Santa Clara Valley using EPA's DRASTIC computer program;

however, the results have not been integrated into other programs. Neither the ACWD nor the SMCEHSD has basin sensitivity maps.

Groundwater is vulnerable to point source and no-point source pollution from industrial and other activities at the surface. Pollutants move in the subsurface along groundwater gradients and in the absence of vertical conduits, follow regional horizontal gradients toward the San Francisco Bay. High priority areas are those where unconfined aquifers are potentially in direct contact with pollutants. Medium priority areas are more protected from pollutants due to the presence of an aquitard that retards or inhibits pollutant migration. Low priority areas are located in fine-grained sediments, low yielding aquifers and have extremely flat horizontal gradients.

Figure 26 presents a simplified approach to defining priority areas for groundwater protection in the South Bay Basins. This approach is based on hydrogeologic information from local agencies, the S.F. Regional Board's MTBE vulnerability map, drinking water well locations, recharge pond locations, and the historic San Francisco Bay shoreline.

With very limited exceptions, all groundwater in the South Bay serves as a significant drinking water resource. As described in this report, 351 public water supply wells serve a population of 1.75 million South Bay people and provide up to half the drinking water supply. However, there are areas within the South Bay Basins that are more vulnerable and/or critical in terms of groundwater protection. Thus it is possible to prioritize areas for groundwater protection. High priority is assigned to the unconfined forebay area. Moderate priority is assigned to the confined zone where aquitards exist. Low priority is assigned to the baylands areas adjacent to San Francisco Bay.

The priority areas shown in Figure 26 should be revised as wellhead protection zones are delineated under the DHS's DWSAP program. In addition, the SWRCB's Groundwater Ambient Monitoring and Assessment Program will help identify wells that are more vulnerable to contamination. The results of both these programs should be integrated into this prioritization approach as data become available.

7.0 PROJECT FOCUS AREAS

Eight groundwater protection focus areas were identified for special attention based on the experience of Groundwater Committee members and concerns expressed at stakeholder meetings. Focus areas were selected because they represent common problems that are typically not addressed by existing protection programs, or because they represent recent efforts with the potential to enhance existing programs. These focus areas include the following:

1. **Identification and Sealing of Vertical Conduits.** Vertical conduits can provide a pathway for the migration of shallow groundwater pollution into deeper aquifers. This effort was directed at surveying local abandoned well programs and compiling information on minimum work that should be conducted to locate and seal abandoned wells.
2. **Leaking Sewer Lines.** These are an often-overlooked potential source of groundwater pollution, particularly as related to historical discharges from drycleaners. The Groundwater Committee qualitatively evaluated the potential extent and magnitude of leaking sanitary sewer lines and, based on a pilot study in Sunnyvale, developed a strategy for prioritization.
3. **Drycleaner Cleanups.** Historical solvent leaks from drycleaning facilities pose a significant, but relatively unquantified threat to South Bay groundwater quality. In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances resulted in impacts to groundwater. Investigation and cleanup of drycleaner sites has not been a major focus of any groundwater protection program, yet they are often located proximate to recharge areas or drinking water supply wells.
4. **Electronic Reporting of Chlorinated Volatile Organic Compound (VOC) Plumes.** Electronic reporting will allow for better tracking, management, and prioritization of these sites. The Groundwater Committee sent request letters to 105 VOC sites in the South Bay Basins. Electronic reporting information can be used to set priorities in regulatory oversight, share information with local agencies so they can better manage their resources, and create regional plume maps.
5. **Coordination with the Drinking Water Source Assessment and Protection (DWSAP) Program.** The Groundwater Committee has reviewed the methods that local agencies and water suppliers are using to prepare DWSAPs for the Department of Health Services (DHS). The Groundwater Committee has also evaluated how DHS and various groundwater protection and cleanup programs can share information.
6. **Surface Water and Groundwater Interaction.** This is an important consideration in groundwater protection. The Groundwater Committee focused its attention on the reduction in natural recharge due to development, the reduction of stream flows caused by the pumping of shallow wells, and the potential for the increased use of stormwater detention basins to contaminate groundwater.
7. **Emphasis on Groundwater Protection in City and County General Plans.** Cities and counties in the South Bay must prepare general plans. The Groundwater Committee reviewed these plans to identify important elements that may provide groundwater protection and cleanup strategies at the local level.
8. **Regulatory Structure and Information Management.** This topic, also known as the “Regulatory Maze”, is the result of overlapping authority, limited budgets, and differing priorities amongst the various groundwater protection agencies. Historically, there has been

very little data sharing amongst state and local agencies and with the public, mostly because they do not have good information sharing mechanisms (e.g., a common database)

7.1 Identification and Sealing of Vertical Conduits

7.1.1 Introduction

Vertical conduits are pathways that allow groundwater to move between a shallow water-bearing zone and a deeper water-bearing zone or vice versa. Vertical conduits can be manmade (abandoned wells, improperly sealed wells, elevator shafts, or hollow piles, for example), or they can be naturally occurring (e.g., root holes, facies changes, or liquefaction-caused structures). This discussion focuses on understanding the nature of vertical conduits, locating and mitigating their effects, and looking at how searches for these conduits are conducted. Figure 27 is a generalized cross-section illustrating potential vertical conduit conditions.

7.1.2 Manmade Conduits

Water Wells. A well that penetrates more than one aquifer may allow water from one aquifer to contaminate another aquifer if the well is not properly constructed. Water may leak along the outside of the well casing if the well is not properly sealed, or the casing may deteriorate and develop holes that allow water and chemical movement inside the casing. As a result, water from one aquifer can mix with one or more other aquifers. A small amount of contaminated or low-quality water can degrade a large volume of clean groundwater to the point that it no longer meets drinking-water standards.

Water supply wells constructed to modern standards may be screened across multiple deep water-bearing zones. If shallow contaminated groundwater can affect even the shallowest of these screened zones through manmade or natural conduits, then even a properly constructed water supply well can act as a vertical conduit to transport contaminants downward. In addition, although not typical, vertical conduits can allow movement of contaminated deeper water to less-contaminated shallow water. An example of this is in Santa Clara County, where there is an area of highly saline connate water under pressure beginning at about 300 feet, which will rise into the overlying aquifers if wells are screened across it.

Unsealed or abandoned wells directly connect the land surface (or an area within a few feet of the land surface) with groundwater (Figures 27 and 28), allowing polluted surface water to contaminate the groundwater. Examples of pollutants that can enter the groundwater include human or animal wastes, petroleum products, fertilizers, pesticides, and solvents. Once an aquifer is contaminated, it is expensive and difficult to correct the damage.

Rapid urban expansion has taken place in the South Bay study area. Unfortunately, many agricultural and domestic wells, up to 100 years old, have been built over with no record of proper destruction. These lost wells are likely to be screened across several water-bearing zones and to have rusted or otherwise-damaged steel casings. In downtown San Jose, redevelopment or new construction projects commonly uncover three to five wells for each recorded well. Identification and proper destruction of these potential conduits is critical to include in any groundwater protection program.

Notable examples of abandoned wells that have led to cross-aquifer contamination are the Fairchild Superfund site (San Jose) and the Middlefield-Ellis-Whiseman Superfund site (Mountain View). Solvents released at the Fairchild facility contaminated a municipal well to a depth of nearly 275 feet. Solvents released at the Middlefield-Ellis-Whiseman site contaminated an agricultural well to a depth of 510 feet. Fate and transport studies have shown that the mechanism for the vertical movement of contaminants was through improperly abandoned wells. The best-documented information on the vertical movement of contaminants through wells in Santa Clara County is in Iwamura (1980). Figure 28 illustrates the location of many vertical conduits in the South Bay.

Cathodic Protection Wells. Most large manufacturing facilities, tank farms, and pipelines in the San Francisco Bay region have cathodic protection wells. Although California does have well standards for the construction of these wells, these standards mainly protect against the introduction of water from the surface. Cathodic protection wells typically have shallow seals without casing and are not properly destroyed at the end of their useful life. Cathodic protection wells generally have not been constructed to prevent cross-aquifer contamination from occurring, especially at older facilities. It is imperative that the locations and construction logs for cathodic protection wells be incorporated into the wells database. Many cathodic protection wells were never located on well maps and State well numbers may not be assigned to older cathodic protection wells.

Structural Pilings. Structural pilings for large projects, such as bridges and high-rise buildings, may penetrate aquitards between shallow and deeper water-bearing zones. The Uniform Building Code and the S.F. Regional Board have guidelines to prevent pilings from acting as conduits between the water-bearing zones, but they are not yet part of standard construction techniques. Regulatory agencies are applying the guidelines as they are made aware of projects, but these safeguards have not commonly been applied in the past. This issue is of particular importance in urban areas because of the move to redevelop inner cities via brownfields initiatives, where construction projects will inevitably encounter residual soil and shallow groundwater contamination.

Geoexchange Wells. Geoexchange systems (also known as geothermal heat pumps or ground source heat pumps) are unique mechanical devices that conveniently heat and air condition buildings and heat domestic water at a lower cost. In the winter, a geoexchange system collects the earth's natural heat through a configuration of closed pipes, called loops, installed below the surface of the ground or submersed in a pond or lake. Water circulating in the loop carries this heat to the home, where electrically-driven compressors and heat exchangers concentrate the earth's energy and release it inside the home at a higher temperature. In summer, the process is reversed to cool the home. Excess heat is drawn from the home, expelled to the loop, and absorbed by the earth.

Vertical loop systems consist of polyethylene loops up to 400 feet in length, which are placed in 4- to 6-inch bore holes where they act as heat exchangers. All vertical boreholes are grouted with bentonite. Vertical systems are the most common type of system installed on small town lots or in commercial applications. Commonly, four to twelve bore holes might be used for a residence, depending on its size. Horizontal systems are installed in trenches that are approximately 5.5 to 6 feet deep and require 15 to 20 percent more loop pipe because they are affected by the annual fluctuation of the earth's temperature. Other installation configurations include "slinky loops" and pond loops.

For vertical loop systems, the potential exists to penetrate one or more water-bearing zones that may be polluted. Care must be taken to ensure the pollution is not spread and that existing remediation systems are not adversely impacted. This includes ensuring separation is maintained between the pipe and the borehole wall during grouting.

7.1.3 Naturally Occurring Vertical Conduits

Stratigraphy. Stratigraphic or facies changes play an important part in the vertical transport of groundwater and its associated contaminants. Discontinuous and leaky aquitards are common in the heterogeneous alluvial sediments of the study area. A relatively impermeable silt or clay layer may change laterally, in a matter of yards, into a more permeable silty sand or sand. For example, a paleo-stream channel may have eroded through a low-permeability strata to connect two higher-permeability strata. Continuous core from drilling, along with hydrogeologic data from the site and from nearby sites, are necessary to evaluate the potential for stratigraphic pathways and are a vital part of any contaminant-transport study, especially near public water supply wells.

Root Holes. It is not uncommon to find root hole features in paleosols cores taken up to 100 feet below the surface. These root holes provide unhindered access for shallow groundwater to reach deeper water-bearing zones. Before the introduction of non-native grasses to California landscapes, California native bunch grasses had root systems up to 27 feet long to take advantage of a fluctuating water table. Few of these grasses remain in California today, but their legacy is apparent in the root holes seen in deeper sediments than today's grass roots can reach.

Liquefaction-caused Structures. Liquefaction, commonly due to earthquakes, causes sand boils (venting) and lateral-spreading fissures. These features generate sand bodies that short-circuit across finer-grained, low-permeability materials. Sand boils cause an irregular feeder pipe of sand from the liquefied zone up to the ground surface at the time of the earthquake and deposit a circular or oval sand body up to a few feet thick. These structures will be repeated through the stratigraphic sequence and can connect permeable zones, allowing substantial vertical migration of contaminants. Lateral spreads cause fissures that then fill (or partially fill) with upwelling sand from the liquefied zone. Lateral-spreading fissures as long as 650 feet have been observed. The sand-filled fissure can intercept a significant width of a contaminant plume and move it downward as much as 50 feet.

7.1.4 Conduit Searches

Protocols. Well location and construction details are considered proprietary information under California law. In order to receive well location information, a requester must have a valid environmental reason. Section 13752 of the California Water Code states:

“Reports made in accordance with paragraph (1) of subdivision(b) of Section 13751 shall not be made available for inspection by the public, but shall be made available to governmental agencies for use in making studies, or to any person who obtains a written authorization from the owner of the well. However, a report associated with a well located within two miles of an area affected or potentially affected by a known unauthorized release of a contaminant shall be made available to any person performing an environmental cleanup study associated with the unauthorized release, if the study is conducted under the order of a regulatory agency. A report released to a person conducting an environmental cleanup study shall not be used for any purpose other than for the purpose of conducting the study.”

There are several published guidance documents for locating abandoned wells. These documents outline the steps to be taken in a comprehensive well search. Some of the more widely available documents are listed below.

- ASTM D 6285-98, “Standard Guide for Locating Abandoned Wells”
- ASTM D 5299-92, “Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities”
- “Sealing Abandoned Water Wells,” Illinois Department of Energy and Natural Resources
- California Well Standards, 1991, Bulletin 74-90, California Department of Water Resources, Part III, Destruction of Wells
- California Well Standards, 1981, Bulletin 74-81, California Department of Water Resources, Part III, Destruction of Wells
- S.F. Regional Board, 1986, staff memo prepared by Thomas Berkins. “Guidelines for the Identification, Location, and Evaluation of Deep Well Conduits”

None of these documents discusses the presence of, or how to locate, naturally occurring vertical conduits. Site-specific hydrogeologic conditions must be determined through literature searches, review of nearby sites, and a subsurface investigation designed to discover naturally occurring vertical conduits.

7.1.5 South Bay Agencies' Well Search Programs

Alameda County Water District (ACWD). The ACWD has gathered all available public records, as well as its own well data, and created a database of historical and active wells, including cathodic protection wells. A user can provide the ACWD with an address and a search radius, and the ACWD will search the database and provide the user with all available data.

The ACWD has also developed a comprehensive well search program that is part of its Well Destruction Program as outlined in Appendix E. This program was developed in cooperation with the cities of Fremont, Newark, and Union City. When land-use changes are proposed for properties, the cities require the property owners or developers to obtain a letter from the ACWD indicating whether wells are located within the boundaries of the development. This requirement gives the ACWD the opportunity to conduct a search for wells before development occurs.

Copies of correspondence, from or submitted to the city, related to a development project, rezoning application, building permit, demolition permit, or underground tank removal are sent to the ACWD for review and comment. In addition, parties involved in property transfers can also submit plans for review and comment. A record check is then conducted for each submittal to determine whether any wells exist on the property. The ACWD's computer database, well data sheets, well logs, a 1959 well map, 1954 aerials, 1925 Sanborn maps, and 1915 well maps are all reviewed for the existence of a well on the property. In addition, the ACWD conducts a site visit to verify that all wells identified during the records search have been located, or, if the records search indicates that no wells exist at a property, to verify the absence of wells.

Santa Clara Valley Water District (SCVWD). The SCVWD has a fairly comprehensive wells search protocol. It has a GIS-based database of all known wells, including active, inactive, and destroyed supply, monitoring, and cathodic protection wells. As with the ACWD, responsible parties or their consultants need only give the SCVWD a case identification, a location, and a search radius, and the SCVWD will search its database and provide the responsible party with all available data. The SCVWD has not yet completed a comprehensive survey to locate historical wells, so information on the locations of historical and abandoned wells is not necessarily complete.

However, the SCVWD database does include the location and available data on more than 3,000 historical and abandoned wells. The responsible party must complete the vertical conduit study with an air photo search; careful review of historical publications, documents, and maps; and a house-to-house canvass for existing unregistered wells.

San Mateo County Environmental Health Services Division (SMCEHSD). The SMCEHSD maintains a well database in Access that is currently being updated. Well searches are performed for environmental cleanup studies upon request by the person conducting the study. The search radius is determined by the County inspector for the district where the unauthorized release has occurred after discussion with the person conducting the study, and based on the characteristics of the release and the local geologic and hydrogeologic conditions. The search is conducted using information in the well database and in files kept at the county office. The known well locations are shown on a map, and the known data pertaining to these wells are displayed in an Excel spreadsheet. The information gathered is then given to the County inspector and to the requester.

Currently, the SMCEHSD is locating all wells in the county with a GPS unit. The collected field information is stored in a well database in Access, together with all known well characteristics. GIS coverage of the well locations is generated with the collected GPS data. In the future, the Access database will be linked to the GIS coverage, allowing an interactive display of the known well information on a digital map. Any changes or updates made to the Access database will be reflected in the GIS coverage.

S.F. Regional Board. There is no standard requirement in board orders to conduct a vertical conduit study. However, requirement for such a study is included on a case-by-case basis. All Superfund sites in the region have been required to perform well searches.

7.1.6 Conclusions and Recommendations for Identification and Sealing of Vertical Conduits

Conclusions

- Naturally occurring conduits are present that allow shallow contaminated groundwater to migrate to a deeper water-bearing zone, which may be hydraulically connected to even deeper water-bearing zones.
- Vertical migration also includes the upward movement of deeper contaminated water to shallower water-bearing zones.
- Vertical conduits play a substantial role in the transport of contaminants from shallow groundwater to deeper municipal drinking-water supplies. On a site-specific or individual contamination case basis, the presence or absence of vertical conduits is unknown until established by investigation.
- The topic of vertical conduits must be addressed in much more detail than is possible in this report. It is not possible to fully implement a groundwater protection strategy for a groundwater basin without knowing and understanding all the pathways that pollutants can follow to reach a municipal or private water supply well.
- There are many manmade vertical conduits in the South Bay that can and do act as portals for contaminants to migrate into municipal water supplies.
- Guidance documents are available to users looking for abandoned wells. In addition, this report provides a compilation of available abandoned and historical well locations (Figure 28).

Recommendations

- The EPA, the State Water Resources Control Board (SWRCB), or a water-providers' group (such as the National Ground Water Association) should develop funding for a comprehensive study and report on all aspects of vertical conduit location and sealing.
- Well-permitting agencies in the South Bay, as well as those in the rest of the Bay Area, should emulate the ACWD's program for well searches. One significant and unique aspect of the ACWD program is that it requires coordination with local building permit departments so that vertical conduits can be located when site redevelopment occurs. Using GIS technology to bring the disparate databases together and including information provided by consultants and private parties can greatly simplify the search for vertical conduits. Funding may be available from the EPA or the state for such an effort.
- A vertical conduit study should be required at all groundwater contamination sites and as a standard requirement in all S.F. Regional Board cleanup and abatement orders. Such a study should be considered part of the initial remedial investigation. Suggested language is as follows: "The responsible party shall conduct an investigation of manmade and naturally occurring vertical conduits within an area at least encompassing the farthest currently known extent of contaminant migration from the site." Guidelines for the minimum investigation are included in the S.F. Regional Board's 1986 staff report titled, "Guidelines for the Identification, Location, and Evaluation of Deep Well Conduits" (Appendix G).
- Well searches and proper destruction of abandoned wells should be required before development or new construction begins at a site. This will provide an authoritative basis for writing ordinances and for involving city and county building departments in solving this problem.

7.2 Leaking Sewer Lines

7.2.1 Introduction

This section summarizes a brief qualitative evaluation of the potential for exfiltration from sewer lines in the South Bay to affect groundwater quality. We believe the primary potential for degradation of groundwater quality is from the historic disposal of solvents, such as at drycleaners and electronics manufacturing facilities (wafer fabricators, plating shops, and printed circuit board shops). In the context of sewer lines affecting water quality, exfiltration (i.e., leakage from sewer lines to groundwater) is a major factor. The issue of sewer lines acting as preferential pathways, particularly along the underlying gravel or sand pipe bedding and backfill, plays a secondary role and is not addressed here.

Impacts of leaking sanitary sewer lines were assessed with respect to potential introduction of solvents to shallow groundwater in the South Bay Basins. There have been many documented incidents of illegal discharges of hazardous wastes, including solvents, to sewers throughout the state, some resulting in fines and jail terms. Drycleaners routinely and legally discharged waste solvents to sewer lines in earlier decades, which in many instances has probably resulted in impacts to groundwater (Izzo, 1991).

As regulation of wastewater treatment facilities has increased, and as municipalities have improved public outreach and education efforts, the discharges of chlorinated solvents to sewer lines, have decreased. Permitted discharge limits for VOCs have also decreased. For South Bay wastewater treatment facilities, 1 mg/l is the most common limit for total VOCs (expressed as total toxic organics) in a permitted discharge. In the past, VOC limits have been as high as 5 mg/l at the Palo Alto Regional Water Quality Control Plant, and higher elsewhere.

This review includes a general overview of the means by which solvents, particularly from the drycleaning industry, have been discharged to and released from sewer systems. Air emissions data are also reviewed to estimate the current quantities of chlorinated solvents conveyed by sewer systems. A brief qualitative review of one sewer system, the city of Sunnyvale's, is presented in Appendix H. Recommendations are provided for additional measures to characterize the potential significance of leaking sanitary sewer lines on groundwater quality. This review does not evaluate impacts to groundwater from nitrates, metals, pathogens, pharmaceuticals, or other contaminants that may be introduced to groundwater from leaking sewer lines.

7.2.2 Background

Infiltration, or leakage of groundwater into sewer lines, usually occurs when the water table is at a higher elevation than the sewer line. Inflow results in increased flows to the sewage treatment plant (or publicly owned treatment works [POTW]), particularly during the winter months. Inflows may carry untreated pollutants that, under lower water table conditions, would not normally be available for transport via the sewer line. The additional pollutant load might create greater treatment demands of the influent at the POTW before its ultimate discharge to San Francisco Bay as effluent. Conversely, the increased inflow might result in greater dilution of the respective pollutants, although this "benefit" will fade out with the establishment of a mass discharge limit (total maximum daily load) for protection of San Francisco Bay. Of additional concern are pollutants that don't make it to the treatment plant, but are discharged from the sewer line through leakage, also known as exfiltration.

Exfiltration is leakage from the sewer line and in most cases, into surrounding groundwater. This usually occurs where the water table is below the sewer line, however, in cases where the water table is higher than the sewer line, solvent leakage can occur, particularly if the chemical is in a free product stage. Exfiltration can affect adjacent groundwater both biologically and chemically. Biologically, the leaking sewer line can introduce pathogens into surrounding groundwater. This is particularly an issue where there may be a human health exposure pathway via a shallow domestic or agricultural well. This impact,

however, is generally of less significance in wells that tap deeper aquifers where natural filtration occurs to remove the pathogens. Of more significance, are chemicals transported in the sewer lines that are released and migrate to and affect both shallow and deeper aquifers. This is a key issue if the discharge occurs within a recharge zone or via a vertical pathway that connects shallow waters with those of deeper aquifers.

In the South Bay, one of the categories of chemicals of greatest concern, which threatens the quality of drinking-water resources, is chlorinated solvents. Discharges of chlorinated solvents originate from both large industrial facilities, particularly the electronic sector, and the seemingly more modest but pervasive former drycleaner facilities. Below is a general discussion of the chlorinated solvent issue, with a focus on recent studies pertaining to discharges from former drycleaning facilities.

7.2.3 Quantities of Chlorinated Solvents Conveyed by Sewer Lines

To determine past and current quantities of solvents conveyed by sanitary sewer lines, records were obtained from the Bay Area Air Quality Management District (BAAQMD). Table 10 summarizes BAAQMD's estimates of emissions of solvents (halogenated volatile organic compounds [HVOCs]) from South Bay POTWs.

**Table 10. 1998 Estimated HVOC Emissions from South Bay POTWs
 Pounds per Year, Calculated by BAAQMD**

PLANT NAME	1,1,1-TCA	Methylene Chloride	PCE	TCE
City of Sunnyvale Water Pollution Control	Not reported	573	122	134
San Jose/Santa Clara Water Pollution Control Plant	964	9,335	3,298	406
Palo Alto Regional Water Quality Control Plant	98	1,767	196	687
City of Millbrae	17	17	111	26
San Mateo Water Quality Control Plant	405	810	670	337
South Bayside System Authority	300	4,683	1,527	279
Union Sanitary District	148	876	501	125
Hayward Waste Water Treatment Plant	5,733	488	206	53

Abbreviations and synonyms: 1,1,1-TCA is 1,1,1-trichloroethane, or methyl chloroform; methylene chloride is also called dichloromethane; PCE is perchloroethylene or tetrachloroethylene; TCE is trichloroethylene

Estimated air emissions of VOCs from POTWs provide a means of gauging the quantity of solvents conveyed by sanitary sewer systems. Estimates are obtained using a complex set of emissions factors and equations summarized in EPA Document AP-42, "Compilation of Air Pollutant Emission Factors."

Plant operators, however, consider these estimates to be rather high; in some instances more than twice the quantities they calculate based on influent concentrations of VOCs measured semi-annually in routine pretreatment monitoring. Table 11 presents estimates of annual solvents discharged to selected sewer systems, based on measured influent concentrations.

Table 11. Estimated Annual Quantity of Solvent Discharged to Sewer System Based on Influent Concentrations and Dry Season Average Daily Flow (1998)

Facility, Solvent	Dry Season Flow (mgd) ^a	Influent Conc. (ug/l)	Estimated Quantity Treated, (pounds per year)
Sunnyvale, TCE	17.4	6.0	317
San Jose/Santa Clara, PCE	135.0	3.3	1,354
South Bayside System Authority, PCE	18.9	2.0	115

^a millions of gallons per day

By comparing results in Tables 10 and 11, one can see that results, estimated using influent concentrations, correlate with higher treatment plant quantities. For example, for the South Bayside System Authority, the estimated mass of PCE treated is less than 10 percent of that estimated by BAAQMD's calculation, while for San Jose/Santa Clara, the estimated mass is less than 50 percent of the BAAQMD's estimate. For Sunnyvale, the estimate is higher. However, influent sampling in years before and after this event were non-detect. With only one or two data points per year, it is difficult to gauge the accuracy of the above estimates. Table 12 reviews five years of influent VOC concentrations at the South Bay's largest POTW, the San Jose/Santa Clara Water Pollution Control Plant.

Table 12. San Jose/Santa Clara Water Pollution Control Plant Influent Concentrations 1995 – 2000

(concentrations in ug/l)

Solvent	3/95	9/95	3/96	9/96	3/97	9/97	3/98	9/98	3/99	9/99	3/00	9/00
1,2-Dichloroethane	Nd	2	Nd	Nd	Nd	Nd	Nd	Nd	1.8	Nd	Nd	Nd
Dichloromethane	2.4	11	5.6	6.3	7.55	6.3	6.65	6	2.8	Nd	2.8	42.2
Tetrachloroethene	Nd	1.6	1.6	Nd	4.01	3.3	5.74	Nd	0.7	Nd	Nd	15.5
1,1,1-TCA	1.1	Nd										
Trichloroethene	Nd	Nd	Nd	Nd	1.25	Nd						

To further evaluate the potential quantity of solvents conveyed by sewer lines, the City of Sunnyvale's sewer system was reviewed qualitatively in more detail. This review is presented in Appendix H.

7.2.4 General Review of Perchloroethylene and Sewer Lines

Izzo (1992) presents a detailed review of the mechanisms by which PCE from drycleaners enters and leaves sewer lines. Izzo's report profiles how PCE in pure phase may exit a sewer pipe as vapor, liquid, or a combination of both, either through permeating clay and concrete sewer pipes, or by leaking through joints and cracks in the lines. PCE is considerably more dense than water (1.63 g/cm³), allowing it to sink once it encounters the saturated zone. PCE in vapor form is nearly six times denser than soil air, allowing it to sink to the water table where it can dissolve into the groundwater.

Izzo's report presents several case studies from Central Valley cities in which PCE contamination of soil and groundwater, facilitated by sewer lines, has created plumes extending more than half a mile from the drycleaner source.

The South Bay has also experienced PCE contamination of groundwater from drycleaners. There were approximately 345 drycleaners within the study area in 1998, according to permit records maintained by the BAAQMD. There have been about 42 sites involving release of PCE from drycleaners to soil and groundwater within the study area, of which about 24 are currently open and undergoing investigation or remediation.

7.2.5 Conclusions and Recommendations for Leaking Sewer Lines

Conclusions

The potential for exfiltration of solvents from sewer lines exists and is a potential threat to groundwater quality in the South Bay. In Sunnyvale, that potential is considerably lower due to an aggressive and exemplary industrial pretreatment program. The Sunnyvale Water Pollution Control Plant is in the wastewater treatment business and expends its funds and efforts to maintain full compliance with its NPDES permits. Groundwater issues have not been the focus of its programs, although many of its efforts have resulted in improved groundwater protection.

The limited scope of this evaluation has not revealed direct evidence of any solvent releases to groundwater specifically from sewer line exfiltration. Yet solvent groundwater contamination has been detected in the basin in locations where there are no nearby sources, other than sewer lines. The potential impacts from exfiltration of solvents, whether in the past or ongoing, are probably small in comparison with the numerous plumes of solvents emanating from solvent tanks, sumps, and spills. Nonetheless, where solvents are discovered in groundwater without an obvious source, investigators should take note of nearby historic and existing sewer lines, as they may be the source.

Recommendations

- Influent VOC data for sewer systems overlying sensitive groundwater basins should be reviewed to better understand the magnitude of solvent conveyance and potential release from sewer lines in past decades.
- POTW inspectors should review influent data and compare VOC concentrations to permitted discharges to determine whether source investigation is warranted. For systems with consistently elevated influent VOC concentrations, trunk line sampling for VOCs should be conducted to determine sources and ensure conditions causing ongoing groundwater contamination are not present.
- As a pilot program, for one sewer system, sampling of aqueous, adsorbed, and vapor-phase solvents should be completed to estimate the total mass of solvents residing in or moving through the sewer system (i.e., sample influent water, influent sludge, and sewer gas). Estimating the total solvent load will allow better quantification of the mass of solvents potentially entering groundwater in the pure phase, dissolved, and vapor phase.
- Pretreatment limits allowing discharge of HVOCs to sewers should be reviewed to determine the degree of groundwater protection they offer in light of the potential for sewer line leaks.
- As a pilot program, at a selected facility, sampling should be conducted concurrent with sewer-flushing activity to estimate the amount of latent free-phase solvent that may be pooled within a sewer system.
- Where no obvious nearby sources exist, current and historic sewer lines should be mapped in relation to solvent impacts and groundwater flow direction.

7.3 Drycleaner Cleanups

7.3.1 Summary of Findings

According to BAAQMD records, there were about 350 drycleaners in the South Bay as of 1998, while only 42 have been investigated, primarily as a result of impending property transactions. Historical drycleaner facilities may pose one of the top threats to South Bay groundwater quality because they are numerous and a high percentage are believed to have leaked, and the fact that they are often located proximate to recharge areas or drinking water supply wells. Furthermore, investigation and cleanup of drycleaner sites, particularly historical leaks, has not been a specific focus of any state or local groundwater protection program.

In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances resulted in impacts to groundwater. Drycleaning equipment made prior to 1986 commonly used the gravity separation method, in which wastewater was separated from the heavier PCE and then discharged into the sewer system. Although local sewer districts permitted these releases in most cases, pipe leakage of wastewater from this potentially persistent source could have resulted in soil and groundwater contamination. Section 7.2 of this report discusses the potential for groundwater contamination from solvents discharged to leaking sewer lines.

An emerging issue at solvent cleanup sites, which could carry over to current and historic drycleaner leak sites, is the presence of solvent stabilizers, such as 1,4-dioxane. Solvent stabilizers have thus far received little attention from a regulatory perspective. For sites where the solvent stabilizer plume is larger than the primary solvent plume, additional cleanup may be required.

As an outgrowth of this project, and in recognition of the need to better understand threats from drycleaners, the S.F. Regional Board recommended that the SCVWD receive a \$70,000 grant from the State Water Pollution Cleanup and Abatement Account. The grant would be used to conduct a detailed study of past and current drycleaner operations in northern Santa Clara County.

7.3.2 Conclusions and Recommendations for Drycleaner Cleanups

- A comprehensive inventory of historical and current drycleaner facilities should be developed.
- Historical and current drycleaner facilities should be prioritized with respect to groundwater threats for further evaluation/investigation.
- The S.F. Regional Board should work with cities, counties, CUPAs, and the BAAQMD to develop a pilot project in a specific city or other area for identifying and prioritizing drycleaner facilities based on threats to groundwater quality.
- California should join EPA's State Coalition for Remediation of Drycleaners (<http://www.drycleancoalition.org>) and develop a statewide drycleaner monitoring and remediation program.

7.4 Electronic Reporting of Chlorinated Volatile Organic Compound (CVOC) Plumes

7.4.1 Introduction

This section discusses the first attempt in California to use electronic reporting for chlorinated volatile organic compound (CVOC) plumes. In November 2000, the S.F. Regional Board sent a letter to 105 dischargers requiring the electronic submittal of selected groundwater data.

The initial request for electronic reporting was limited to CVOC plumes in the South Bay for which the S.F. Regional Board is the lead agency, so that this effort would coincide with the preparation of this report. S.F. Regional Board staff is attempting to obtain comparable electronic information about CVOC plumes managed by the Department of Toxic Substances Control (DTSC) and the EPA. The Groundwater Committee expects that ultimately, all CVOC dischargers regulated by the S.F. Regional Board will submit electronic information using the GeoTracker program (see Section 6.4.2).

The primary purposes of the electronic reporting are:

1. To create a regional map of CVOC plumes in the South Bay area
2. To improve the ability of regulatory agencies to evaluate the status of groundwater cleanup projects throughout the region and to better prioritize oversight efforts
3. To compile and retain the data in a digital format that allows easier sharing of the data with local agencies that permit well drilling or manage the groundwater basin

To ensure that the electronic data received from the dischargers were uniform in content and format, dischargers were required to submit the monitoring data in a standardized format. Numeric data regarding plume size, CVOC concentrations, and other parameters were reported by entering the data into an Excel template that could be downloaded from the S.F. Regional Board's Web site. Each discharger was also required to submit a plume outline map, based on the MCL isoconcentration line for the most widely dispersed contaminant, in the form of either an Arcview shape file or a series of coordinates that defines the plume outline. To achieve uniformity, the request specified that coordinates be given in relation to the North American Datum of 1983.

The individual plume outlines were compiled into a single GIS coverage to create a regional map of nearly all significant South Bay CVOC plumes (Figure 22). This plume map can be overlaid with drinking-water wellhead protection zones and basin-sensitivity maps so that sites can be better prioritized and managed. SCVWD staff assisted the S.F. Regional Board staff in processing the plume outline data.

7.4.2 Electronic Reporting Results

A total of 74 sites submitted electronic reports. This included 72 of the initial 105 sites that were sent request letters, and two EPA sites that voluntarily submitted data. Most of the sites submitting data were in the Santa Clara Groundwater Basin. Of the 74 sites reporting, 64 were from the Santa Clara Valley, nine from Niles Cone, and one from the San Mateo Plain (Tables 13a and 13b).

**Table 13a. Summary of South Bay CVOC Sites Submitting Electronic Reporting Information
And Conducting Groundwater Extraction in 2000**

Site Name:	Site Street Address:	Site City:	Year 2000 Plume Length (ft.)	Average extraction rate year 2000 (gpm)	Total Mass Removed from Groundwater year 2000 (lbs.)	Total Mass Removed from Groundwater since GW Extraction began (lbs.)	Max. Conc. of Total VOCs year 2000 (ppb)	Years Pumping	Deed Restriction
1098 Alta Avenue	1098 Alta Ave.	Mountain View	1,600	20	25	181	930	5	N
680 West Maude Avenue	680 West Maude Ave.	Sunnyvale	950	28	32	60	1,306	1	N
844 East Charleston	844 East Charleston	Palo Alto	275	15	220	295	805	1	N
974 Arques Avenue	974 East Arques Ave.	Sunnyvale	675	18	99	224	4,317	3	N
Advanced Micro Devices, Inc.	901/902 Thompson Place	Sunnyvale	5,200	25	27	739	2,168	17	Y
Advanced Micro Devices, Inc.	1165 East Arques Ave.	Sunnyvale	3,900	29	39	852	353	14	Y
Advanced Micro Devices, Inc.	915 DeGuigne Dr.	Sunnyvale	3,500	55	110	4,601	575	17	Y
Applied Materials, Building 1	3050 Bowers Ave.	Santa Clara	580	0	0	558	163	15	N
Ashland Chemical Co.	8610 Enterprise Dr.	Newark	2,500	1	15	750	209,030	10	N
Borden Chemical Inc.	41100 Boyce Rd.	Fremont	750	13	6,647	26,015	9,604	6	N
Bourns-Santa Clara	1500 Space Park Dr.	Santa Clara	NR	94	48	230	382	15	N
Brandenburg Family Assoc. 1	153 West Julian St.	San Jose	140	1	10	550	20,230	12	N
Chemcentral	31702 Hayman St.	Hayward	1,300	7	1,080	8,470	37,576	?	?
Fairchild/Micropower	3080/3100 Alfred St.	Santa Clara	800	84	36	764	346	12	Y
FEI (TRW) 825 Stewart	825 Stewart Dr.	Sunnyvale	5,650	19	180	3,100	9,080	15	Y
FMC Corporation	8787 Enterprise Dr.	Newark	2,350	21	250	5,493	1,806,600	14	N
FMC Corporation	328 West Brokaw Rd.	Santa Clara	2,100	99	54	1,194	770	7	Y
fmr. AMI Semiconductor Site	3800 Homestead Rd.	Santa Clara	2,060	94	19	201	958	9	Y
fmr. Ampex Corp. Facility	728 San Aleso Ave.	Sunnyvale	1,700	13	3	37	153	4	N
fmr. CTS-Printex Facility	1950 Colony St.	Mountain View	667	19	10	98	793	10	N
fmr. Ford Aerospace	3825 Fabian Way, MS D-07	Palo Alto	2,300	69	65	262	5,000	10	N
fmr. Intersil-DTKSM	1276 Hammerwood Ave.	Sunnyvale	NR	NR	NR	NR	2,035	3	N
fmr. King's Court Clnrs	728 Blossom Hill Rd.	Los Gatos	680	12	NR	52	2,000	5	Y
fmr. Romic Chemical Corp.	37445 Willow St.	Newark	1,875	3	14	564	1,200	10	N

**Table 13a. (continued) Summary of South Bay CVOC Sites Submitting Electronic Reporting Information
AND Conducting Groundwater Extraction in 2000**

Site Name:	Site Street Address:	Site City:	Year 2000 Plume Length (ft.)	Average extraction rate year 2000 (gpm)	Total Mass Removed from Groundwater year 2000 (lbs.)	Total Mass Removed from Groundwater since GW Extraction began (lbs.)	Max. Conc. of Total VOCs year 2000 (ppb)	Years Pumping	Deed Restriction
fmr. Siemens-SMI-Sunnyvale	639 North Pastoria Ave.	Sunnyvale	NR	NR	NR	742	5,222	3	N
fmr. Velcon Filters Facility	1759/61 Junction & 1750 Rogers	San Jose	850	30	479	1,755	23,400	5	N
Great Western Chemical Co.	945 Ames Ave.	Milpitas	3,300	53	81	8,462	20,960	14	N
Hewlett-1501 Page Mill Rd.	1501 Page Mill Rd.	Palo Alto	1,500	9	106	1,120	4,100	5	N
Hewlett-Packard-395 PMR	395 Page Mill Rd.	Palo Alto	3,200	8	2	337	55,770	4	Y
Hewlett-Packard-640 Page Mill	640 Page Mill Rd.	Palo Alto	3,200	45	65	965	55,770	18	Y
IBM	5600 Cottle Rd.	San Jose	3,370	743	152	10,678	168,400	17	N
InnerConn Tech & Union Bank	327 Moffett Boulevard	Mountain View	500	7	3	13	659	8	N
Intersil/Siemens Site	N. Tantau Ave & Homestead Rd	Cupertino	2,620	185	124	2,821	2,400	14	N
Jones Chemicals	985 Montague Expressway	Milpitas	3,125	97	264	23,848	27,334	16	N
Lynch Circuits	1140 West Evelyn Ave.	Sunnyvale	600	9	6	41	3,982	6	N
McKesson Chemical Co.	33950 Seventh St.	Union City	2,650	78	240	5,775	1,364	15	N
Middlefield-Ellis-Whisman & Moffett Field	Middlefield Rd, Ellis St., Whisman Rd	Mountain View	7,610	675	204	46,390	49,100	19	Y
Moffett Federal Airfield		Moffett Field	2,800	82	568	1,168	18,630	2	N
Mohawk Laboratories	932 Kifer Rd.	Sunnyvale	NR	36	1,287	26,754	351,500	7	N
Montwood – Plymouth St.	1615 & 1625 Plymouth St.	Mountain View	NR	3	5	68	1,770	6	N
Owens Corning	960 Central Expressway	Santa Clara	NR	2	1	91	170	8	N
Philips 730 Evelyn Avenue	730 East Evelyn Ave.	Sunnyvale	1,060	26	7	99	155	12	N
Philips 740 Kifer Rd.	740 Kifer Rd.	Sunnyvale	1,150	20	8	64	242	17	N
Philips 811 Arques & Offsite OU	811 East Arques Ave.	Sunnyvale	5,600	293	2,132	42,000	85,940	18	N
SDOU—Subunits 3 and 4	1077 East Arques Ave.	Sunnyvale	2,600	37	94	235	863	2	Y
Siliconix, Inc.	2201 Laurelwood Rd.	Santa Clara	1,000	5	59	260	11,221	10	N
Spieker Properties	2710 Lafayette St.	Santa Clara	NR	2	5	143	1,073	9	?
Stewart Dr. Subunits 1, 2, and 5	999 East Arques Ave.	Sunnyvale	2,655	23	26	181	78,170	10	?

**Table 13a. (continued) Summary of South Bay CVOC Sites Submitting Electronic Reporting Information
AND Conducting Groundwater Extraction in 2000**

Site Name:	Site Street Address:	Site City:	Year 2000 Plume Length (ft.)	Average extraction rate year 2000 (gpm)	Total Mass Removed from Groundwater year 2000 (lbs.)	Total Mass Removed from Groundwater since GW Extraction began (lbs.)	Max. Conc. of Total VOCs year 2000 (ppb)	Years Pumping	Deed Restriction
UTC. Chemical Systems	600 Metcalf Rd.	San Jose	14,623	11	24	2,200	180,000	13	?
UTC. Chemical Systems	600 Metcalf Rd.	San Jose	2918	NR	NR	NR	180,000	3	?
UTC. Chemical Systems	600 Metcalf Rd.	San Jose	1239	NR	NR	NR	180,000	3	?
Varian-601 Calif Ave	601 California Ave.	Palo Alto	3,200	28	79	1,576	55,770	13	Y
Western Microwave, Inc./Sobrato	1271 Reamwood Ave.	Sunnyvale	NR	1	4	10	2,580	5	?

NR = Not Reported; ? = Deed restriction status not clear

**Table 13b. Pilot Electronic Reporting Project For
South Bay CVOC Sites NOT Conducting Groundwater Extraction in 2000**

Site Name:	Site Street Address:	Site City:	Plume Length (ft.)	Total Mass of VOCs Removed from Groundwater during GW Extraction (lbs.)	Year 2000 Maximum Total VOCs in Groundwater (ppb)	Years Pumping	Deed Restriction
Cupertino Electric Inc.	1132 N. Seventh St	San Jose	NR	NR	NR	0	N
Deluxe	1551 Dell Ave.	Campbell	500	237	243	6	N
Edward Ave. Site	3465-3475 Edward Ave.	Santa Clara	400	NR	18,700	0	N
Fairchild San Jose	101 Bernal Rd.	San Jose	650	146861	2,670	16	Y
FMC Corporation	333 West Brokaw Rd.	Santa Clara	920	NR	1,661	0	N
FMC Corporation	333 West Julian St	San Jose	575	9	529	5	Y
FMC Corporation	495 East Brokaw Rd.	San Jose	316	NR	8,890	1	N
fmr. Englehard-Adult Edu. Ctr	333 Moffett Boulevard	Mountain View	1420	NR	438	0	N
fmr. Metropolitan Corporate Ctr	3165 Kifer Rd	Santa Clara	300	NR	135	0	N
fmr. Rohm and Haas	800 Chestnut St	Redwood City	1690	NR	7,417	0	N
fmr. Varian Assoc, Inc. Facility	3100 Jay St	Santa Clara	180	45.6	180	8	N
Georgia-Pacific Corporation	38801 Cherry St	Newark	300	7	101	4	Y
Hewlett Pkrd-3175 Bowers	3175 Bowers Ave.	Santa Clara	400	48	138	11	N
Hewlett Pkrd-3500 Deer Crk	3500 Deer Creek Rd.	Palo Alto	575	1144	36,720	8	N
Hewlett Pkrd-Wolfe Rd.	10900 Wolfe Rd., Bldg. 44L	Cupertino	175	NR	22	0	N
Intel Santa Clara 3	2880 Northwestern Pkwy	Santa Clara	240	38.1	44	8	N
Magnetic Peripherals, Inc. (MPI)	3333 Scott Boulevard	Santa Clara	365	157	105	8	Y
Villa Cleaners	36565 Newark Boulevard	Newark	110	13	15,600	1	N

NR = Not Reported; ? = Deed restriction status not clear

The S.F. Regional Board required submittal of selected groundwater-monitoring information at all CVOC plume sites in the South Bay that are under board order. The results allowed the S.F. Regional Board to better understand the feasibility of electronic reporting of CVOC plume data to summarize the status of these groundwater cleanup projects.

7.4.3 Plume Dimensions

The median plume, based on monitoring data from 2000, was reported to be 1,360 feet long and 50 feet deep below the ground surface. Since several of the plumes are commingled, the number of actual plumes is only 64, compared with 74 sites responding.

Table 14. Plume Size Based on MCL Isoconcentration Data (Year 2000)

Plume Length (feet) Based on MCL Isoconcentration Line				
Median	Average	Minimum	Maximum	n (count)
1,360	1,972	110	14,623	64
Plume Depth (feet) Below Ground Surface				
Median	Average	Minimum	Maximum	n (count)
50	57	9	364	63

7.4.4 Cleanup Progress

Ideally, groundwater cleanup progress is measured by comparing the maximum concentrations of CVOCs to drinking water standards. However, these standards are in the part-per-billion range and unlikely to be achieved for several decades, primarily because CVOCs preferentially adsorb to aquifer material and desorb into groundwater at very slow rates.

Cleanup progress can also be measured by comparing the maximum historical concentrations detected in groundwater monitoring wells to year 2000 results. This comparison provides a large-scale indication of cleanup progress, since the maximum concentrations were measured, on average, in 1991 for TCE and in 1993 for vinyl chloride. Figures 29 and 30 and Tables 15 and 16 show comparisons of the maximum historical and year 2000 concentrations for total CVOCs, TCE, and vinyl chloride. In general, the results show significant progress in groundwater cleanup. For example, the maximum levels of TCE and vinyl chloride were reduced an average of 93 percent and 90 percent, respectively.

Table 15. Maximum TCE Concentrations in Groundwater (ppb)

	Median	Average	Minimum	Maximum	n (count)
Historical	5,950	152,320	5	6,100,000	72
Year 2000	599	7,674	1	92,000	72

Drinking-water standard is 5 ppb

Table 16. Maximum Vinyl Chloride Concentrations in Groundwater (ppb)

	Median	Average	Minimum	Maximum	n (count)
Historical	333	4,216	1	53,000	54
Year 2000	31	773	1	8,500	54

Drinking-water standard is 0.5 ppb

7.4.5 Groundwater Extraction

Most CVOC release sites in the South Bay use groundwater pump-and-treat as an interim or final remedial measure. Of the 74 sites that submitted electronic data, only seven had not pumped groundwater. The earliest pumping began in 1981, and most sites have pumped for more than 10 years. The median site has been conducting groundwater extraction for 12 years. The total amount of water removed from shallow aquifers on an annual basis for CVOC remediation is nothing short of astounding. The combined groundwater withdrawal rate for these sites in 2000 was 3,259 gallons per minute (gpm), or 5,254 acre-feet per year. In comparison, ACWD's total municipal use is about 20,000 acre-feet per year. Of the 54 sites still pumping, the median site pumped groundwater at a rate of 20 gpm in 2000. Because some sites remove very large amounts of water (743 gpm was the maximum in 2000), the mean extraction rate was greater (64 gpm). Fifteen sites pumped less than 10 gpm; 21 pumped 10 to 50 gpm; 10 sites pumped 50 to 100 gpm; and four pumped more than 100 gpm.

7.4.6 Effluent Discharge

Given the very large volume of groundwater withdrawn for remediation purposes, it is important to consider what is done with the water after treatment. Only five sites indicated that they reuse treated effluent onsite or re-inject the water back into the aquifer. Eleven sites discharge treatment plant effluent to a POTW. The majority of sites (42) simply discharge their treated effluent into a surface water receiving body, with 31 of these discharging water to the local storm drain, and 11 discharging water to a nearby creek.

7.4.7 Turning Off The Pumps

Groundwater extraction has been discontinued at 13 of the 67 sites that conducted pumping, even though cleanup standards have not been reached. Typically, sites that have been authorized to discontinue pumping have the following characteristics.

- The plume is not located in a sensitive groundwater area.
- Groundwater extraction had been implemented for a significant period of time (average eight years).
- Concentrations in all wells were stable or declining.
- The mass of chemicals removed relative to the volume of water withdrawn from the aquifer had diminished to the point that continued pumping was not justifiable.
- Ongoing monitoring is required.

7.4.8 Mass of CVOCs Removed

While most sites are far from reaching the part-per-billion cleanup standards, a very significant mass of CVOCs has been removed from aquifers. Cumulatively, 382,000 pounds of CVOCs have been removed from the groundwater at 62 sites. This does not include the additional mass of CVOCs removed from unsaturated soils using soil vapor extraction. At many sites, the mass removed by soil vapor extraction significantly exceeds the mass recovered from groundwater.

Table 17. Total Solvent Mass Removed From Groundwater

	Median	Average	Minimum	Maximum	n (count)	Total Mass All Sites
Year 2000 Mass Removed (in pounds)	44	300	0.3	6,647	50	15,024
Total Mass Removed From Groundwater Since System Startup (in pounds)	316	6,159	7	146,861	62	381,875

The mass of chemicals released at the many CVOC release sites varies tremendously. As Table 17 (above) shows, the maximum mass of CVOCs removed from groundwater at a single site was 146,861 pounds. Two other sites have removed more than 40,000 pounds each. Thus, of the total 381,875 pounds removed, 232,000 pounds have been removed at only three sites. Table 18 (below) categorizes sites on the basis of the amount of CVOCs removed.

Table 18. Pounds of Solvents Removed from Groundwater

	Pounds	Number of Sites
Year 2000	> 1,000	4
	100 - 1,000	11
	10 - 99	20
	< 10	13
Since System Startup	> 40,000	3
	20,000 - 40,000	3
	1,000 - 19,999	13
	100 - 999	23
	< 100	19

From a remediation point of view, considerable effort is being expended to monitor and remediate plumes. This effort has been successful at protecting groundwater.

7.4.9 Innovative Remedial Technologies

In the early 1990s, groundwater scientists began to recognize the limitations of pump-and-treat as a technology for restoring aquifers to drinking water quality. While pump-and-treat systems often achieve very good results in the first years after start-up, the mass of CVOCs removed generally decreases with time at most sites. With most of the South Bay CVOC release sites having pumped groundwater for more than 10 years, many sites have already reached this point of diminishing returns with conventional pump-and-treat technology, yet very few sites have reduced concentrations to MCLs. Thus, the use of innovative remedial technologies, especially methods of breaking down CVOCs in place (i.e., within the aquifer as opposed to extracting groundwater and treating it at the surface), has been steadily increasing over the past few years.

Table 19 summarizes the use of various remedial measures among sites that submitted the requested information. As can be seen in this table, many sites have attempted to excavate contaminated soils from their source areas. A fair number have attempted soil vapor extraction either in conjunction with groundwater extraction or as a standalone measure. Only six sites have constructed slurry walls to confine contamination and prevent migration.

Relatively few sites have attempted remedial measures that can be considered innovative in situ treatment methods. Only three sites reported full-scale implementation of chemical oxidation methods to degrade CVOCs, although another 10 have tested the viability of this method at their sites. Only two sites are

conducting enhanced bioremediation as a full-scale remedial measure, while six are conducting pilot-scale tests of the method. Similarly, only two sites have implemented permeable reactive barriers, such as reduced iron filings walls. Other potential remedial measures, such as dual-phase extraction, air sparging, or thermal methods, have received even less attention. Interestingly, only one site reports implementing natural attenuation as a remedial measure.

Table 19. Summary of Remedial Technologies Utilized at South Bay Cleanup Sites

Remedial Measure	Number of Sites/Level of Implementation		
	Not Tried	Pilot/Test	Full Scale
Groundwater Extraction	7	0	65
Soil Vapor Extraction	37	7	28
Slurry Wall	65	0	6
Source Excavation	27	2	43
Chemical Oxidation	59	10	3
Enhanced Bioremediation	65	6	2
Permeable Reactive Barrier	65	5	2
Soil Fixation	0	0	1
Dual-phase Extraction	0	0	1
Natural Attenuation	0	1	0
Air Sparging	0	0	1
Six-phase Heating	0	0	1

7.4.10 Conclusions and Recommendations for Electronic Reporting of CVOC Plumes

The Groundwater Committee has identified several changes in the reporting format to address the goals of the electronic reporting project.

- Future data should be submitted using a direct Internet platform or a revised Excel spreadsheet. Year 2000 reporting used an Excel spreadsheet.
- The location and pumpage rates of extraction wells should be included.
- The estimated mass of pollutants remaining in the aquifer should be submitted. While there is relatively solid data on the mass of pollutants removed from the aquifers, there are few estimates on the mass of pollutants remaining in the aquifers.
- The S.F. Regional Board should require groups of dischargers to submit a composite plume map for commingled plumes. Both EPA and DTSC have successfully required groups of dischargers to submit composite maps.
- A major advantage of electronic data submittal is that it allows for statistical analysis of the plumes as a whole. Sites showing significant progress in cleanup can be identified and further investigated to determine what makes their approach better and whether it could be used by other sites. Meanwhile, sites making insufficient progress can also be identified. Annual or biennial reports documenting cleanup progress should be prepared for the public.
- GIS coverage of the plume outlines should be transferred to GeoTracker.
- Concerns have been raised about comparing a site historic maximum concentration versus the current site maximum concentration and whether this provides a meaningful measure of site cleanup, particularly when the two measurements came from different monitoring wells. Complete historical records of concentration data for key individual wells, or mean maximum historic concentrations versus mean current maximum concentrations (95 percent confidence interval) could provide a better understanding of site cleanup status.

7.5 Coordination with the Drinking Water Source Assessment and Protection (DWSAP) Program

The Drinking Water Source Assessment and Protection (DWSAP) program is being implemented in the South Bay Basins by the DHS, water purveyors, ACWD, SCWD, and the SMCEHSD.

The methods used to conduct the DWSAP program in the South Bay Basins and the status of these programs are described below. Recommendations for using data generated for the DWSAP program and facilitating coordination among agencies responsible for groundwater protection in the South Bay Basins are also provided below.

7.5.1 Niles Cone Coordination

Two new programs have been identified as essential components for managing ACWD's groundwater resources in the future. The first is the Wellhead Protection Program, which will identify areas vulnerable to groundwater contamination. This program will also specify management practices to reduce contamination risk, identify areas to be monitored, and present a contingency/emergency response plan for a contamination incident. Potential contaminant sources will be identified, and appropriate land-use planning compatible with the protection of groundwater quality will be considered.

The other new program is the DWSAP, which requires the identification of sensitive surface water and groundwater areas, an inventory of potential threats within those areas, and an assessment of source vulnerability. The groundwater portion of this program overlaps extensively with the Wellhead Protection Program. The primary difference between the Wellhead Protection Program and DWSAP is that the Wellhead Protection Program additionally identifies management strategies to minimize the potential for groundwater quality impacts. Because of the overlap between these programs, their development will be closely coordinated.

The ACWD has informed the DHS of its intent to conduct its own DWSAP program for its groundwater and surface water sources in accordance with DHS requirements, rather than relying on DHS staff to perform this work. Since DHS is requiring a DWSAP for all new sources of water, a "pilot" Source Water Assessment Program (SWAP) is currently being prepared for four Aquifer Reclamation Program (ARP) wells that will serve as supply wells for the ACWD's future desalination facility. This facility is scheduled to be operational 2003. The pilot SWAP will serve as a model for developing a SWAP for all ACWD facilities.

The ACWD will be performing all required components of a SWAP, including the delineation of protection zones, which will be conducted using a numerical groundwater flow model or DHS's modified calculated fixed radius method. ACWD's model, the Integrated Groundwater-Surface water Model (IGSM), is a finite-element model that incorporates all the major components of the hydrologic cycle within the ACWD, including rainfall, runoff, groundwater recharge and pumping, evapotranspiration, subsurface flows, and seawater intrusion. The ACWD has completed the delineation of protection zones for the four new supply wells and is currently compiling information and data necessary to complete the physical barrier effectiveness (PBE) checklist and inventory of potentially contaminating activities (PCAs).

The PBE checklist will be completed using existing information, including type of aquifer and aquifer material, the presence of abandoned or improperly destroyed wells within the protection zones, water levels, and well construction details. The inventory of PCAs will be completed using a variety of readily available information and databases, including:

- A list of businesses from the cities of Fremont, Newark, and Union City
- Leaking Underground Storage Tank (LUST) and Spills, Leaks, Investigation, and Cleanup (SLIC) sites within the ACWD
- Internet-based environmental database search (VISTACheck)
- Internet-based business search using the Yellow Pages

Upon completion of the PBE checklist and inventory of PCAs, the ACWD will follow DHS's DWSAP guidelines and complete the vulnerability ranking, assessment map, and assessment summary. In order to fulfill the public notification requirements after completing the SWAP, the ACWD will provide the necessary information regarding the DWSAP in its annual consumer confidence report.

The ACWD's staff is active in the DHS DWSAP Data Advisory Committee, which meets every other month. Participation in the Data Advisory Committee enables the district's staff to stay abreast of developments in the DWSAP program. The ACWD's staff also participates in DHS's DWSAP Technical Advisory Committee and Policy Advisory Committee, which meet semi-annually.

7.5.2 Santa Clara Valley Coordination

The SCVWD is assisting local public water suppliers and DHS in preparing DWSAP Assessments. Larger public water suppliers are completing the assessments themselves, while DHS will complete the assessments for small systems. A first step in conducting an assessment is to determine groundwater protection zones. To help public water suppliers and DHS complete this step, the SCVWD developed a GIS-based application for determining protection zones using the DHS-modified calculated-fixed-radius method. The application calculates groundwater protection zones based on well construction and pumping information provided by the public water suppliers and on groundwater gradient direction and effective porosity data developed by the SCVWD. The application then produces maps showing the drinking water well being assessed; the calculated protection zones, streets, fuel leak sites, and wells; the values used to calculate the protection zones; and the radius of the protection zones.

The SCVWD will give local public water suppliers information they need to evaluate the PBE associated with the well being assessed. This information includes the type of aquifer, aquifer material, the presence of nearby abandoned or improperly destroyed wells, and static water conditions in unconfined aquifers. Additionally, the SCVWD will provide the locations of the following PCA information to public water suppliers: wells, including abandoned and destroyed wells, known leaking underground storage tanks, known solvent plumes, surface water, and groundwater recharge ponds.

The SCVWD staff also participates in the DHS DWSAP Data Advisory Committee. SCVWD staff shares information with local public water suppliers via the SCVWD Water Retailer Committee and subcommittees. In turn, local public water suppliers support SCVWD groundwater management activities by providing information. The most critical elements of the DWSAP for groundwater protection efforts in the Santa Clara Valley are the well information, including well construction and pumping data, and the vulnerability assessments. The well information supports SCVWD groundwater modeling efforts, while the vulnerability assessment information will assist the SCVWD in prioritizing groundwater monitoring and protection efforts.

7.5.3 San Mateo County Environmental Health Services Division Coordination

The SMCEHSD has been under contract with the DHS since 1996 as a local primacy agency. As such, the SMCEHSD has regulatory jurisdiction over all non-state-owned public water systems supplying fewer than 200 service connections. DHS has also contracted with the SMCEHSD to conduct the DWSAP for all systems within the county's jurisdiction. Within San Mateo County, there are 18 community water systems; eight non-transient, non-community water systems, and 13 transient non-community water

systems, totaling 39 small public water systems; to be assessed before June 30, 2003. Only two small water systems are located in the San Mateo Plain. To date, no assessments have been completed.

7.5.4 Conclusions and Recommendations for Coordinating with the DWSAP Program

The DWSAP program is underway in each of the South Bay Basins. The ACWD is working on DWSAPs for two primary well fields, consisting of 17 wells, and two reclamation sites, consisting of four wells, in the Niles Cone. Thirteen water retailers, SCVWD, and DHS are completing assessments for more than 250 wells in the Santa Clara Valley. The SMCEHSD and two water retailers are completing assessments for 10 wells in the San Mateo Plain.

The deadline for completing the drinking-water source assessments is June 2003. It was too early to incorporate their specific results into this report or evaluate whether the DWSAP program is achieving its goals. However, the DWSAP program is a good step forward in groundwater protection and opens the door to a number of possibilities for increasing coordination and cooperation among agencies.

A large amount of information will be collected as the DWSAPs are completed. Information will be collected on well locations (using GPS coordinates), PBEs, well construction, well operation, areas of contribution to individual wells, the presence of PCAs, and well vulnerability. This information will be accessible by reviewing individual assessments, but there is no mechanism in place at this time to make the maps and data available digitally outside of DHS due to security concerns. As a result, the usefulness to groundwater management agencies and regulators may be limited until the security concerns are addressed.

The goals of the DWSAP program include improving drinking-water quality through wellhead protection, informing the public and water suppliers about potential water-quality threats, supporting effective groundwater management, and focusing cleanup and pollution-prevention efforts on serious drinking-water threats. The following recommendations are designed to facilitate reaching the DWSAP program goals.

- The S.F. Regional Board should provide information on PCAs to DHS and local public water suppliers, including the locations of contamination sites, information on the extent and severity of contamination at those sites, and plume maps. The data may be used to further evaluate PCAs that may be located near public water supply wells. DHS could distribute this information to water suppliers in the South Bay. The information could be made available online through DHS's Web site or through a link to the S.F. Regional Board's Web site.
- DHS should provide the S.F. Regional Board and local groundwater management agencies with maps of well locations and delineated protection areas. Regulators, groundwater management agencies, and local land use agencies can then use the information to prioritize cleanup, pollution prevention, and monitoring needs.
- Water suppliers that are completing assessments should coordinate their PCA inventories with local municipalities to identify current and historical businesses located within each protection zone that might not otherwise be apparent through standard research methods. Historical maps that indicate former businesses, such as Sanborn Insurance maps and historical Yellow Pages, should also be reviewed to identify historical PCAs.
- Well-permitting agencies should create maps of all known well locations, including abandoned, destroyed, and active wells. This information is vital to groundwater protection and cleanup efforts. This information should also be available online.
- A groundwater management plan should be developed for the San Mateo Plain. A groundwater management plan would identify the groundwater management objectives for the areas and describe the programs necessary to achieve those objectives. In addition, a groundwater management plan could facilitate funding and approval of new programs. It may be

advantageous for groundwater management to be coordinated between East Palo Alto, located in the San Mateo Plain Basin, and Palo Alto, located in the Santa Clara Valley Basin.

7.6 Surface Water and Groundwater Interaction

In the past, management of water resources has focused either on surface water or on groundwater, as if they were separate entities. As development of land and water resources increases, it is apparent that development of either of these resources affects the quantity and quality of the other. Therefore, effective management of land and water resources requires a clear understanding of the linkages between groundwater and surface water. An approach that recognizes surface water and groundwater as a single continuum is essential, yet difficult, because of limitations in knowledge about the interactions of groundwater and surface water, and the overlapping jurisdiction of state and local agencies. These difficulties are complicated by the fact that the boundaries for watersheds and groundwater basins often do not coincide.

Nearly all surface water features (streams, lakes, reservoirs, wetlands, and estuaries) interact with groundwater. Several issues have been identified, which simultaneously affect the quality and quantity of surface water and groundwater due to the dynamic relationship between the two. The affects of these issues on water quality and quantity must be understood in order to develop effective water resource management strategies. These issues include surface water diversion and groundwater withdrawal, water quality, surface water infiltration to groundwater, groundwater discharge to surface water, and changing land use (as it affects runoff and recharge).

7.6.1 Surface Water Diversion and Groundwater Withdrawal

Diversion of water from streams not only leads to reductions in stream flow, but can also cause significant declines in local groundwater levels as less surface water is available for infiltration and groundwater replenishment. Conversely, groundwater pumping near streams can cause significant declines in stream flow and beneficial riparian habitat as groundwater, which might normally discharge to a stream, is captured for agricultural or domestic use.

Riparian Water Rights. The California Water Code (Section 1200) provides property owners with the right to divert water on their own property, including surface water and groundwater that is considered to be a subterranean stream flowing through a known and definite channel. All diverters of both surface and groundwater claiming water under riparian water rights are required to file a Statement of Water Diversion and Use with the SWRCB. Certain physical conditions must be present for groundwater to be subject to riparian rights: (1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel. All other groundwater is considered to be “percolating” groundwater and is not subject to riparian water rights permitting.

In the past, the SWRCB has approved diversions from seasonal or perennial surface water bodies, and from groundwater adjacent to surface water bodies, but did not always have a full understanding of the biological and hydrological impacts of the diversions. Withdrawing water from shallow aquifers near surface water bodies can diminish the available surface water supply by capturing some of the groundwater underflow that otherwise would have discharged to surface water, or by inducing flow from surface water into the surrounding aquifer system. A recent report prepared for the SWRCB (Moyle and Kondolf, 2000) recommended that the SWRCB work with other state, federal, and local agencies and academic institutions to promote better hydrological and biological data collection and research to improve the management of riparian rights.

Riparian zones are commonly dependent upon both surface water and subsurface water. Specific impacts to riparian zones due to modifications in surface-subsurface water interaction include:

- Reduced ability to provide aquatic habitat for invertebrates, fish and other wildlife
- Reduced primary productivity, biodiversity, and reproductive success
- Stress to riparian vegetation
- Changes in nutrient and carbon cycling
- Reduced ability to mitigate floods and erosion

Effective management of water resources requires an understanding of the role of site-specific riparian zones and their dependence on the interaction of groundwater and surface water. For example, change due to addition of water in summer, when no-flow is normal, results in introduction of shallow-rooted plants and trees that can dislodge during flood events.

Wells in Alluvial Areas. One specific concern in the South Bay is the reduction of water to riparian zones, such as along San Francisquito Creek, due to surface water diversion and/or pumping of shallow groundwater from wells located along the creek banks. Throughout the study area, many wells were installed in alluvial areas during drought years. Since 1982, the San Mateo County Planning Department has required setbacks of wells from creeks and riparian corridors in the county's coastal zone. In areas where riparian vegetation is absent, new wells must be 50 feet away from the center line of a perennial creek or 30 feet from the center line of a seasonal creek. If there is riparian vegetation present in either a perennial or seasonal creek, the well setback distance is measured from the edge of the riparian vegetation. A similar setback requirement is also being considered for the San Francisquito Creek watershed.

SCVWD well standards require a minimum 50 foot sanitary seal on all water supply wells in Santa Clara County. However, the standards provide for a variance to the sanitary seal depth if (1) a water supply cannot be obtained from a deeper depth and (2) the Santa Clara County Environmental Health Department approves a shallower seal. According to the SCVWD, ecological criteria are not taken into account when wells are placed within streambed alluvium or when sanitary seal depth variances are approved.

The ACWD permits water supply wells within the vicinity of creeks and streams when the wells meet standard construction requirements. Because creeks and streams are considered potential sources of contamination, these requirements include: (1) a setback of 50 feet, (2) a location above known levels of flooding, and (3) a maximum seal depth. The Alameda County Health Department must certify water quality from the well prior to its use.

7.6.2 Water Quality

Impacted surface water can cause degradation of groundwater quality, and, conversely, pollution of groundwater can degrade surface water. Much of the groundwater contamination in the study area is in shallow aquifers that are directly connected to surface water. In some of these settings, groundwater can be a major and potentially long-term contributor to contamination of surface water and vice versa. The transition zone between groundwater and surface water should be considered when evaluating the fate, transport, and effects of contaminated groundwater.

Surface Water Infiltration to Groundwater. Impacted surface water has the potential to affect the existing or potential beneficial uses of groundwater. Groundwater beneficial uses that could be affected by impacted surface water include municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply.

Stormwater runoff that enters creeks and San Francisco Bay may be contaminated with sediments, nutrients, metals, salts, fertilizers, pesticides, fuels, solvents, oils, grease, and/or microorganisms. Studies

have shown that some urban creeks in South San Francisco Bay are impaired by chemicals found in stormwater runoff (EPA, 1999).

Allowing rain and runoff to infiltrate the soil reduces the quantity of pollutants reaching local streams and San Francisco Bay. When implemented throughout a stream's watershed, infiltration protects the stream from increased peak flows, which can cause down-cutting, bank erosion, sedimentation, and losses of property and habitat. However, any drainage feature that infiltrates runoff poses some risk of potential groundwater contamination. The risks associated with groundwater infiltration can be managed by:

- Designing landscape drainage features so that they promote infiltration of runoff, but do not inject runoff so that it bypasses the natural processes of filtering and transformation that occur in the soil
- Taking reasonable steps to prevent the illegal discharge of wastes to drainage systems

To reduce the potential risks of groundwater contamination from infiltrated stormwater runoff, the S.F. Regional Board prohibits the unauthorized construction or use of any "artificial excavation for the purpose of extracting water or injecting water into the underground" (S.F. Regional Board, 1995).

The S.F. Regional Board encourages the use of infiltration as a strategy to manage urban runoff and help protect the beneficial uses of streams and San Francisco Bay. S.F. Regional Board staff expects that, as part of their National Pollutant Discharge Elimination System (NPDES) permitted stormwater management programs, municipalities will encourage developers to implement the designs and methods described in different erosion and sediment transport control manuals. One such manual, utilized in Santa Clara County, is "Start at the Source – Design Guidance Manual for Stormwater Quality Protection." The Santa Clara Valley Urban Runoff Pollution Prevention Program also prepared a memorandum in June 1999 detailing additional considerations for incorporating the "Start at the Source" document into development projects.

This memorandum suggested the following conditions.

- Do not encourage infiltration or percolation into areas with high groundwater (less than five feet below grade or the bottom of the drainage feature); areas that drain, or are near, hazardous-materials storage or use; or areas that may affect known groundwater pollutant plumes.
- Retention and detention ponds at commercial/industrial sites should be periodically inspected by the local urban runoff pollution prevention program.
- For landscape and swales, select vegetation that requires the least amount of pesticides, herbicides, and nitrate fertilizer. Consider using native plants, which are suited to the local environment and require less care.
- Design drainage, including infiltration features, to be appropriate to site soils (note that shrink-swell clay soils are prevalent in some areas).

The municipal stormwater permit for the Santa Clara Valley, which will serve as a template for stormwater permits in other areas, contains language describing limitations on the use of infiltration treatment measures for the purpose of groundwater protection. The permit states that, at a minimum, structural treatment best management plans (BMPs), which are designed primarily to function as infiltration devices (such as infiltration trenches and infiltration basins), must meet several conditions.

- Use of infiltration devices shall not cause or contribute to groundwater quality objectives being exceeded.
- Pollution prevention and source control BMPs shall be implemented at a level appropriate to protect groundwater quality at sites where infiltration devices are to be used.
- Infiltration devices shall be adequately maintained to maximize pollutant-removal capabilities.

- The vertical distance from the base of any infiltration device to the seasonal high groundwater mark shall be at least 10 feet.
- Unless stormwater is first treated by a means other than infiltration, infiltration devices shall not be recommended for areas of industrial or light industrial activity, areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway), automotive repair shops, car washes, fleet storage areas (bus, truck, etc.), nurseries, and other high-threat land uses and activities, as designated by each co-permittee.
- Infiltration devices shall be located a minimum of 100 feet horizontally from any water supply wells.

Groundwater Discharge to Surface Water. Polluted groundwater has the potential to affect the existing or potential beneficial uses of surface water, particularly in creeks and San Francisco Bay. Surface water beneficial uses that could be affected by polluted groundwater include: the estuarine habitat, freshwater replenishment, industrial service supply, marine habitat, fish migration, municipal and domestic supply, water contact recreation, non-contact water recreation, and wildlife habitat.

For example, freshwater replenishment is identified in the Basin Plan as a beneficial use. This beneficial use is defined as “uses of water for natural or artificial maintenance of surface water quantity or quality.” This beneficial use would occur if groundwater is entering a freshwater surface water body. Therefore, if groundwater is impacted where it reaches surface water, the Basin Plan requires that it meet ambient water quality criteria for fresh water.

7.6.3 Changing Land Use

The natural interaction of surface water and groundwater can be critically affected by a change of land use. As explained below, increased impervious surfaces have resulted in adverse effects on hydrology, morphology, water quality, and ecology of surface water and groundwater. Specifically, development and redevelopment activities have resulted in increased impervious surfaces and stream channelization.

Impervious Surfaces. As development alters the natural landscape, the percentage of land covered by impervious surfaces also increases. Impervious surfaces can be defined as any material that prevents infiltration of water into the soil or subsurface. While rooftops, roads, and parking lots are the most prevalent and easily identified impervious (or low permeability) surfaces, the list also includes sidewalks, patios, bedrock outcrops, and compacted low permeability soil.

In developed areas, rainfall that once filtered slowly into the ground now becomes surface runoff, which flows across compacted earth and impervious manmade surfaces (asphalt, concrete, rooftops, etc.) and into storm drains. This disruption of the natural hydrologic cycle causes stormwater runoff to reach streams and rivers faster than the runoff can be absorbed. In addition, less water percolates into soil, resulting in reduced groundwater recharge, less water in aquifers, and a lowered groundwater table. Another effect of reduced infiltration, particularly in the dry season, is a reduction in stream base flows, which has similar ecological impacts as water diversion, described in Section 7.5.1.

Stream Channelization. Stream channelization or modification has had a profound impact on riverine ecosystems. While channelization has allowed for more efficient irrigation and drainage of farmland, provided more navigable waterways, and helped control floods, this has often been at the expense of biotic health and diversity of the river ecosystem. Studies have demonstrated that fisheries associated with channelized stream reaches are far less productive than those associated with unchannelized stream reaches (Jackson, 1989). As a result, attempts are now being made to restore the river morphology and ecology that have been degraded by channelization in the past, with the expectation of successful fisheries recovery of these water systems.

Restoration efforts can and should be addressed on both short-term and long-term scales, and at both the reach and watershed levels. Perhaps the most effective restoration goal for the long-term is to improve the riparian vegetation along streams in order to create suitable fish habitat, control soaring water temperatures, and help control stream-bank erosion and sediment loads into the waterways.

Increased stream channelization is another result of urban development that affects the interaction of surface water and groundwater. Channelization using hardscape, such as concrete, has resulted in reduced infiltration of surface water. During the recent past, some creeks in the study area have been restored using bioengineering techniques, thereby enhancing the riparian corridor areas and increasing the potential for seepage of surface water into groundwater.

7.6.4 Dry Wells or Stormwater Drainage Wells

Dry wells are constructed in the vadose zone to dispose of and infiltrate storm runoff. Dry wells are more commonly used in areas with a combination of low-density population, undeveloped curbs and gutters, and proper geologic conditions. Geologic conditions that are conducive to the use of dry wells are karst, fractured bedrock, and sandy soils (EPA, 1999).

Dry wells are preferable to other types of drainage wells that intersect the water table because infiltrated waters are typically filtered by vadose-zone soil before reaching groundwater (if they are constructed significantly above the seasonally high groundwater table). The actual reduction of contaminant concentrations during infiltration depends on the physical and chemical characteristics of the specific contaminants in the stormwater as well as the soil in the vadose zone. Installation of new dry wells and other stormwater infiltration devices is expected to increase nationwide as many states start implementing stringent municipal stormwater runoff regulations. Stormwater drainage wells are used extensively throughout the country to remove stormwater or urban runoff from impervious surfaces.

Existing Dry Well Regulations. The federal underground injection control regulations specifically define Class V injection wells to include “drainage wells used to drain surface fluid, primarily storm runoff, into a subsurface formation.” On the federal level, management and regulation of stormwater drainage wells falls primarily under the Underground Injection Control Program authorized by the Safe Drinking Water Act.

In California, stormwater drainage wells are individually permitted. The S.F. Regional Board’s Basin Plan requires local agencies to develop a shallow drainage well control program that consists of locating existing wells and establishing a permitting program for new and existing wells (S.F. Regional Board, 1995).

The SCVWD adopted a stormwater infiltration device policy in 1993. The policy includes general siting and construction requirements and siting restrictions and prohibitions (SCVWD, 1993). The ACWD does not allow drainage wells to be constructed due to their threat to groundwater quality.

Dry Wells in Atherton. Within the study area, dry wells are used extensively in the town of Atherton, located in the San Mateo Plain, where there are approximately 27 documented dry wells. Many of these dry wells were constructed in the 1950s and 1960s and typically consist of a two- to three-foot diameter hole, 25 to 30 feet deep, filled with well-graded gravel and capped with standard manhole tops. The town has no formal maintenance procedures other than cleaning out the wells’ inlets.

Where these dry wells appear to be functioning, they provide the only means of augmenting broad-area ponding and surface seepage for the disposal of stormwater runoff. Part of Atherton is very flat former farmland that was developed without the benefit of improvements to carry away runoff. According to city officials, the town’s large lot sizes (one acre minimum) and the reluctance of nearby jurisdictions to accept Atherton’s runoff make dry wells the only practical way of dealing with existing runoff.

7.6.5 Conclusions and Recommendations for Surface Water and Groundwater Interaction

Based on the review above, the Groundwater Committee has developed the following conclusions and recommendations.

Conclusions

Surface water diversion and the pumping of shallow screened groundwater supply wells is controlled under the California Water Code by the SWRCB. Throughout the study area, many wells were installed in alluvial areas during drought years. Withdrawal of either surface water or the connected groundwater underflow can adversely affect riparian zones, including primary productivity, nutrient cycling, habitat, biodiversity, and the ability to mitigate floods and erosion. For the most part, ecological criteria are not taken into account when wells are installed in the vicinity of creeks and streams.

Impacted surface water can cause degradation of groundwater quality, and, conversely, pollution of groundwater can degrade surface water. To prohibit the potential risks of groundwater contamination from infiltrated stormwater runoff, the S.F. Regional Board encourages the appropriate use of infiltration. The Santa Clara Valley's municipal stormwater permit contains language that describes limitations on the use of infiltration treatment measures for the purpose of groundwater protection. This permit may serve as a template for stormwater permits in other areas.

The Basin Plan identifies freshwater replenishment as a beneficial use. Therefore, the Basin Plan requires that where groundwater "meets" surface water it must meet ambient water quality criteria for fresh water.

The natural interaction of surface water and groundwater can be critically affected by a change in land use. Specifically, development and redevelopment activities have resulted in increased impervious surfaces and stream channelization. These actions result in reduced infiltration, which in turn results in reduced groundwater and stream base flows, which in turn has an adverse effect on riparian habitat.

Dry wells are constructed in the vadose zone to dispose of and infiltrate stormwater runoff. While they are prohibited by the ACWD, they are permitted, under certain conditions by the SCVWD, and are used extensively in Atherton, which is located in the San Mateo Plain. If dry wells are constructed properly (significantly above the seasonally high groundwater table), the injected waters are typically filtered by vadose-zone soil before reaching groundwater.

Recommendations

Creek Protection

- Further evaluation should be done to identify and prioritize creeks, riparian corridors, and watersheds that are vulnerable to impacts from surface water diversion and groundwater withdrawal.
- Groundwater conditions adjacent creeks should be evaluated and compared to the SWRCB's test for determining whether subsurface flow should be subject to riparian rights.
- Creek annual flows should be determined and wells located along creeks, should be identified along with their construction details (seals, screened intervals, filter pack intervals).
- The next version of the SWRCB's Strategic Plan should state that the SWRCB will work with federal, state, and local agencies and academic institutions to promote better hydrological and biological data collection and research to improve the management of riparian rights.
- Guidelines should be developed to assist Board staff and other regulatory agencies to evaluate plans to restore creeks using bioengineering techniques.

Groundwater Protection

- Infiltration of stormwater should be performed appropriately to minimize groundwater pollution. Language, such as in the Santa Clara Valley's municipal stormwater permit, should be used as a template for other stormwater permits to describe appropriate use of stormwater infiltration as treatment.
- The location and construction details of all dry wells in the study area should be identified and evaluated relative to the depth of the seasonal high water table in the vicinity of each dry well.

7.7 Groundwater Protection Language in South Bay City and County General Plans

7.7.1 Summary of Findings

General plans prepared for cities and counties in the South Bay Basins were evaluated to identify goals, objectives, or policies that contain groundwater protection strategies. Elaborate strategies have been developed in some cities where groundwater is being used as a primary source of water supply. In other cities, where groundwater use is limited and where water is supplied from sources outside the South Bay Basins, few or no strategies have been developed to protect groundwater resources. The general plans were also reviewed to identify groundwater cleanup strategies where groundwater has already been impacted. Appendix F summarizes the available contacts and Web sites for the planning departments of cities and counties located in the South Bay Basins. A summary of specific groundwater protection strategies identified in South Bay general plans is also provided in Appendix F.

Twenty-seven cities are located in three counties in the South Bay Basins (Figure 1). Copies of available general plan elements that describe water resources and pollution prevention were obtained for each of the cities and counties in the South Bay Basins. General plans for Union City and Hillsborough were not available. Groundwater protection strategies are described in various planning elements within the general plans, including land use, conservation, natural resources, open space, environmental concerns, environmental management, environmental quality, natural environment, and water resources. Various elements of the general plans were reviewed to answer the following questions.

- Does the general plan identify the city or county's source of water and, if so, is groundwater a key component of the water supply?
- Does the general plan specify groundwater pollution protection strategies?
- Does the general plan specify surface water protection strategies to prevent adverse impact to groundwater?
- Does the general plan specify groundwater cleanup strategies where groundwater has already been impacted?

All cities in the Niles Cone and Santa Clara Valley use groundwater for a portion of their public water supply. Cities where groundwater is a key component of the water supply include Fremont, Newark, and Union City (Niles Cone); and Campbell, Cupertino, San Jose, and Santa Clara (Santa Clara Valley). As described in previous sections of this report, groundwater is currently not being used as the primary source of water supply in the San Mateo Plain except in East Palo Alto and the East Menlo neighborhood of Menlo Park. The following cities have general plans that describe the source of public water supply, be it groundwater or imported surface water: Fremont and Newark (Niles Cone Basin); Campbell, Cupertino, Milpitas, Mountain View, Palo Alto, San Jose, Saratoga, Santa Clara, and Sunnyvale (Santa Clara Valley Basin); and Belmont, East Palo Alto, Foster City, Menlo Park, San Carlos, and San Mateo (San Mateo Plain Basin).

Results of the general plan review indicate that several cities and all three counties in the South Bay Basins include groundwater protection strategies in their general plans. The level of detail within the plans varies considerably. Most cities, where groundwater is the primary source of public water supply,

have general plans that contain detailed groundwater protection strategies. Examples of cities where elaborate groundwater protection strategies have been developed include Fremont (Niles Cone) and Morgan Hill, San Jose, Santa Clara, and Sunnyvale (Santa Clara Valley). With the exception of Redwood City, there are no cities in the San Mateo Plain with groundwater protection strategies addressed in their general plans. Some cities, such as Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, and Saratoga, are bedroom communities located on the margins of the groundwater basin.

Examples of specific groundwater protection strategies included within some general plans are listed below.

- Coordinate with water agencies to monitor water quality and maintain good water quality
- Protect recharge areas
- Prevent groundwater contamination due to impacts from new development
- Require methods to prevent groundwater pollution
- Design standards to prevent high water table; saltwater intrusion
- Prevent subsidence
- Enforce local codes to prevent contamination
- Manage storage of hazardous materials
- Enforce hazardous materials regulations to prevent groundwater pollution
- Manage reclaimed water to avoid adverse impact to groundwater
- Identify and seal abandoned wells that may act as conduits for groundwater pollution
- Prevent cross-contamination through sewers, installation of piles, dry wells, and improperly abandoned wells

Most of the general plans for cities in the South Bay Basins do not include specific surface water protection strategies to prevent adverse impact to groundwater. An element of Cupertino's general plan includes a policy to "retain creek beds, riparian corridors, water courses, and associated vegetation in their natural state to protect wildlife habitat and recreation potential and assist groundwater percolation."

The general plans were also reviewed to identify groundwater cleanup strategies where groundwater has already been impacted. Mountain View is the only city that has developed an action to "provide assistance to state, regional, and federal agencies overseeing cleanup of groundwater contamination in Mountain View."

7.7.2 Conclusions and Recommendations Based on Review of South Bay General Plans

Conclusions

City and county general plans provide a range of groundwater protection strategies in the South Bay. Each city and county determines the relative importance of various issues to local planning and decides how they are addressed in the general plan. The source of public water supply for each city is described in most of the general plans where groundwater is being used.

Some cities have extensive and specific discussions on groundwater protection issues in their general plans, while other cities are silent. The correlation among general plan discussions and implementation was not fully examined in this review.

Moreover, this survey did not include interviews with local planners or review of specific ordinances. The Groundwater Committee's experience is that most cities do not take an active role in groundwater protection. Notable exceptions are Newark, Fremont, and Union City, which require the investigation and sealing of vertical conduits as a condition of redevelopment permits.

Recommendations

- The S.F. Regional Board and local agencies should compile examples of general plan groundwater protection strategies and ordinances and make these available to local planners. Such information could be communicated in workshops or in mailers, or posted online.
- City and county planning agencies need better access to information on existing groundwater pollution sites when considering redevelopment projects so that future land uses are compatible with existing cleanup requirements. For example, some South Bay sites are being cleaned up to levels that are protective of industrial uses; however, if local land-use changes, there needs to be a mechanism for revisiting cleanup standards.
- The S.F. Regional Board and local groundwater management agencies need to encourage local planners to take a more active role in groundwater protection. Specifically, land use agencies need to be encouraged to impose permit requirements related to groundwater protection for development in sensitive groundwater areas. Examples of permit requirements could be sealing of vertical conduits and restrictions on hazardous materials storage and use.

7.8 Regulatory Structure and Information Management

7.8.1 Regulatory Maze

The regulatory structure for groundwater protection is fairly complicated and has been characterized by overlapping authority, limited budgets, and differing priorities. Historically, there has been very little data sharing among the various state and local groundwater protection agencies mostly because they do not have good information sharing mechanisms. Notable exceptions include local agencies supplying well-permitting data to the Department of Water Resources (DWR) and LUST cleanup data to the Regional and State Boards. Likewise, the various state groundwater protection agencies do not have good mechanisms for making information accessible to the public.

In the South Bay, eight different agencies regulate groundwater cleanup projects. The evaluation of local groundwater protection must be considered in light of the state's own diversified and decentralized management of groundwater resources. California is unique in the nation in its multi-agency approach to groundwater protection. Responsibility for groundwater protection is shared among local agencies, the California State and Regional Water Boards, DWR, and DHS. Information sharing is hindered because each agency has historically used a unique database. Furthermore, groundwater protection, from a pollution prevention standpoint, has been a low priority. High-priority groundwater protection programs have generally focused on addressing problems that have already occurred (e.g., state Superfund Program, Leaking Underground Fuel Tank Program, Solid Waste Assessment Test, MTBE Program) although pollution prevention is the most effective and economical groundwater protection strategy. A comparison of groundwater protection measures for various state and federal programs is shown in Table 20.

Table 20. Comparison of Groundwater Protection Measures for Various State and Federal Programs

Protection Measure	Fuel Leaks/ MTBE	Non-Fuel Leak Groundwater Pollution (Typically solvent plumes)				Landfills	Above-ground Tanks	Dry Cleaners
	LUST	RWQCB SLIC	RWQCB Superfund	DTSC Site Mitigation	EPA Superfund	EPA Sub D/ RWQCB WDRs	AGT Program	N/A
Comprehensive list of regulated sites	Y	Y	Y	Y	Y	Y	N/A	N
Tracking system for site status	Y	N/A	N/A	N/A	N/A	N	N	N
Individual cleanup orders issued	N	Y	Y	Y	Y	Y	N	N
Prioritization system established	Y	N	N	N	Y	N	N/A	N
Site information available online	Y	N/A	N/A	N	N	N	N/A	N
Location information available online	Y	N	N	N	N	N	N/A	N

Y = Yes, protection measures implemented

N/A = Either not publicly available, available but not up to date, or under development

N = No, protection measures not implemented

The South Bay Groundwater Protection Evaluation has provided a unique opportunity to compare local approaches and see how state and federal programs are implemented in three basins. Local approaches range from the tightly managed Niles Cone Basin to the moderately managed Santa Clara Valley and the unmanaged San Mateo Plain. The varying approaches reflect the authority of the local agency, the importance of groundwater as a local water supply, and the basin's sensitivity to pollution. Some programs are working exceptionally well and could serve as models to other agencies both within and outside the study area (Table 21). For example, the SCVWD's GIS Program and ACWD's Well Abandonment Program are both highly effective.

Table 21. Comparison of Local Agencies' Groundwater Management Programs

Program	Niles Cone	Santa Clara Valley	San Mateo Plain
Local Agency	ACWD	SCVWD	SMCEHSD
Ambient Water Quality Monitoring Wells	Yes	Yes	No
Annual Monitoring Reports	Yes	No	No
GIS Status	Initial development	Moderately developed	Initial development
Leaking Underground Storage Tank Oversight	Non-LOP ¹ Program	LOP ¹	LOP ¹
Control of Retail Pumping	Yes	Yes	No
Links Redevelopment Permits to Locating and Sealing Vertical Conduits	Yes	No	No
Requires Setbacks of Wells from Creeks and Riparian Corridors	Yes	No	Yes

¹Local Oversight Program

Several new statewide groundwater protection programs are being developed that will address many of the data shortcomings discussed above. These programs, which are discussed in detail in Section 6, include:

- SWRCB's System for Water Information Management (SWIM) and Water Information Network (WIN)
- SWRCB's GeoTracker project
- SWRCB's Comprehensive Groundwater Quality Monitoring Program
- SWRCB's Groundwater Ambient Monitoring and Assessment (GAMA) Program
- DHS' Drinking Water Source Assessment Protection (DWSAP) Program
- DWR's Bulletin 118 Update on Groundwater Basins of California

7.8.2 Conclusions and Recommendations for Regulatory Structure and Information Management

- The S.F. Regional Board should make information available on groundwater pollution sites to DHS and local public water suppliers. DHS should provide the S.F. Regional Board and local groundwater management agencies with electronic data on well locations and delineated protection areas. Regulators and groundwater management agencies can then use this information and data to prioritize cleanup, pollution prevention, and monitoring needs.
- A groundwater management plan should be developed for the San Mateo Plain that identifies the groundwater management objectives for this area and describes the programs necessary to achieve those objectives. A groundwater management plan could facilitate funding and approval of new programs. It may be advantageous for groundwater management to be coordinated between East Palo Alto, located in the San Mateo Plain Basin, and Palo Alto, located in the Santa Clara Valley Basin.
- All groundwater cleanup sites should be listed in a common database, accessible via the internet. For example, fuel cases are tracked using GeoTracker.
- The EPA, DTSC, and S.F. Regional Board should independently maintain Web sites with summary information about the non-fuel groundwater cleanup sites they regulate. The sites should be cross-referenced (i.e., linked to each of the other agencies).
- Agencies should agree on consistent site naming/numbering/tracking conventions.

8.0 KEY FINDINGS AND RECOMMENDATIONS

At the heart of groundwater protection is the need to understand basin hydrogeology and appropriately regulate current and future water quality threats. The Groundwater Committee surveyed a wide range of groundwater protection programs, compiled GIS data layers on pollution sites and well locations, and placed special emphasis on several key focus areas. Based on these efforts, the Groundwater Committee has prepared the following summary findings and recommendations for better protecting groundwater beneficial uses.

8.1 Overall Groundwater Quality

Groundwater quality varies throughout the South Bay Basins, but is generally of very high quality, particularly in deeper aquifer systems. In the deeper aquifers, in inland areas of the basins, water meets drinking water standards in nearly all wells even before treatment. This high quality is due to the natural protection offered by the overlying geologic materials and aggressive programs to locate and cleanup pollutants in areas that supply drinking-water. Deeper aquifers have been impacted by saltwater intrusion due to historical overpumping, especially in the Niles Cone and to a small extent in the Santa Clara Valley. This overpumping has been stopped, and active management in the two basins is slowly reversing the historical damage.

In contrast, there is significant and widespread pollution of the shallow aquifers from a variety of sources, including leaking fuel and solvent tanks (underground and aboveground), historic drycleaner facilities, leaking sewer lines, agricultural fertilizers, and leaking landfills. Cleanups at these sites are regulated by six different agencies. Investigations are complete, and cleanup is underway at the majority of regulated sites. A wide range of pollutants and /or polluting activities has the potential to degrade water quality in the South Bay Basins, with the major chemical threats being MTBE, solvents, nitrates, and salinity (via saltwater intrusion).

8.2 Fuel Leaks and MTBE

Leaking underground storage tanks (LUSTs) and the associated release of MTBE account for the largest number of groundwater pollution sites in the South Bay. As of September 2001, there were 947 open LUST sites and 2,109 closed LUST sites in the South Bay Basins (Figure 21 and Table 6). MTBE will be banned as a fuel additive in California after December 31, 2003. Thus, while new releases continue to be regularly reported, future MTBE releases should become rare after the ban has been fully implemented. Largely due to vigorous oversight efforts by the responsible agencies, groundwater contaminants from these leaking fuel LUSTs have had minimal effects on municipal and domestic wells in the South Bay Basins. To date, only one well has been impacted by MTBE.

Using the State Water Resources Control Board's (SWRCB's) MTBE Prioritization Guidelines, there are 98 high priority (Class A) and 280 medium priority (Class B) sites in the South Bay Basins. All Class A and Class B priority sites have completed an investigation. Further, all Class A and approximately 50 percent of Class B sites have implemented corrective actions. None of the groundwater protection programs, other than LUST, contain prioritization and ranking strategies. Groundwater extraction is a typical remedy for all Class A plumes, or where the plume is migrating. A total of 208 South Bay LUST sites have implemented groundwater extraction, consisting of 52 in Niles Cone, 101 in Santa Clara Valley, and 56 in the San Mateo Plain.

Several new initiatives and programs currently underway directly affect the South Bay Basins. These programs have come about as the LUST Cleanup Program has matured, evolving from an approach of individual case management to one of identifying high-risk sites and marshalling each regulatory agency's efforts to see how they can best protect the South Bay's groundwater resource. The most significant of these programs are described below.

- **Reopening Fuel LUST sites.** The need to reopen closed fuel LUST sites that were closed prior to 1998 is being evaluated to determine if MTBE is a chemical of concern.
- **Monitoring Active Service Stations.** As part of a Pilot Program by the SF Regional Board and SCVWD, monitoring of active service stations was conducted. The preliminary results of this study, together with other SCVWD studies, indicate that MTBE and other gasoline constituents are detected at up to 60 percent of the facilities. Furthermore, at more than 40 percent of the facilities, MTBE is present at concentrations significant enough to threaten groundwater. Direct environmental or groundwater monitoring is needed to properly detect releases (past and future) of gasoline and its constituents, such as Methyl tert Butyl Ether (MTBE), that are not otherwise detected by the UST leak detection system. Releases that are not detected by existing UST system monitoring equipment will continue to pose a significant threat to groundwater supplies and drinking water wells. Several studies demonstrate that 40 to 60 percent of facilities with upgraded or new UST systems have releases that go undetected by the UST monitoring equipment. When releases go undetected and impact groundwater quality, the contamination can, and has, migrated to nearby water supply wells (as was case of the MTBE impact to Great Oaks Water Company well Number 3 in Santa Clara County).
- **Use of GIS in SWRCB's MTBE Guidelines.** The existing GeoTracker (<http://geotracker.swrcb.ca.gov/>) provides a Web-based tool that the public and local agencies can use to conduct case-by-case review of information about LUSTs and drinking water wells. Routine updating of GeoTracker began in late 2001 within the S.F Bay Region, including the South Bay Basins.

8.3 Solvent Plumes

The investigation and cleanup of chlorinated solvents is a significant issue in the South Bay Basins. Intermittent trace levels of volatile organic compounds have been detected in public water supply wells. However, only four wells have had consistent detections above drinking-water standards, and those wells have been destroyed.

Almost all regulatory efforts focus on the large plumes initially discovered in the late 1980s. In most of these cases, investigations are complete and cleanups are underway. Regulatory lead for South Bay solvent sites is shared. The S.F. Regional Board has the bulk of the sites, while local agencies, the Department of Toxic Substances Control (DTSC), and the U.S. Environmental Protection Agency (EPA) share the lead for the remaining sites. The Alameda County Water District (ACWD) and San Mateo County Environmental Health Services Division (SMCEHSD) act as lead agencies for a number of cleanups. The Santa Clara Valley Water District (SCVWD) does not assume lead responsibility for any non-fuel sites.

None of the groundwater protection programs has focused on historical solvent leaks from drycleaning facilities. Drycleaner sources are viewed as significant and relatively unquantified threats to groundwater quality in the South Bay. In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances impacted groundwater. Section 7.2 of this report discusses the high potential for groundwater contamination from solvents discharged to leaking sewer lines.

Recommendations pertinent to solvent plumes are listed below.

- Include prioritization and development of a common database for all sites, regardless of lead agency.
- Require electronic reporting of solvent plume monitoring data to GeoTracker.
- Require coordinated monitoring and reporting of commingled plumes regulated by the S.F. Regional Board, and routine monitoring of groundwater and discharges of treated extracted

groundwater at solvent cleanup sites to determine whether stabilizers are present. For sites where the solvent stabilizer plume is larger than the primary solvent plume, additional cleanup may be required.

- Conduct a comprehensive inventory of historical and current drycleaner facilities and investigate high-priority sites.

8.4 Electronic Reporting Project for Solvent Plumes

A total of 74 sites submitted electronic summary data describing the size and magnitude of solvent plumes and the progress of cleanup attempts. The sites include most of the major South Bay plumes and provide a snapshot of cleanup progress. The median plume length is 1,360 feet (range 110 to 14,623 feet), and the median depth of the pollution extends 50 feet below the ground surface (range 9 to 364 feet).

Cleanup data show impressive progress. A total of 382,000 pounds of solvents has been removed from the groundwater at these South Bay sites, and maximum concentrations have dropped by 93 percent over an average 12-year cleanup period. Cleanup to low part-per-billion drinking water standards is still rare, and most sites are expected to take several more decades to reach these low levels. After more than a decade of active cleanup, several sites are reaching a point where groundwater extraction no longer removes significant mass. Accordingly, dischargers are proposing more passive cleanup methods and long-term monitoring. Ultimately, electronic reporting could allow for better long-term management and tracking of these sites.

In addition to statistical information, the Groundwater Committee also requested submittal of electronic maps of plume outlines. This is the first attempt in Northern California to compile a regional plume map using electronic data. The maps will allow the S.F. Regional Board to better coordinate and prioritize regulatory oversight (Figures 22 and 23). In addition, the maps will allow local well-permitting agencies and water suppliers to better understand the location of these long-term pollution problems.

8.5 Solvent Stabilizers

An emerging issue at solvent cleanup sites is the presence of solvent stabilizers, such as 1,4-dioxane. Solvent stabilizers have thus far received little attention from a regulatory perspective. However, the recent detection of 1,4-dioxane at several South Bay sites that were believed to be fully characterized indicates that monitoring solvent stabilizers in groundwater and in discharges of treated extracted groundwater should become a standard requirement at solvent cleanup sites. For sites where the solvent stabilizer plume is larger than the primary solvent plume, additional cleanup may be required.

8.6 Drycleaner Cleanups

Historical solvent leaks from drycleaning facilities pose a significant but relatively unquantified threat to South Bay groundwater quality. In the past, drycleaners routinely discharged waste solvents to sewer lines, which in many instances resulted in impacts to groundwater. Drycleaners can also cause groundwater contamination as a result of releases from sumps, leaking machines, and dumping. Investigation and cleanup of drycleaner sites has not been a major focus of any groundwater protection program, yet they are often located proximate to recharge areas or drinking water supply wells. As of 1998, there were about 350 drycleaners in the South Bay, while only 42 have been investigated, primarily as a result of impending property transactions.

As an outgrowth of this project, and in recognition of the need to better understand threats from drycleaners, the S.F. Regional Board recommended that the SCVWD receive a \$70,000 grant from the State Water Pollution Cleanup and Abatement Account. The grant would be used to conduct a detailed study of past and current drycleaner operations in northern Santa Clara County.

8.7 Leaking Sewer Lines

The Groundwater Committee conducted a qualitative evaluation of the potential for exfiltration from sewer lines in the South Bay to affect groundwater quality, using the city of Sunnyvale as an example (Section 7.2 and Appendix H). We believe the primary potential for groundwater quality degradation is from the historic disposal of solvents, particularly at drycleaners and electronics manufacturing facilities (wafer fabricators, plating shops, and printed circuit board shops). In the context of sewer lines affecting water quality, exfiltration (i.e., leakage from sewer lines to groundwater) is a major factor.

As regulation of wastewater treatment facilities has increased, and as municipalities have improved public outreach and education efforts, the discharges of chlorinated solvents to sewer lines, have decreased. Permitted discharge limits for VOCs have also decreased. For South Bay wastewater treatment facilities, 1 mg/l is the most common limit for total VOCs (expressed as total toxic organics) in a permitted discharge. In the past, VOC limits have been as high as 5 mg/l at the Palo Alto Regional Water Quality Control Plant, and higher elsewhere.

Recommendations for addressing this potential problem include more frequent monitoring of influent to publicly owned treatment works, focused monitoring of trunk lines and sewer-flushing activities, and review of pretreatment limits allowing discharge of HVOCs to sewers to determine the degree of groundwater protection they offer in light of the potential for sewer line leaks.

8.8 Nitrates

In the Niles Cone, nitrate levels were historically detected above California's primary maximum contaminant level (MCL) of 45 ppm southwest of Union City and south of the Niles district of Fremont. In 1997, however, the nitrates range in all ACWD groundwater production wells was between 0.1 and 24.8 ppm, with an average of 7.7 ppm, well below the MCL.

A relatively small number (18 of 242, or 7 percent) of public water-supply wells in the Santa Clara Valley were reported to have nitrate concentrations greater than California's primary maximum contaminant level (MCL) of 45 mg/l during the period from 1980 to 2000. Since 1996, nitrate in excess of the drinking water standard has only been detected in one well. SCVWD is working with local farmers and land owners by conducting outreach and education on reducing nitrate loading.

Little information is available for nitrates in the San Mateo Plain. From the few water samples collected in the cities of Hillsborough, San Mateo, Menlo Park and East Palo Alto in 2000 and 2001 none of the samples showed nitrate concentrations of concern or that would require ongoing monitoring. Nitrate concentrations in all analyzed wells ranged from non-detect to 45 percent of the MCL. The lowest concentrations were found in East Palo Alto and the highest in the City of San Mateo.

8.9 Emerging Contaminants

Emerging contaminants, including N-nitrosodimethylamine (NDMA), endocrine disruptors, and pharmaceutically active compounds, may be present in sanitary wastewater, recycled water, imported water, and any other water source that receives sanitary wastewater. Emerging contaminants may pose a threat to groundwater quality when such waters are used for artificial recharge or otherwise intentionally infiltrated. The SCVWD is developing a water quality standard for intentional infiltration with recycled water, imported water, local surface water, and storm water runoff. The SCVWD is also evaluating if and to what extent recycled water needs to be treated to meet groundwater protection concerns and users needs for different uses.

8.10 Other Pollutants of Concern

Beyond the major chemical threats to South Bay groundwater quality discussed above, there are several other pollutants that have been released at a small number of toxic sites. These pollutants include arsenic, PCBs, hexavalent chromium, and perchlorate. Hexavalent chromium has received increased media and public attention following the recent DHS announcement of a public health goal of 2.5 ug/l for total chromium.

An inventory of S.F. Regional Board sites shows that only one chromium contamination site is located in the South Bay Basins. Arsenic and hexavalent chromium have been detected in public drinking water wells at concentrations below drinking water standards. They are believed to be associated with natural sources. In the South Bay, there are about 25 regulated groundwater cleanup sites with either arsenic, PCBs, hexavalent chromium, or perchlorate. No comprehensive, cross-agency list of these sites exists.

8.11 Saltwater Intrusion

Saltwater from San Francisco Bay and adjacent salt ponds has intruded freshwater-bearing aquifers in all three South Bay Basins. In the Niles Cone Basin, historical overpumping caused saltwater intrusion to extend almost to the Hayward Fault, approximately five miles east of San Francisco Bay. Saline water appears to have entered the Newark Aquifer through natural gaps in the overlying aquitards and along abandoned or unsealed wells when groundwater levels dropped below sea level. Increasing salinity levels have been documented in several areas of the Niles Cone Basin. The cause of the salinity increase is not known with certainty; it may, however, be due to mixing between residual historical highly saline water and infiltration from the recharge area that dilutes and disperses the saline water.

The ACWD has used imported surface water supplies to supplement local recharge and raise groundwater levels. To restore the saltwater-contaminated aquifers, the district has the following programs in place: an expanded artificial recharge program, an aquifer reclamation program that pumps entrapped saltwater from the basin into San Francisco Bay, and a semi-annual groundwater monitoring and annual reporting program.

In the Santa Clara Valley Basin, some aquifers (especially the shallower ones) adjacent to San Francisco Bay have been affected by saltwater intrusion and subsidence due to historical overpumping. Subsidence has increased the distance that San Francisco Bay water migrated upstream in creeks during high tide and recharged adjacent shallow aquifers with brackish water. Using a chloride ion concentration of 100 mg/l, it is believed that an area encompassing about 18 square miles has been affected. Groundwater quality in the affected area is quite variable depending on proximity to San Francisco Bay. In a thin band proximal to San Francisco Bay and salt evaporation ponds, very high dissolved solid content is noted (3000 – 4000 mg/L).

The SCVWD has used imported surface water supplies to supplement local recharge and raise groundwater levels. In addition, the SCVWD completed a comprehensive effort from 1980 to 1984 to locate and destroy wells fronting San Francisco Bay that were thought responsible for allowing seawater to invade freshwater aquifers. The current Saltwater Intrusion Monitoring Program consists of 21 monitoring wells that are sampled quarterly.

There is minimal data in the San Mateo Plain on the extent of saltwater intrusion and there is no ongoing monitoring program. Saltwater from San Francisco Bay has migrated into deeper aquifers as a result of piles being driven into the subsurface for construction of the Dumbarton Bridge. Recent investigations have found historical wells off Cooley Landing that may also be acting as conduits between San Francisco Bay water and deeper aquifers.

Recommendations pertinent to saltwater intrusion include:

- An investigation by ACWD into the cause of a large increase in the salinity levels within the Centerville-Fremont Aquifer and characterization of water chemistry to determine if saltwater intrusion is the only source of salinity
- Development of a saltwater monitoring and reporting program for the San Mateo Plain
- Additional investigation of the potential for the historical Cooley Landing wells to act as vertical conduits

8.12 Identification and Sealing of Vertical Conduits

Vertical conduits are pathways that allow groundwater to move between a shallow water-bearing zone and a deeper water-bearing zone or vice versa. Vertical conduits can be manmade (abandoned wells, improperly sealed wells, elevator shafts, or hollow piles, for example), or they can be naturally occurring (root holes, facies changes, or liquefaction-caused structures, for example).

Unsealed or abandoned wells directly connect the land surface (or a zone within a few feet of the land surface) with groundwater (Figures 27 and 28), allowing polluted surface water to contaminate the groundwater. Examples of pollutants that can enter the groundwater include human or animal wastes, petroleum products, fertilizers, pesticides, and solvents. Once an aquifer has become contaminated, it can be very expensive and difficult to correct the damage.

Rapid urban expansion has taken place in the South Bay study area. Unfortunately, many agricultural and domestic wells up to 100 years old have been built over with no record of proper destruction. These lost wells are likely to be screened across several water-bearing zones and to have rusted or otherwise-damaged steel casings.

The ACWD has developed a comprehensive well search program that could serve as a model to other local agencies. This program was developed in cooperation with the cities of Fremont, Newark, and Union City. When land-use changes are proposed for properties, the cities require the property owners or developers to obtain a letter from the ACWD indicating whether wells are located within the boundaries of the development. This requirement gives the ACWD the opportunity to conduct a search for wells before development takes place (Appendix E).

There is no standard requirement in S.F Regional Board sites to conduct a vertical conduit study. However, a requirement for such a study is included on a case-by-case basis. All Superfund sites in the region have been required to perform well searches.

Recommendations pertinent to vertical conduits are listed below.

- A comprehensive study and report on all aspects of vertical conduit location and sealing should be completed.
- Well-permitting agencies in the South Bay, as well as those in the rest of the Bay Area, should emulate the ACWD's program for well searches. One significant and unique aspect of the ACWD program is that it requires coordination with local building permit departments so that vertical conduits can be located when site redevelopment occurs. Using GIS technology to bring the disparate databases together and including information provided by consultants and private parties could greatly simplify the search for vertical conduits.
- Well searches and proper destruction of abandoned wells should be required before development or new construction begins at a site. This will provide an authoritative basis for writing ordinances and for involving city and county building departments in solving this problem.

- A vertical conduit study should be required at all groundwater contamination sites and as a standard requirement in all S.F. Regional Board cleanup and abatement orders.

8.13 Surface Water and Groundwater Interaction

Several issues have been identified, which simultaneously affect the quality and quantity of surface water and groundwater due to the dynamic relationship between the two. The effects of these issues on water quality and quantity must be understood in order to develop effective water resource management strategies. These issues include the effect of surface water diversion and groundwater withdrawal on creek and riparian habitat, water quality, surface water infiltration to groundwater (e.g., recharge and stormwater infiltration) groundwater discharge to surface water (e.g., plume discharges), and changing land use (as it affects runoff and recharge).

Historically, the S.F. Regional Board and local agencies have discouraged the infiltration of urban stormwater into groundwater basins to avoid introducing associated pollutants into the subsurface. However, this position has evolved over the past few years to allow rain and runoff to infiltrate, provided best management practices are followed.

The S.F. Regional Board now encourages the use of infiltration as a strategy to manage urban runoff and protect the beneficial uses of streams and the San Francisco Bay. S.F. Regional Board staff expects that municipalities, as part of their National Pollutant Discharge Elimination System (NPDES) permitted stormwater management programs, will encourage developers to implement the designs and methods described in different erosion and sediment transport control manuals. Such infiltration methods must be implemented with groundwater protection in mind.

The municipal stormwater permit for the Santa Clara Valley, which will serve as a template for stormwater permits in other areas, contains language describing limitations on the use of stormwater infiltration for the purpose of groundwater protection. These measures should be periodically reviewed and updated as field data regarding their effectiveness become available.

8.14 Regulatory Structure and Information Management

The regulatory structure for groundwater protection is fairly complicated and has been characterized by overlapping authority, limited budgets, and differing priorities. Historically, there has been very little sharing of data, except as local agencies supply well-permitting data to the Department of Water Resources (DWR) and LUST cleanup data to the Regional and State Boards. The various state groundwater protection agencies do not have a good mechanism for sharing information. With only a few exceptions, the various state groundwater protection agencies do not have a good mechanism for making information accessible to the public.

Several new statewide groundwater protection programs are being developed that will address many of the data shortcomings discussed above. These programs are the SWRCB's System for Water Information Management, the GeoTracker project, and the Ambient Groundwater Monitoring and Assessment Program; the Department of Health Services' (DHS's) Wellhead Protection Program, and DWR's Update on Groundwater Basins of California.

The evaluation of local groundwater protection must be considered in light of the state's own diversified and decentralized management of groundwater resources. California is unique in the nation in its multi-agency approach to groundwater protection. Responsibility for groundwater protection is shared among local agencies, the California State and Regional Water Boards, DWR, and DHS. Information sharing is hindered because each agency has historically used a unique database. Furthermore, groundwater protection, from a pollution prevention standpoint, has been a low priority. High-priority groundwater protection programs have generally focused on addressing problems that have already occurred (e.g., state

Superfund Program, Leaking Underground Fuel Tank Program, Solid Waste Assessment Test, MTBE Program), although pollution prevention is the most effective and economical groundwater protection strategy.

Key recommendations are listed below.

- The S.F. Regional Board should make information available to DHS and local public water suppliers on groundwater pollution sites. DHS should provide the S.F. Regional Board and local groundwater management agencies with electronic data on well locations and delineated protection areas. Regulators and groundwater management agencies can then use this information and data to prioritize cleanup, pollution prevention, and monitoring needs.
- A groundwater management plan should be developed for the San Mateo Plain that identifies the groundwater management objectives for this area and describes the programs necessary to achieve those objectives. A groundwater management plan could facilitate funding and approval of new programs. It may be advantageous for groundwater management to be coordinated between East Palo Alto, located in the San Mateo Plain Basin, and Palo Alto, located in the Santa Clara Valley Basin.

8.15 Statewide Initiatives

Several new statewide groundwater protection programs are being developed that will address many of the data shortcomings discussed previously. These programs are described in detail in Section 6 and include the following:

- SWRCB's System for Water Information Management (SWIM) and Water Information Network (WIN)
- SWRCB's GeoTracker project
- SWRCB's Comprehensive Groundwater Quality Monitoring Program
- SWRCB's Groundwater Ambient Monitoring and Assessment (GAMA) Program
- DHS' Drinking Water Source Assessment Protection (DWSAP) Program
- DWR's Bulletin 118 Update on Groundwater Basins of California

8.16 Summary of Recommendations

Based on the results of this project, the Groundwater Committee developed a set of recommendations to improve groundwater protection in the South Bay. The recommendations are grouped into those that require: 1) coordination among two or more agencies, 2) action by a single agency, and 3) legislative action.

Table 22. Recommendations Requiring Coordination Among Agencies

Topic	Finding	Recommendation	Implementation
VOC Plumes	It is very difficult for local well permitting agencies to determine whether a proposed well is located within a VOC plume.	The location of VOC plumes regulated by the EPA, S.F. Regional Board, DTSC, and local agencies should be accessible to local well permitting agencies.	On a biennial basis, the S.F. Regional Board, in coordination with local agencies, DTSC, and EPA, should produce a plume map for the South Bay Basins that is accessible online in both PDF and Arc/Info formats.
Vertical Conduits and Redevelopment Permits	An effective method for addressing abandoned wells is for the permitting city or county to require investigation and well sealing as a condition of any site redevelopment.	Cities and counties should make investigation and well sealing a condition of any development or redevelopment permit. Funding should be included in the redevelopment permit fee.	The success of the ACWD program should be documented and used as an example for other areas of the South Bay. The SCVWD and San Mateo County should initiate this effort locally. This may require legislative efforts.
City General Plans	Cities show a wide range in their efforts focused on groundwater protection. Most efforts are minimal.	Cities should put more emphasis on groundwater protection when updating their general plans (e.g., well-head protection, integration with DWSAP).	List the priority groundwater protection elements that a general plan should include. Encourage cities to include these elements when updating their general plans and work with local agencies.
Drycleaner Cleanups	As of 1998, there were about 350 drycleaners in the South Bay, while only 42 have been investigated, primarily as a result of impending property transactions. None of the existing groundwater protection programs focuses on drycleaners	Inventory and rank current and historical drycleaners for water quality assessments based on potential threat.	Convene a multi-agency task force that includes representatives from the S.F. Regional Board, local agencies, CUPAs, BAAQMD, and city staff to develop and implement a pilot project in a selected city to determine the feasibility of inventorying and ranking current and historical drycleaners for water quality assessments based on potential threat.
San Mateo Plain Basin Boundaries	The basin boundary between the San Mateo Plain and Westside Basin should be slightly changed to reflect hydrogeology. In addition, new research shows that the San Mateo Plain can be subdivided into two sub-basins, defined in this report as the South San Mateo Plain Sub-basin and North San Mateo Plain Sub-basin.	The San Mateo Plain Basin boundaries should be adjusted to better reflect hydrogeology as shown in Figure 9.	The S.F. Regional Board, San Mateo County, and the DWR should incorporate the revised nomenclature shown in Figure 9 into their respective planning documents.
Leaking Sewer Lines	VOCs discharged to sewer lines may leak and can significantly impact groundwater.	POTW influent concentrations should be routinely monitored and reviewed and compared with discharge data for CVOCs to evaluate the need for further	The S.F. Regional Board should initiate a pilot study with a select group of POTWs to assess the significance of the problem.

Topic	Finding	Recommendation	Implementation
		investigation. Wastewater treatment plants should review current pretreatment standards for CVOCs to evaluate the degree of protection offered in light of potential sewer line leaks.	
Regulatory Maze	Eight different agencies regulate groundwater cleanup projects. No comprehensive list of non-fuel cleanups is available.	All groundwater cleanup sites should be listed on a common Web site or set of linked sites. Fuel cases are using GeoTracker (formerly GEIMS). No current effort for non-fuel cases exists.	EPA, the DTSC, and the S.F. Regional Board should independently maintain Web sites with summary information about the non-fuel groundwater cleanup sites they regulate. The sites should be cross-referenced (i.e., linked to each of the other agencies).
Site Naming/ Numbering/ Tracking	Sites are often regulated by multiple agencies. Each agency maintains its own files and databases using unique naming protocols. Therefore, locating files for the same site at different agencies can be challenging.	Agencies should agree on consistent site naming/numbering/tracking nomenclature.	Encourage agencies to come to a consensus on naming/numbering/tracking nomenclature.
General Plan Implementation	Most cities do not take an active role in groundwater protection.	Cities should impose permit requirements for groundwater protection on development in sensitive groundwater areas.	The S.F. Regional Board, local groundwater management agencies, and local planners should work together to identify sensitive groundwater areas and appropriate groundwater protection strategies.
Groundwater - Surface Water Interaction	Withdrawal of surface water or groundwater connected to creeks can adversely affect riparian zones. Changes in land use can reduce natural groundwater recharge, which in turn can reduce base flow contributions to creeks and other surface water bodies.	The relationship among creek flows, diversions, and groundwater pumping must be better understood. Vulnerability of creeks and riparian corridors to diversions and groundwater withdrawals should be evaluated.	The S.F. Regional Board, local groundwater management agencies, local planners, and creek and watershed protection groups should work together to quantify creek flows, diversions, and wells that withdraw connected groundwater. Rough water budgets should be worked out to bound surface water and groundwater contributions to better understand creek vulnerability.

Table 23. Recommendations Requiring Action by a Single Agency

Topic	Finding	Recommendation	Implementation
Vertical Conduit Searches	Vertical conduits can transport contaminants to deeper aquifers.	Vertical conduit searches should be a standard requirement for all groundwater pollution cases	The S.F. Regional Board, DTSC, EPA, and local agencies should all require conduit searches at the time groundwater impacts are identified.
Institutional Controls	The S.F. Regional Board has approved institutional controls, such as deed restrictions and/or risk management plans, for at least 16 sites in the South Bay.	A comprehensive list of sites with institutional controls should be maintained and made available online.	The S.F. Regional Board should maintain an updated list of cases with institutional controls and make it accessible online.
Annual Groundwater Monitoring Reports	The ACWD and the SCVWD conduct ambient groundwater monitoring and reporting. The SMCEHSD does not conduct ambient groundwater monitoring in the San Mateo Plain due to lack of funding. The ACWD and SCVWD are the only local agencies in the South Bay that compile ambient groundwater monitoring data into an annual report.	Annual monitoring reports should be prepared so that data and interpretations can be shared with other agencies and the public.	The SMCEHSD should seek funding to develop an ambient groundwater monitoring and reporting program.
San Mateo Plain Groundwater Management Plan	There is no groundwater management plan for the San Mateo Plain.	The SMCEHSD, in coordination with other local stakeholders, should develop a groundwater management plan for the San Mateo Basin.	The SMCEHSD should seek funding to develop a groundwater management plan in coordination with local water suppliers.
Groundwater - Surface Water Interaction	Impacted surface water can cause degradation of groundwater quality via stormwater infiltration.	Stormwater infiltration should be used appropriately with consideration to groundwater impacts.	The S.F. Regional Board should require stormwater permits that acknowledge appropriate use of infiltration treatment and groundwater protection.

Table 24. Recommendations Requiring Legislative Action

Topic	Finding	Recommendation	Implementation
Drycleaner Cleanups	There are no formal programs for locating and remediating leaking drycleaner sites.	California should join EPA's State Coalition for Remediation of Drycleaners and develop a statewide drycleaner monitoring and remediation program.	Legislative efforts should be directed at funding California's participation in EPA's State Coalition for Remediation of Drycleaners and eventual development of a statewide drycleaner remediation program.
Threat posed by Operating Gasoline Stations	Studies show that operating gasoline stations with UST's pose a threat to groundwater quality.	Environmental monitoring should be conducted at operating gasoline stations.	The SF Regional Board should begin to require monitoring of operating gasoline stations not currently performing groundwater monitoring. Legislative action is needed to make this a statewide requirement.

9.0 ACRONYMS

ACWD	Alameda County Water District
AGT	Aboveground tank
AHF	Above Hayward Fault
APSA	Aboveground Petroleum Storage Act
ARP	Aquifer Reclamation Program
AWWARF	American Water Works Association Research Foundation
BAAQMD	Bay Area Air Quality Management District
BHF	Below Hayward Fault
CAS	California Aquifer Susceptibility
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (a k a Superfund)
CIWMB	California Integrated Waste Management Board
cm/s	Centimeters per second
CUPAs	Certified Unified Program Agencies
CVOC	Chlorinated volatile organic compound
DERP	Defense Environmental Restoration Program
DHS	Department of Health Services
DoD	Department of Defense
DRASTIC	<u>D</u> epth to water table, <u>n</u> et <u>R</u> echarge, <u>A</u> quifer media, <u>S</u> oil media, <u>T</u> opography, <u>I</u> mpact to vadose zone, and hydraulic <u>C</u> onductivity of the aquifer (U.S. Environmental Protection Agency measurement method)
DTSC	Department of Toxic Substances Control
DWP	Drinking Water Program
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EPA	U.S. Environmental Protection Agency
ft./d	Feet per day
GIS	Geographic information systems
gpd	Gallons per day
gpm	Gallons per minute
GPP	Groundwater protection program
GPS	Global positioning system
HVOCs	Halogenated volatile organic compounds
l	Liter
LIAs	Local implementing agencies
LLNL	Lawrence Livermore National Laboratory
LOP	Local Oversight Program
LUFT	Leaking Underground Fuel Tank
LUST	Leaking Underground Storage Tank
MCL	Maximum contaminant level
mg/l	Milligrams per liter
mgd	Million gallons per day
millimhos/cm	A measure of electrical conductivity (in soil) in millimhos per centimeter
MSW	Municipal solid waste
MTBE	Methyl tertiary butyl ether
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PBE	Physical barrier effectiveness
PCAs	Potentially contaminating activities
PCE	Perchloroethylene, also called tetrachloroethylene
pCi/l	Pico-curies per liter
POTW	Publicly owned treatment works (a k a sewage treatment plant)
ppb	Parts per billion

ppm	Parts per million
RCRA	Resource Conservation and Recovery Act
S.F. Regional Board	San Francisco Bay Regional Water Quality Control Board
SAR	Sodium adsorption ratio
SARA	Superfund Amendments and Reauthorization Act
SCVWD	Santa Clara Valley Water District
SLIC	Spills, Leaks, Investigation, and Cleanup
SPCC	Spill Prevention Control and Countermeasure Plan
SWAP	Source Water Assessment Program
SWRCB	State Water Resources Control Board
TCE	Trichloroethylene
TDS	Total dissolved solids
ug/l	Micrograms per liter
USGS	U.S. Geological Survey
USTs	Underground storage tanks
VOCs	Volatile organic compounds
WDRs	Waste Discharge Requirements

10.0 REFERENCES

Niles Cone References

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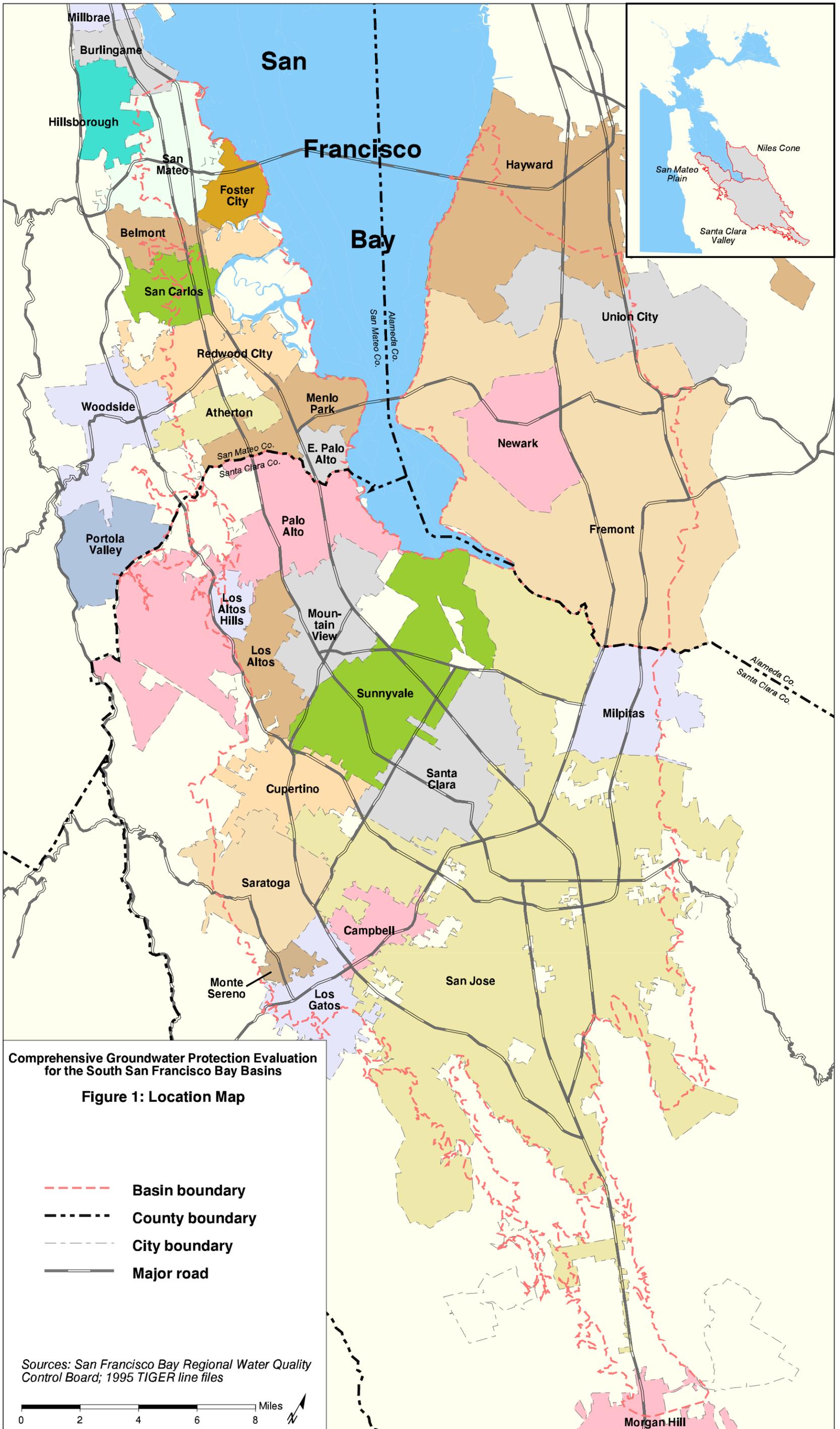
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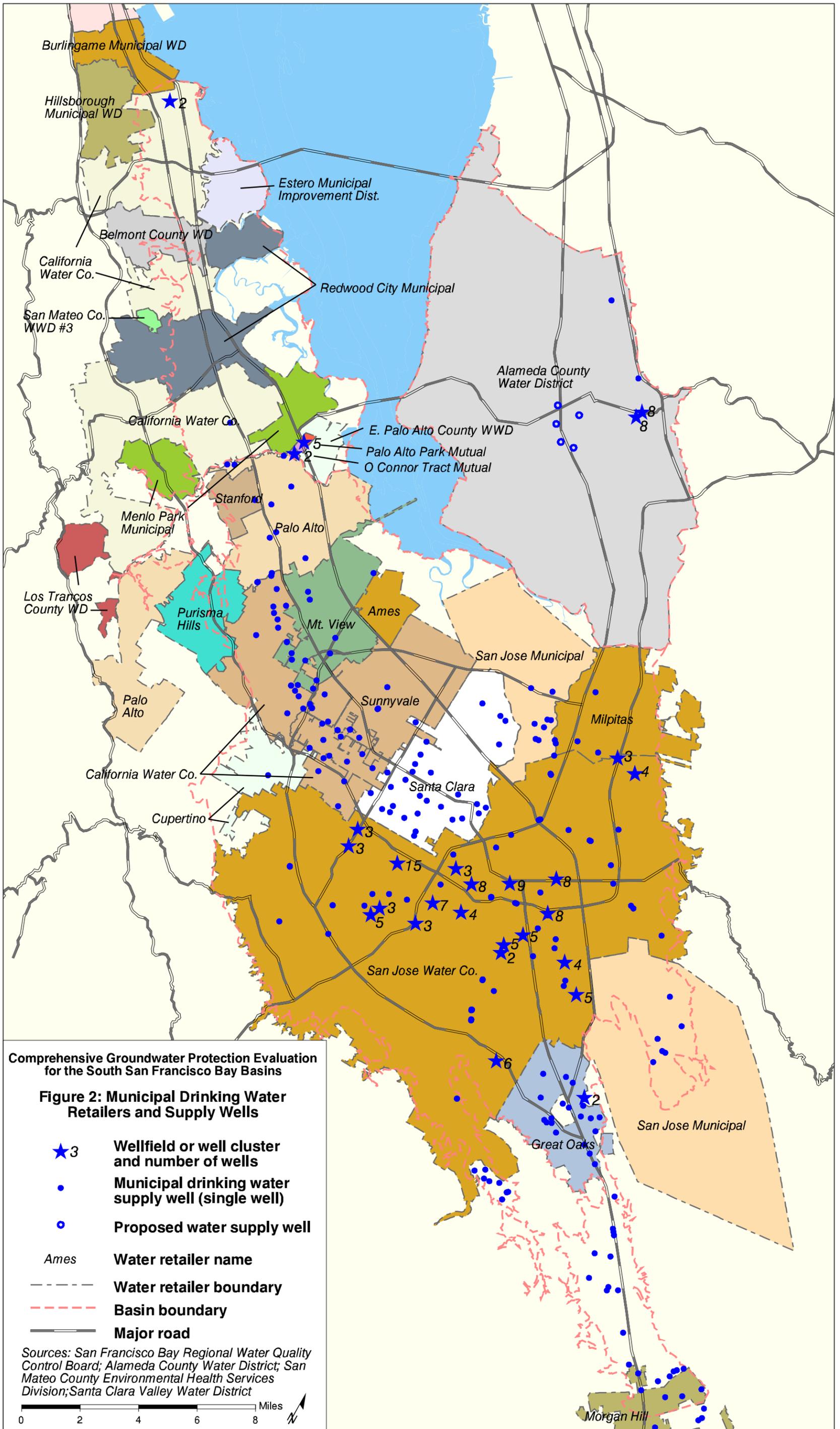
Groundwater Protection References

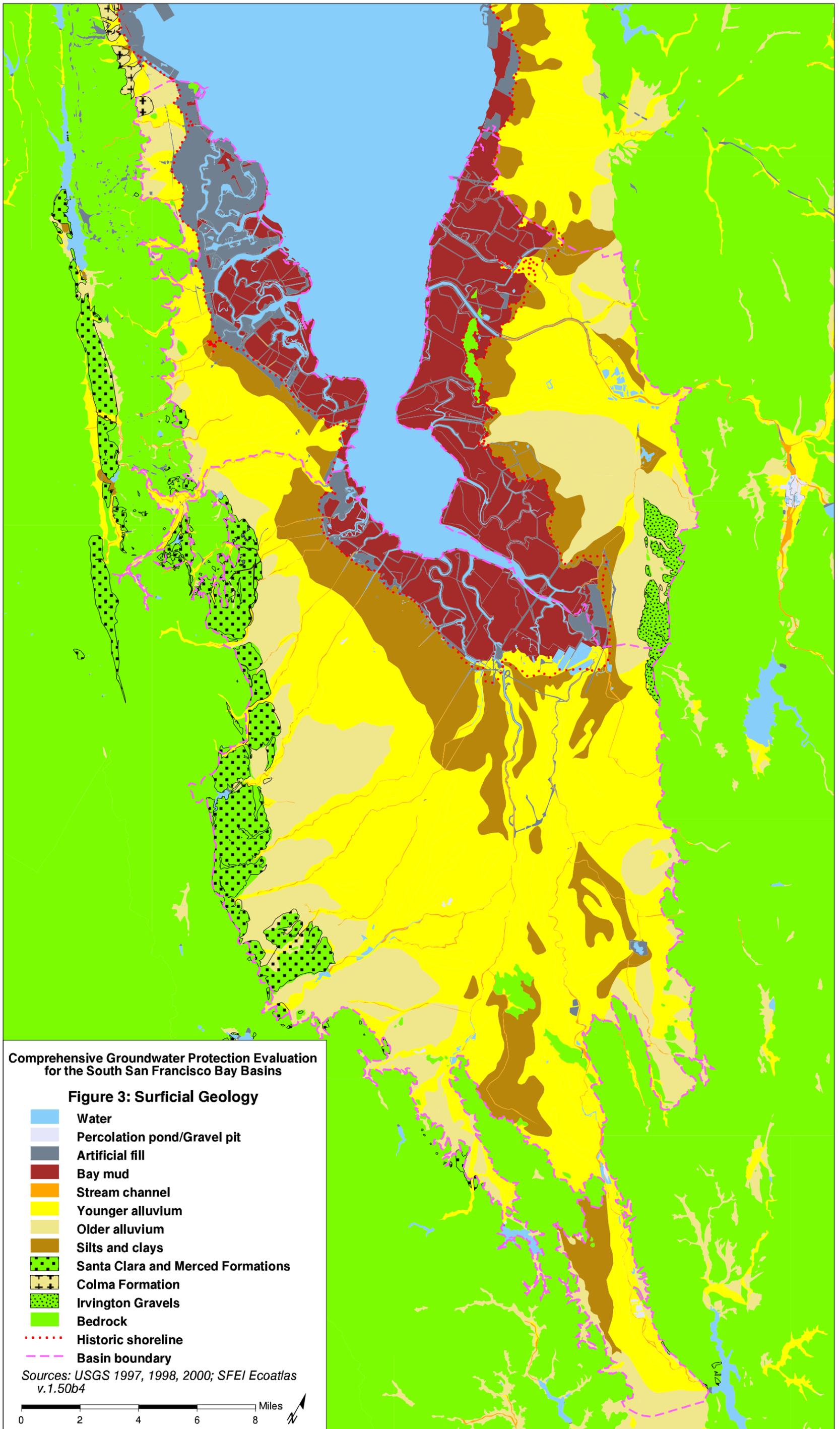
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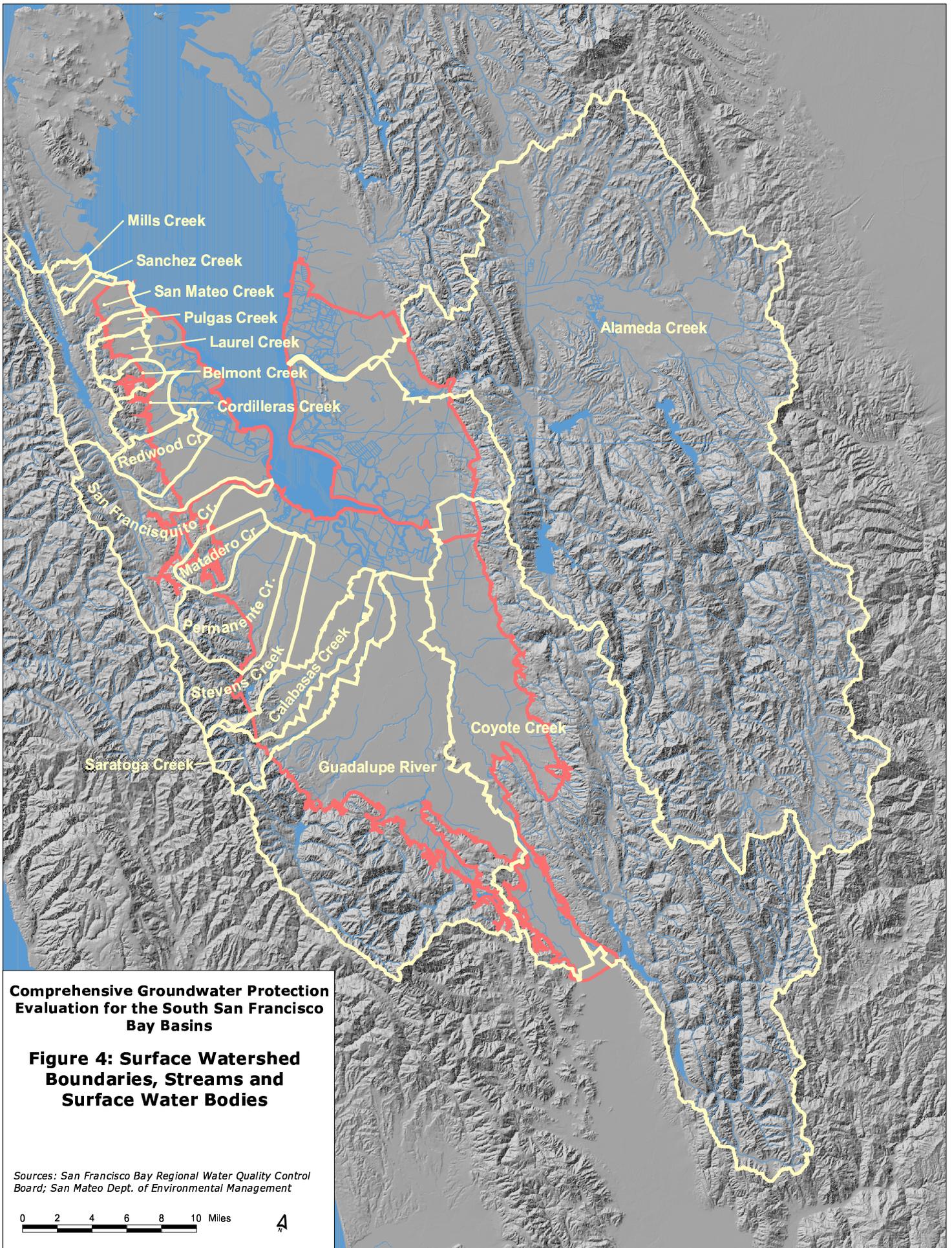
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**Comprehensive Groundwater Protection
Evaluation for the South San Francisco
Bay Basins**

**Figure 4: Surface Watershed
Boundaries, Streams and
Surface Water Bodies**

Sources: San Francisco Bay Regional Water Quality Control Board; San Mateo Dept. of Environmental Management

0 2 4 6 8 10 Miles



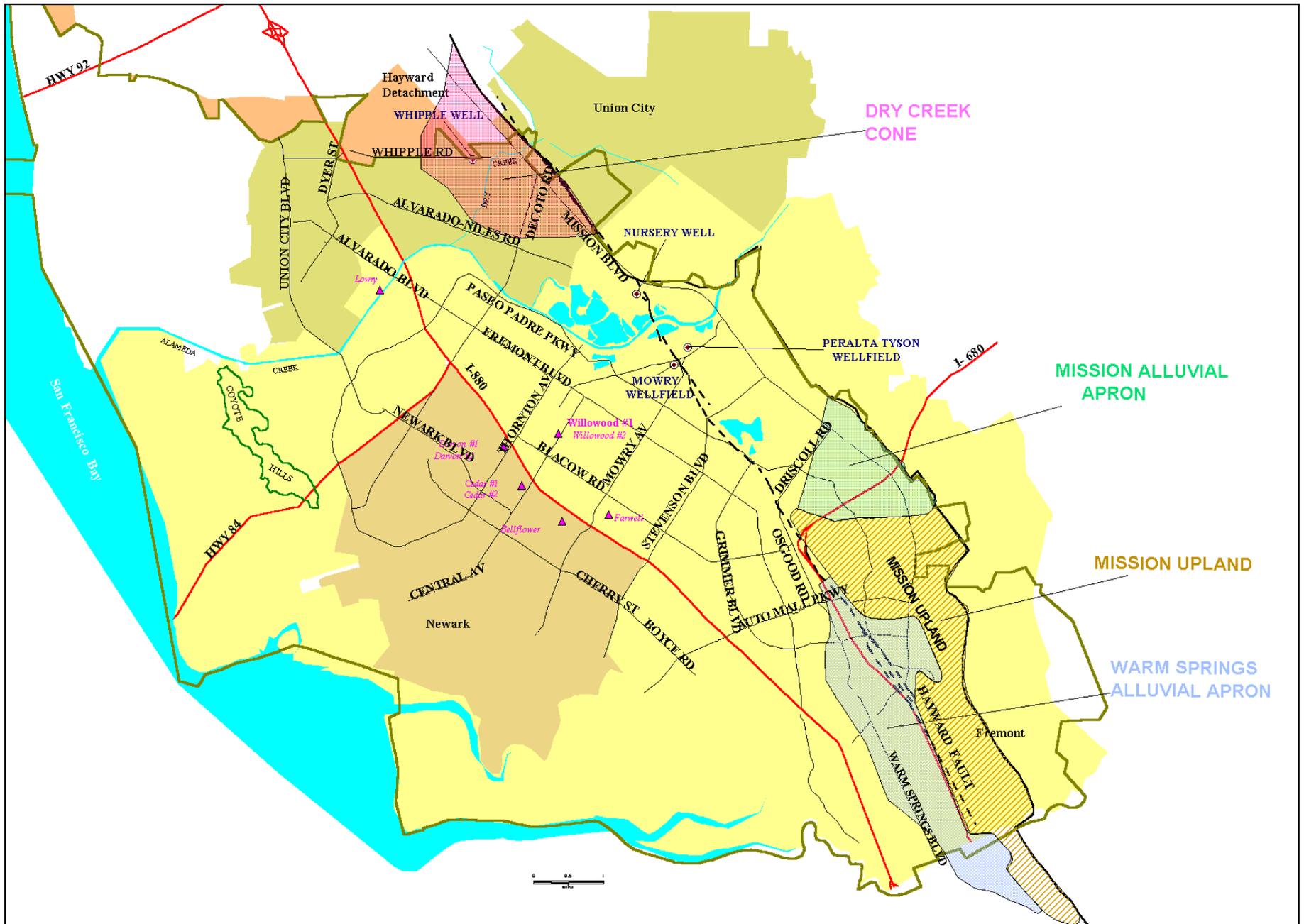


Figure 5: Niles Cone Groundwater Basin (Source: Alameda County Water District)

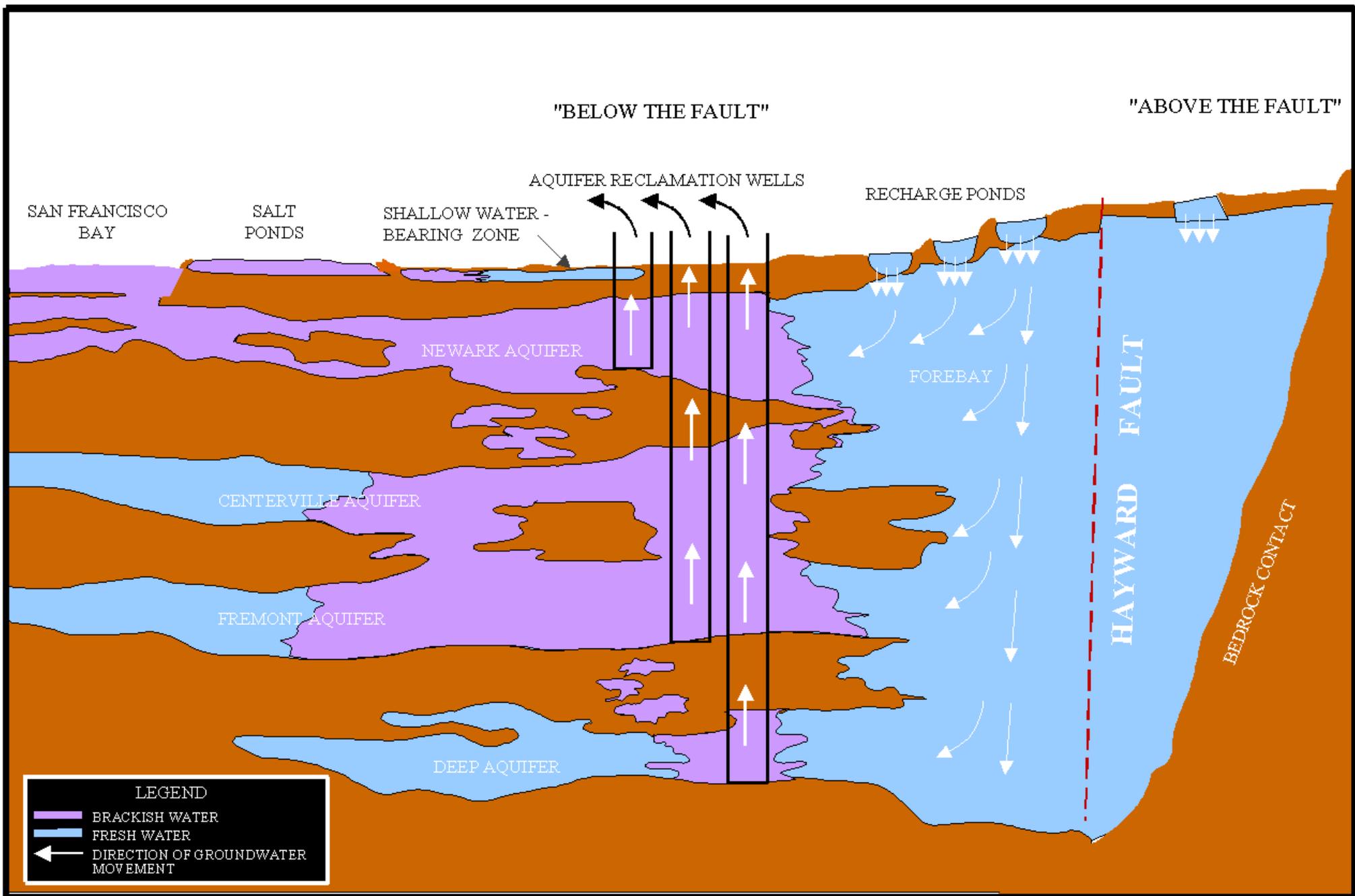


Figure 6: Niles Cone Groundwater Basin Cross-Section Schematic (Source: Alameda County Water District)

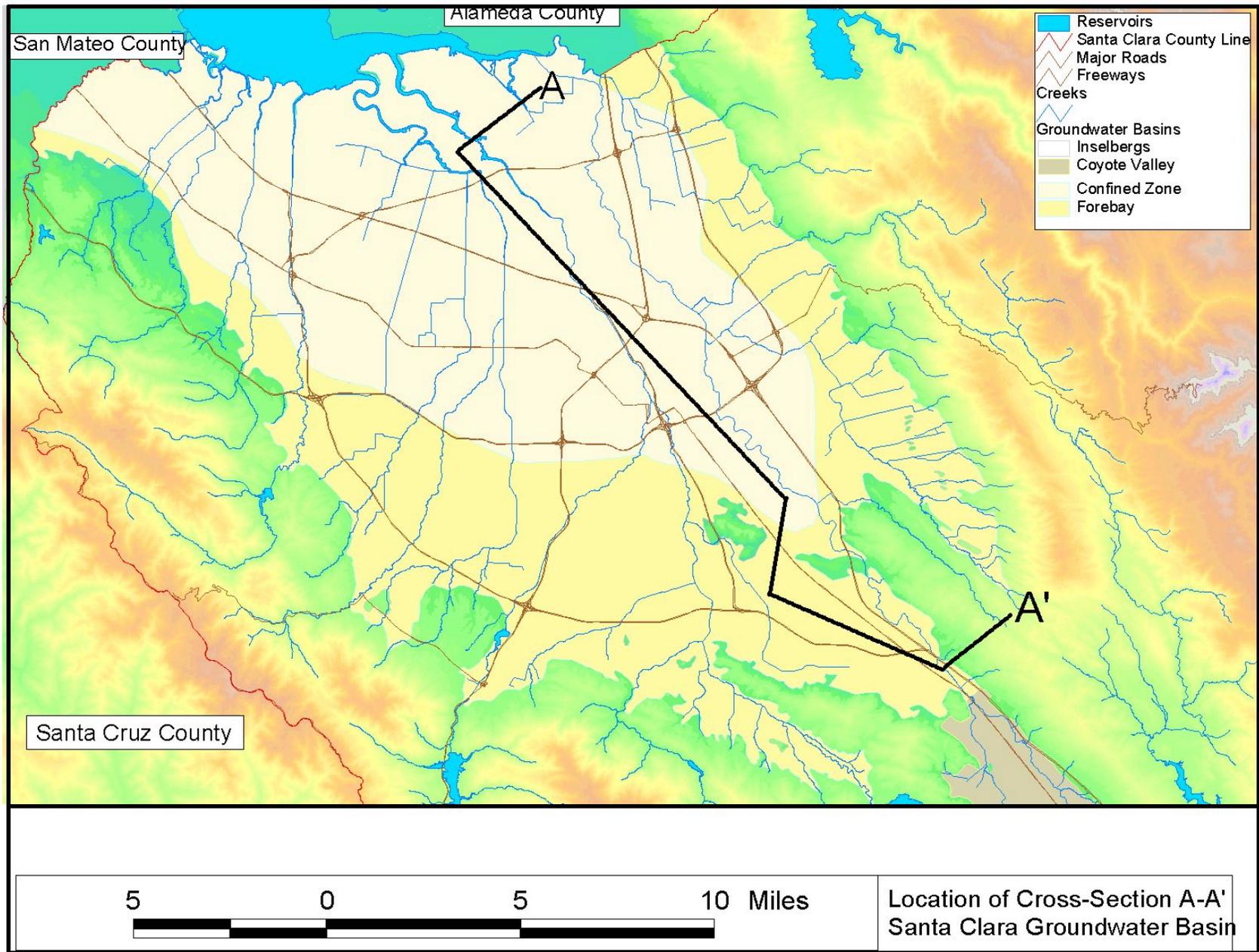
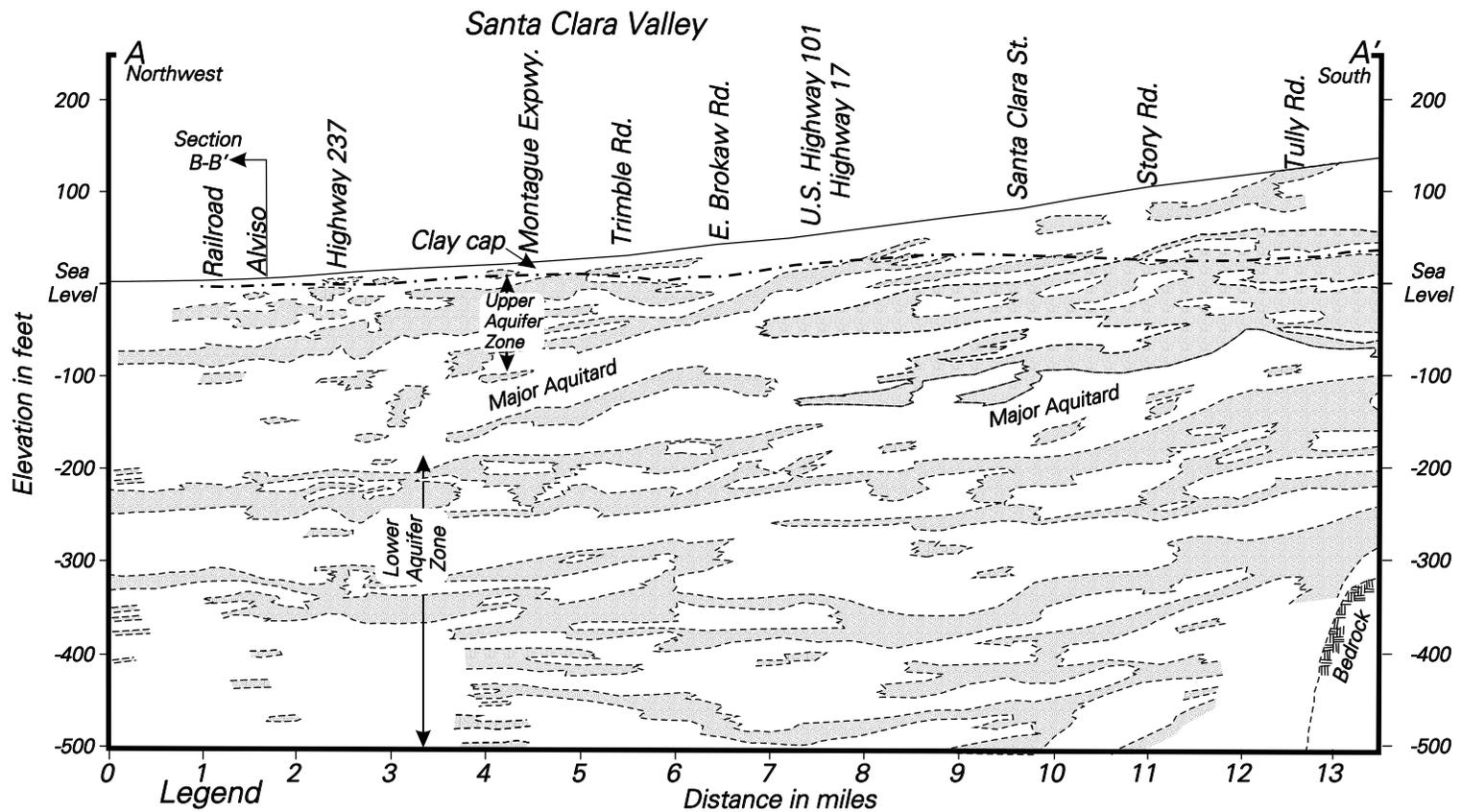


Figure 7: Santa Clara Valley Groundwater Basin (Source: Santa Clara Valley Water District)



- | | |
|---|--|
| <p>  Distinguishable aquifers - mixtures of gravel and sand. Medium to high permeabilities
  Approximate water table, 1984 </p> | <p>  Aquitard - mixtures of clay and silt, with some sand and gravel, low to very low permeabilities </p> |
|---|--|

- Notes:
1. Refer to Figure 2 for location of section.
 2. Interpretive section based on available well logs.
 3. Aquifers are grouped into Upper Aquifer Zone and Lower Aquifer Zone, separated by "Major" aquitard

Figure 8a: Santa Clara Valley Groundwater Basin Cross-section Schematic (Source: Iwamura 1995)

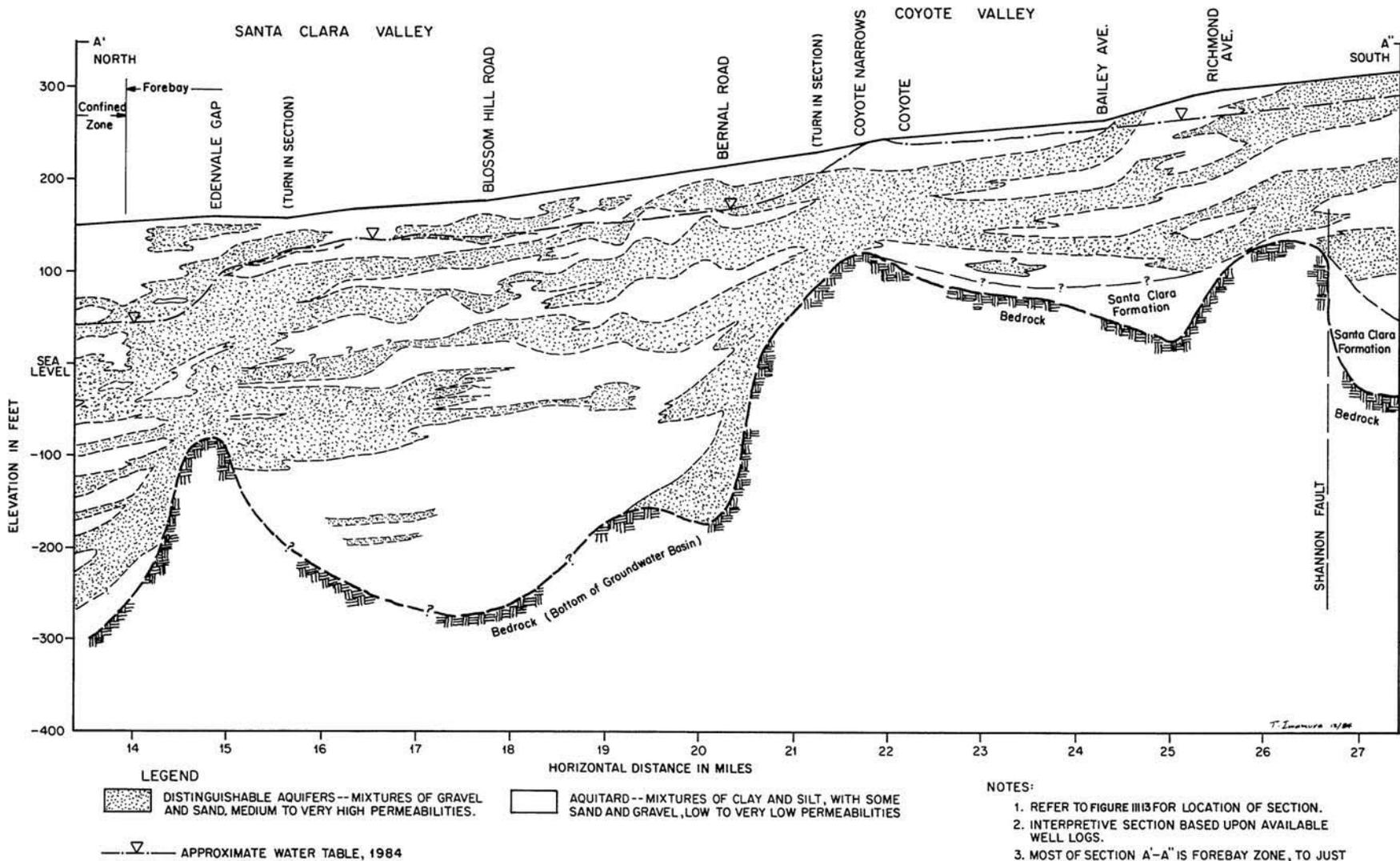
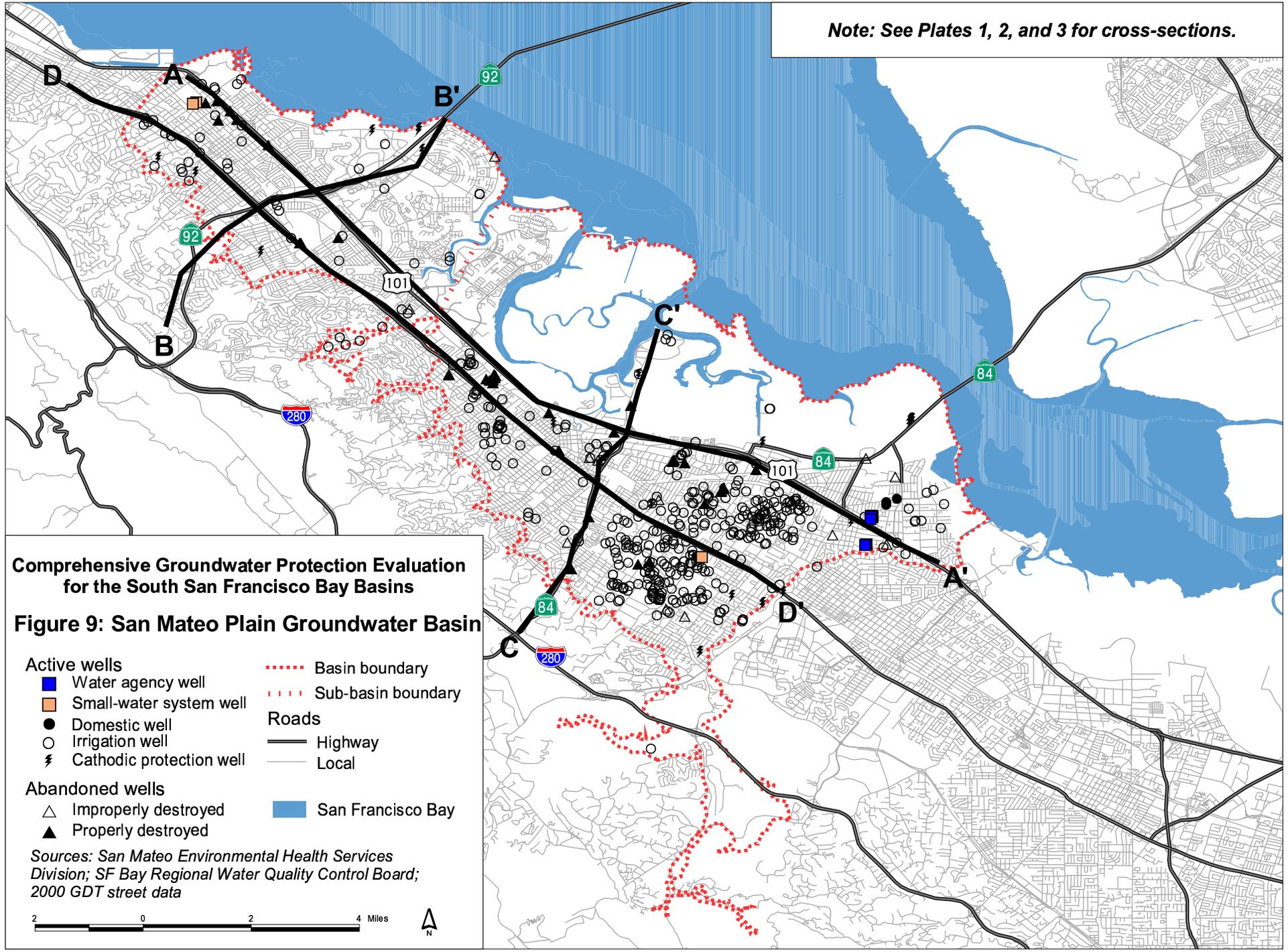


Figure 8b: Geologic Cross-section of the Santa Clara and Coyote Valleys

Note: See Plates 1, 2, and 3 for cross-sections.



Comprehensive Groundwater Protection Evaluation for the South San Francisco Bay Basins

Figure 9: San Mateo Plain Groundwater Basin

- | | |
|----------------------------|--------------------------|
| Active wells | Basin boundary |
| ■ Water agency well | - - - Sub-basin boundary |
| ■ Small-water system well | — Highway |
| ● Domestic well | — Local |
| ○ Irrigation well | |
| ⚡ Cathodic protection well | |
| Abandoned wells | ■ San Francisco Bay |
| △ Improperly destroyed | |
| ▲ Properly destroyed | |

Sources: San Mateo Environmental Health Services Division; SF Bay Regional Water Quality Control Board; 2000 GDT street data



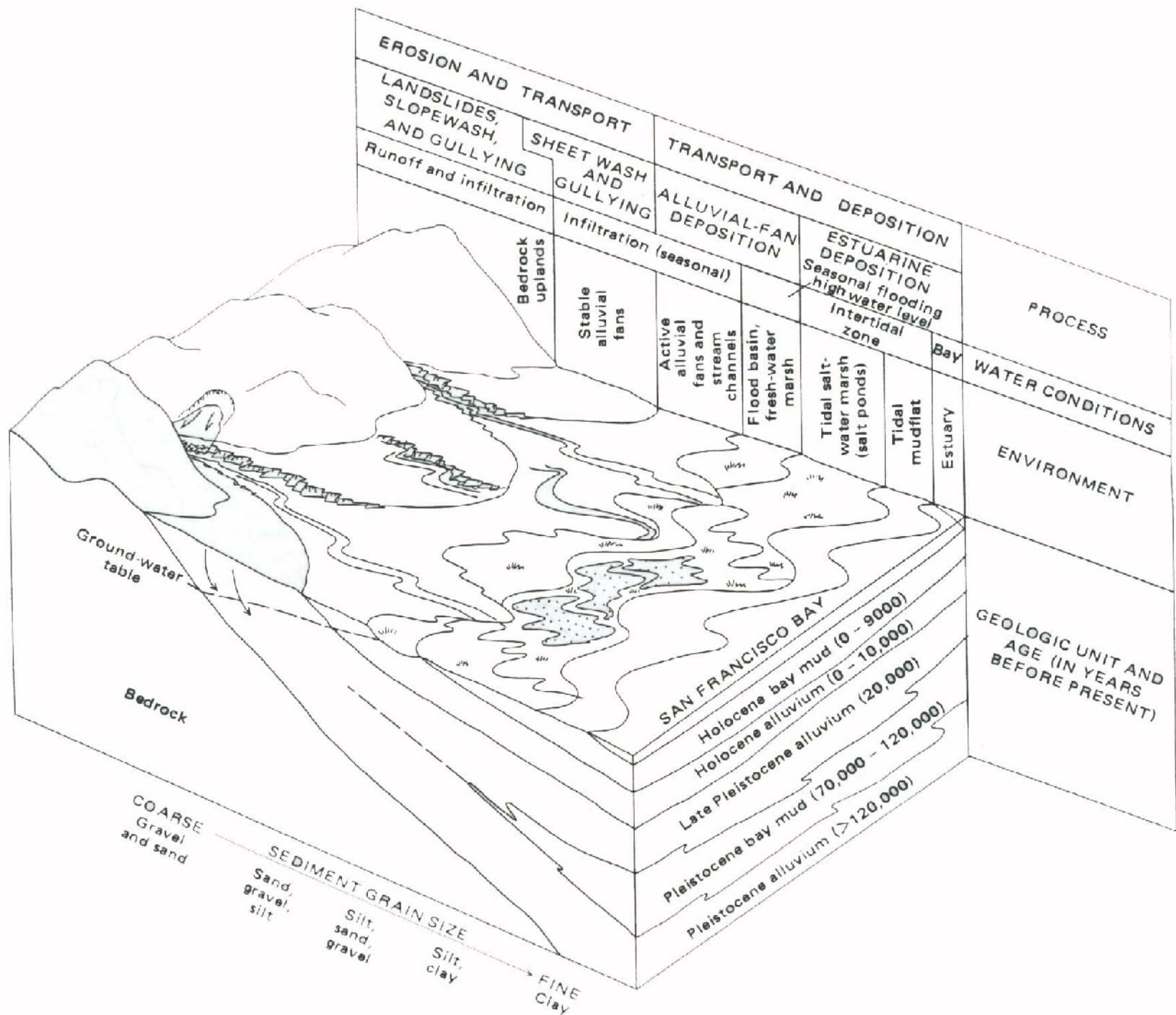
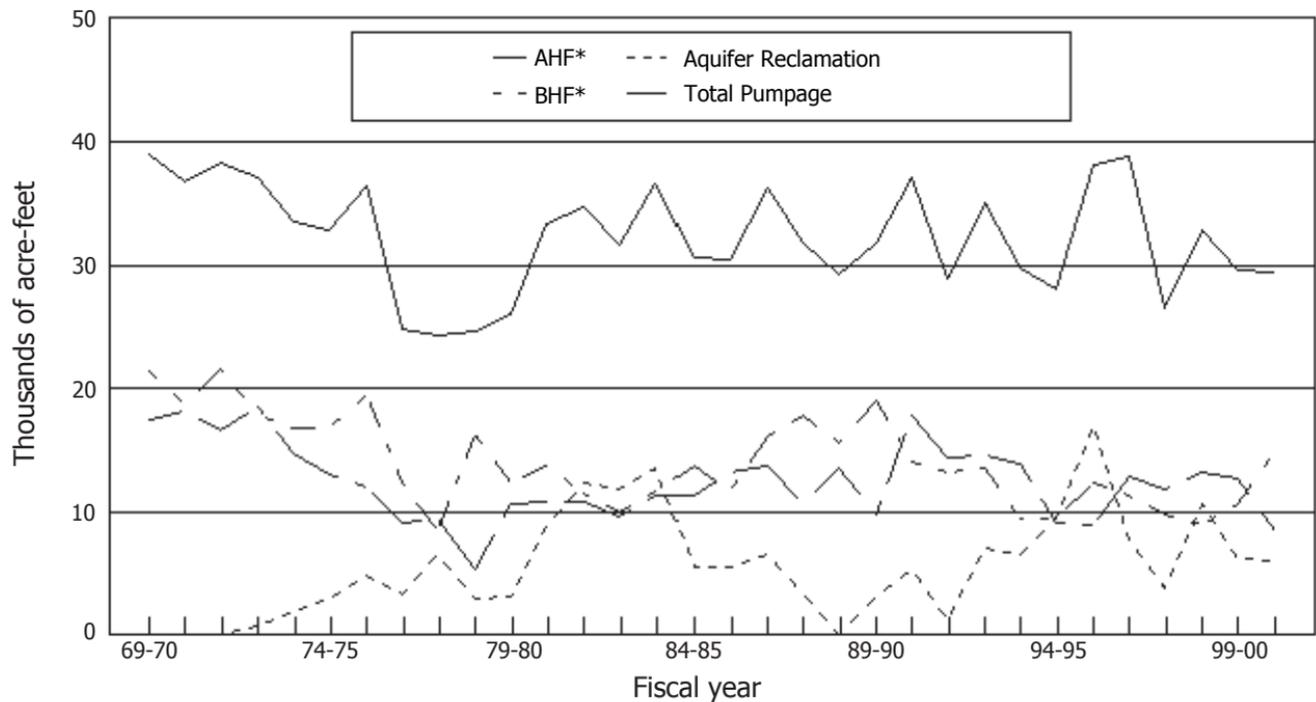


Figure 10: San Mateo Plain Conceptual Model of Alluvial Fan Deposition (Source: Halley et al., 1979)



* Includes private pumping

Figure 11: Historical groundwater production in ACWD (actual through 2000-01) (Source: ACWD)

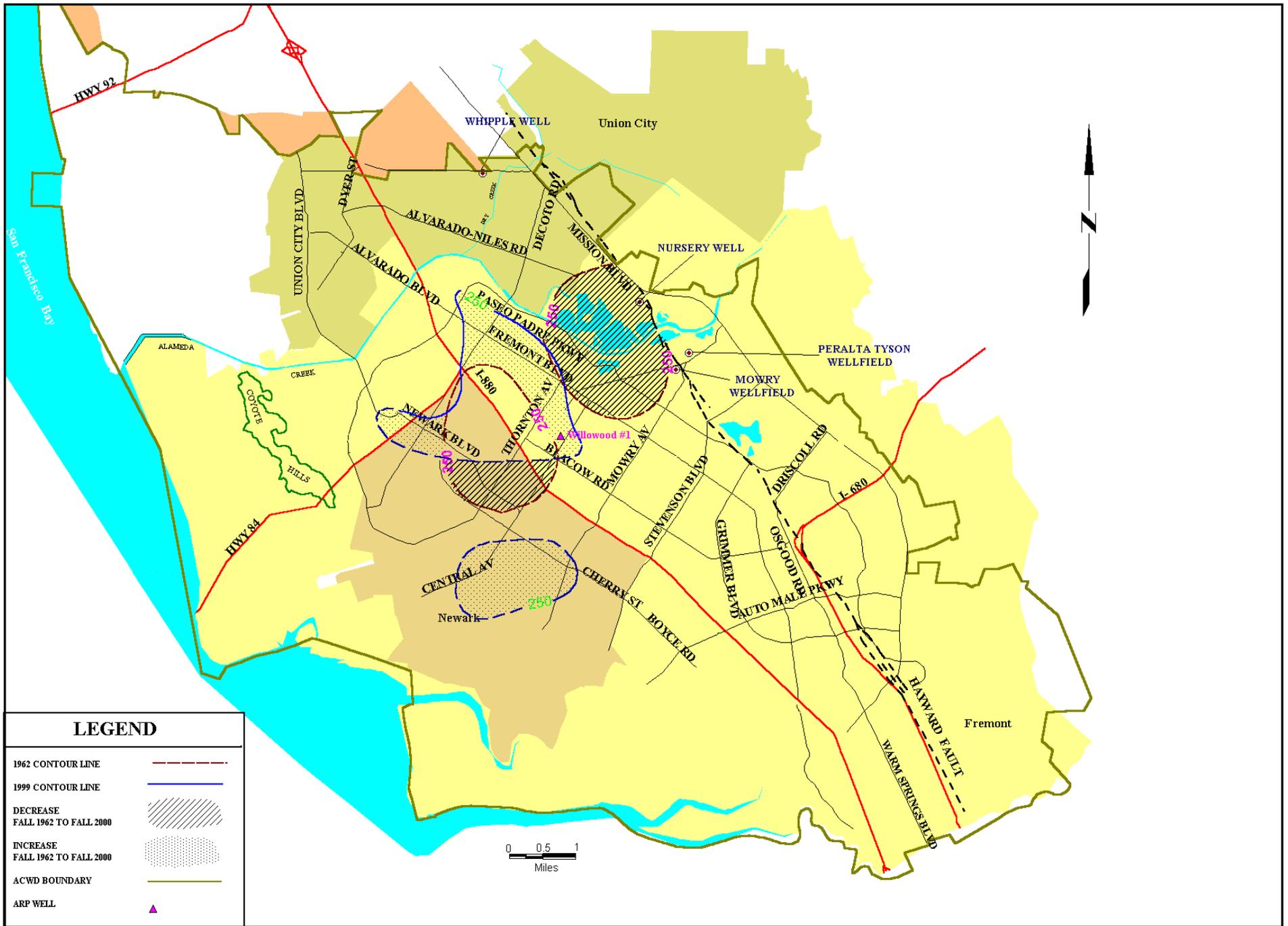


Figure 14: Comparison of 1962 and 2000 250-ppm Chloride Contours, Deep Aquifer (Source: Alameda County Water District)

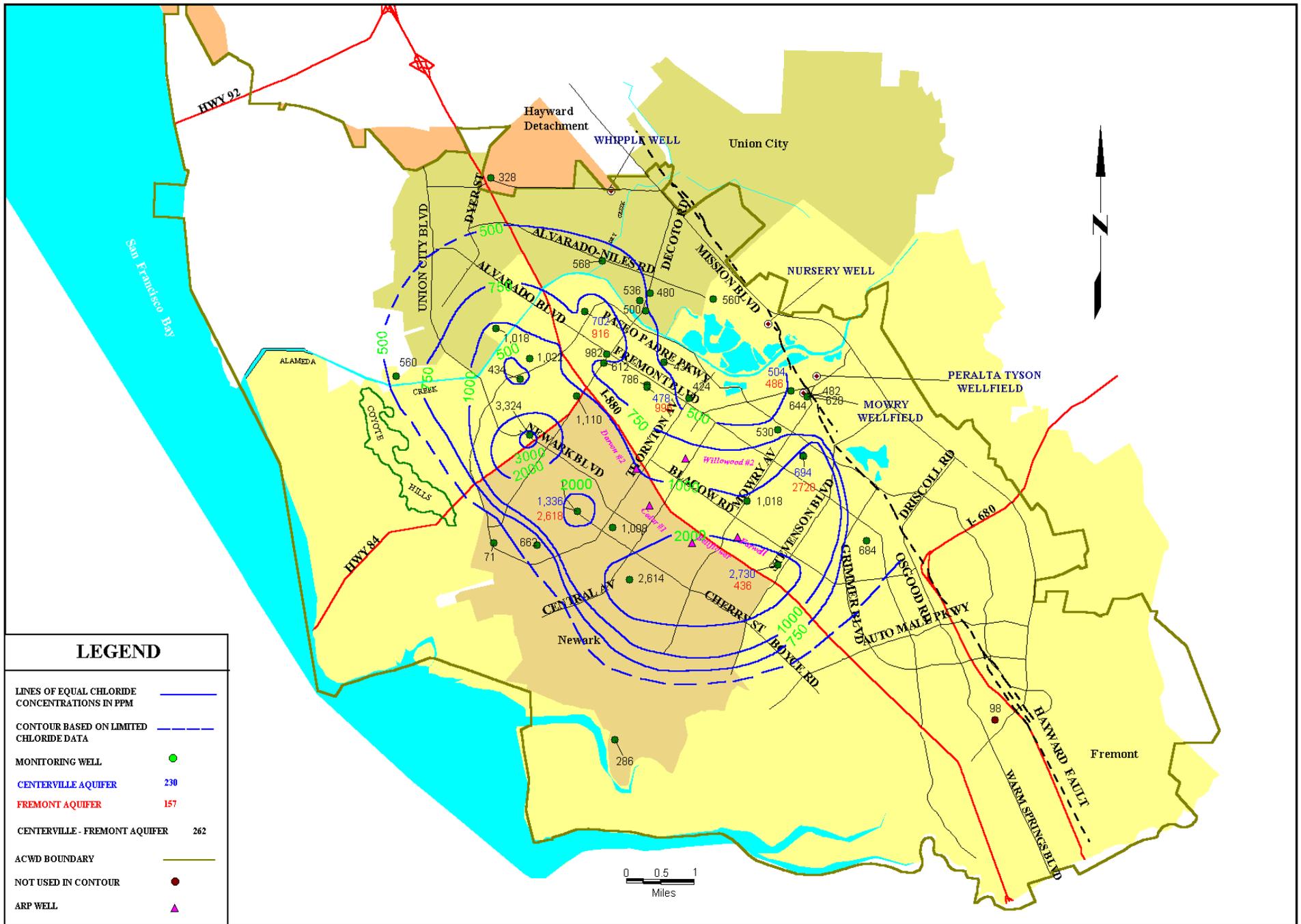


Figure 16: Total Dissolved Solids in the Centerville-Fremont Aquifer, Niles Cone Basin (Source: Alameda County Water District)

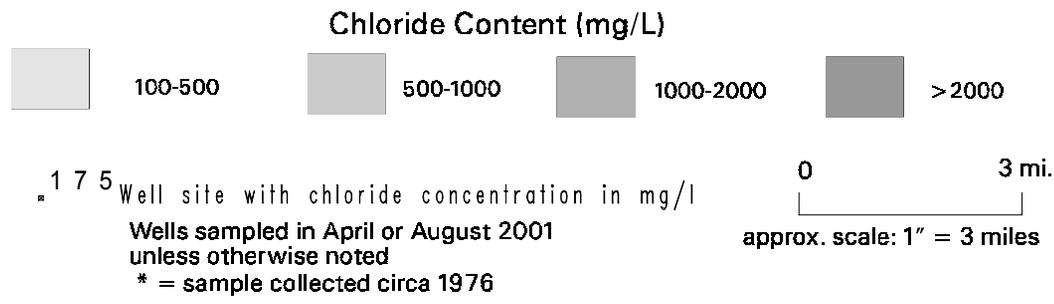
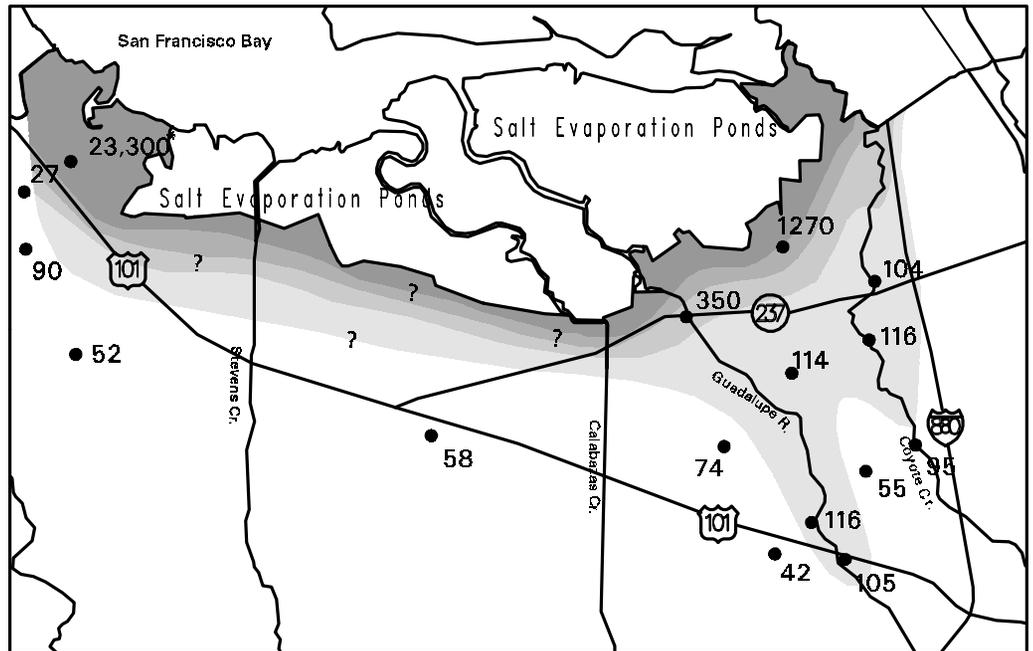
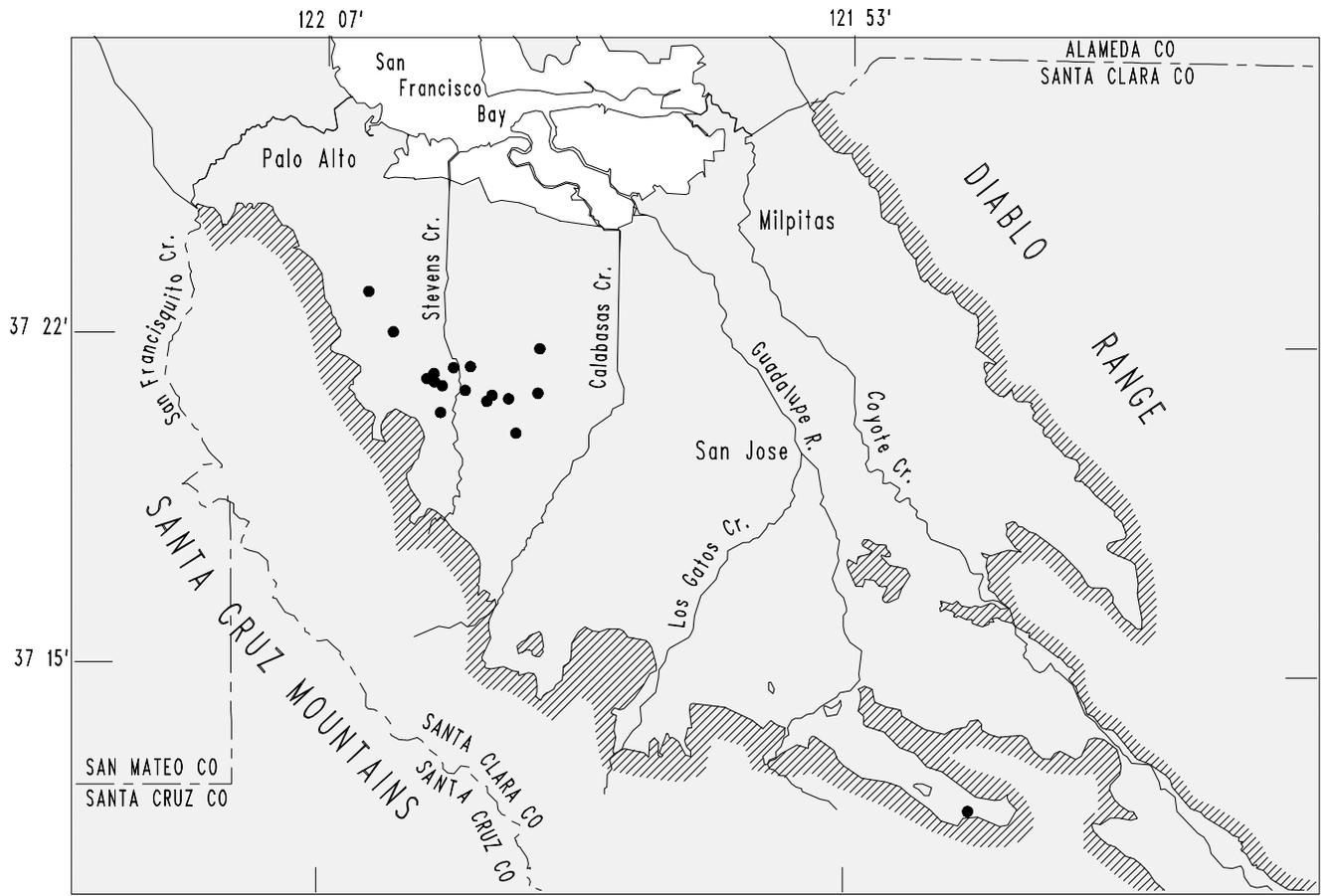


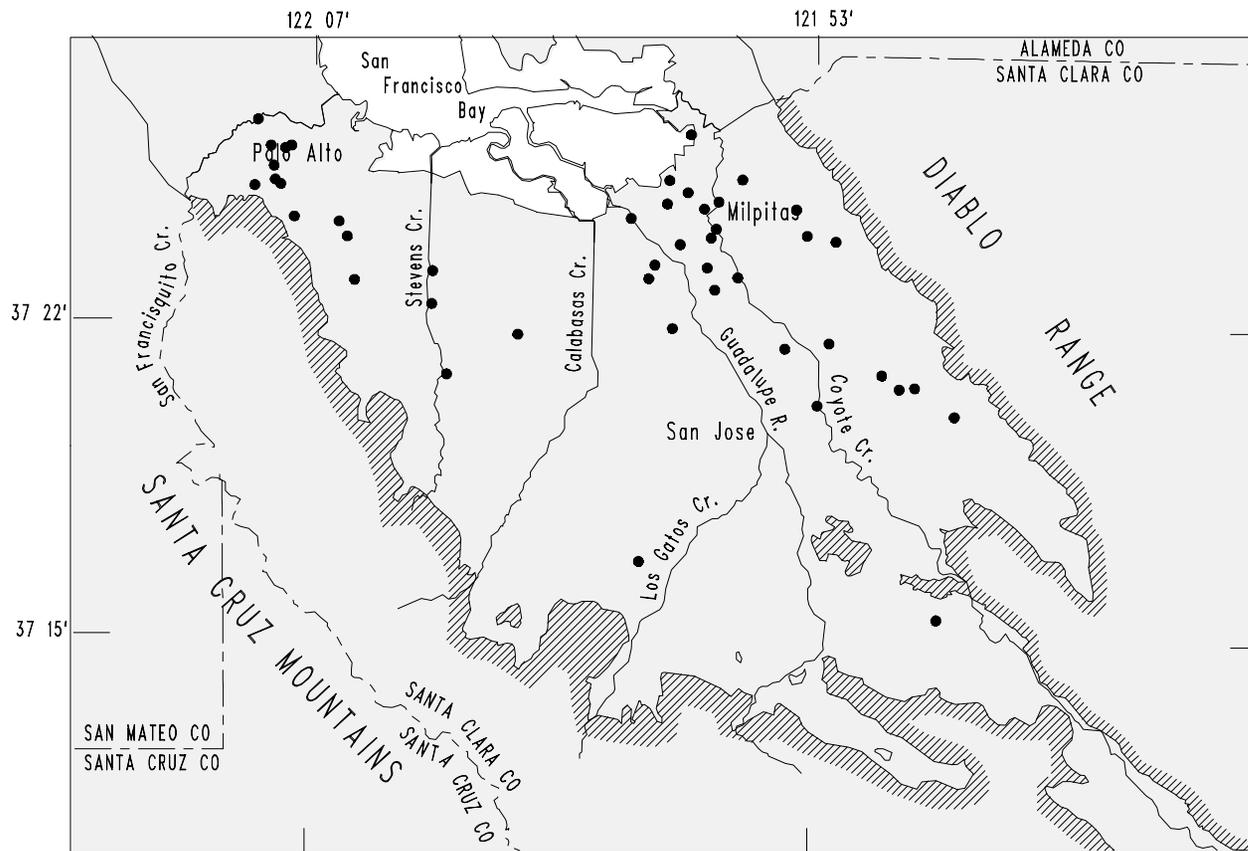
Figure 18: Saltwater Intrusion in the Upper Aquifer System of the Santa Clara Valley Basin
 (Source: Santa Clara Valley Water District)



EXPLANATION

- Well Sites with Nitrate >45 mg/L
- ▨ Contact between non water-bearing (hachured side) and water-bearing formations

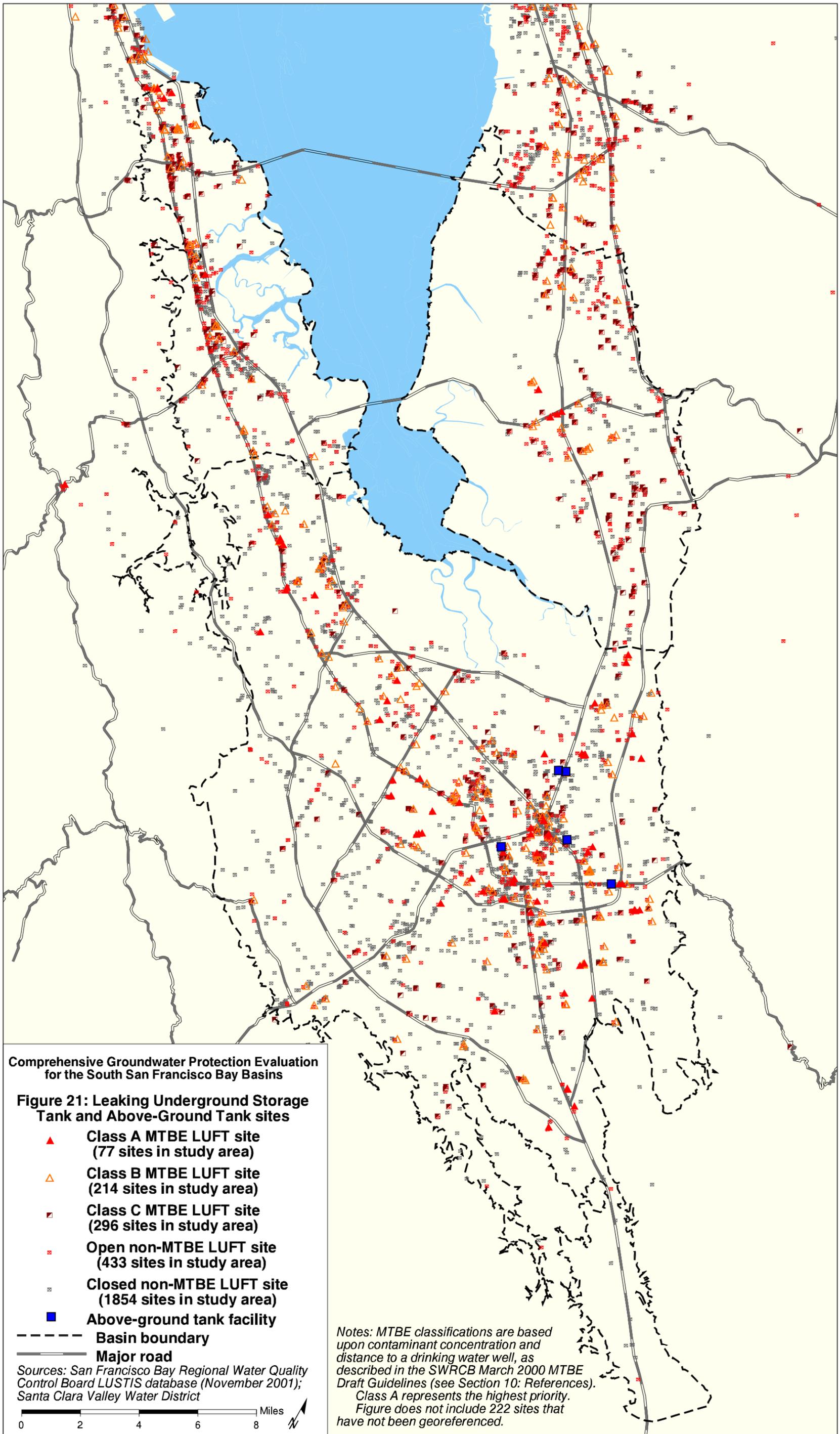
Figure 19: Public Water Supply Wells in the Santa Clara Valley Basin Reported to Have Nitrate Above the MCL
 (Source: Santa Clara Valley Water District)



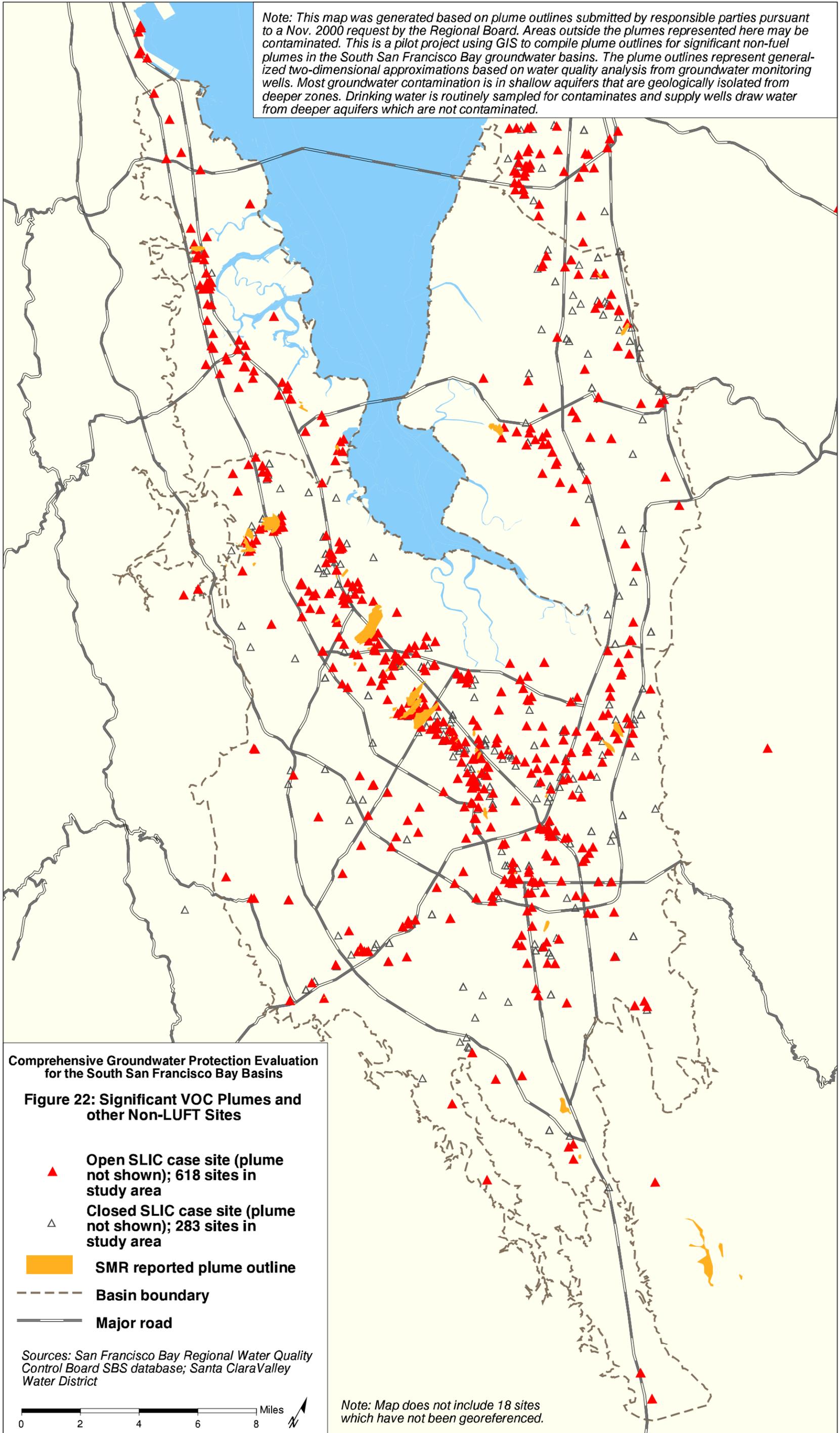
EXPLANATION

- Well Sites with Manganese >50 ug/L
- ▬ Contact between non water-bearing (hachured side) and water-bearing formations

Figure 20: Wells in the Santa Clara Valley Basin Reported to Contain Manganese Greater Than the MCL
(Source: Santa Clara Valley Water District)



Note: This map was generated based on plume outlines submitted by responsible parties pursuant to a Nov. 2000 request by the Regional Board. Areas outside the plumes represented here may be contaminated. This is a pilot project using GIS to compile plume outlines for significant non-fuel plumes in the South San Francisco Bay groundwater basins. The plume outlines represent generalized two-dimensional approximations based on water quality analysis from groundwater monitoring wells. Most groundwater contamination is in shallow aquifers that are geologically isolated from deeper zones. Drinking water is routinely sampled for contaminants and supply wells draw water from deeper aquifers which are not contaminated.



Comprehensive Groundwater Protection Evaluation for the South San Francisco Bay Basins

Figure 22: Significant VOC Plumes and other Non-LUFT Sites

- ▲ Open SLIC case site (plume not shown); 618 sites in study area
- △ Closed SLIC case site (plume not shown); 283 sites in study area
- SMR reported plume outline
- - - Basin boundary
- Major road

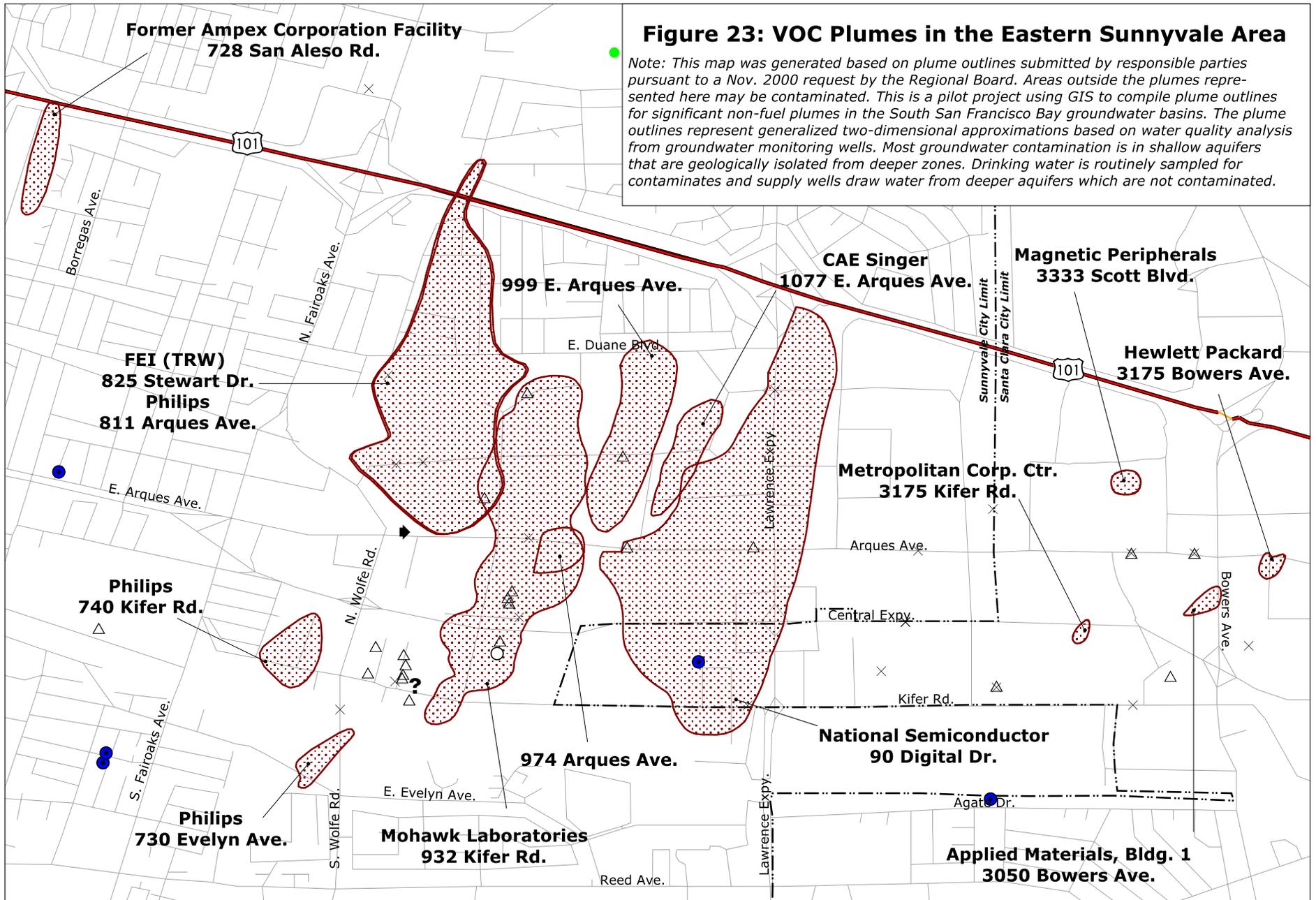
Sources: San Francisco Bay Regional Water Quality Control Board SBS database; Santa Clara Valley Water District



Note: Map does not include 18 sites which have not been georeferenced.

Figure 23: VOC Plumes in the Eastern Sunnyvale Area

Note: This map was generated based on plume outlines submitted by responsible parties pursuant to a Nov. 2000 request by the Regional Board. Areas outside the plumes represented here may be contaminated. This is a pilot project using GIS to compile plume outlines for significant non-fuel plumes in the South San Francisco Bay groundwater basins. The plume outlines represent generalized two-dimensional approximations based on water quality analysis from groundwater monitoring wells. Most groundwater contamination is in shallow aquifers that are geologically isolated from deeper zones. Drinking water is routinely sampled for contaminants and supply wells draw water from deeper aquifers which are not contaminated.



 Contour of the most-dispersed chlorinated volatile organic compound in groundwater

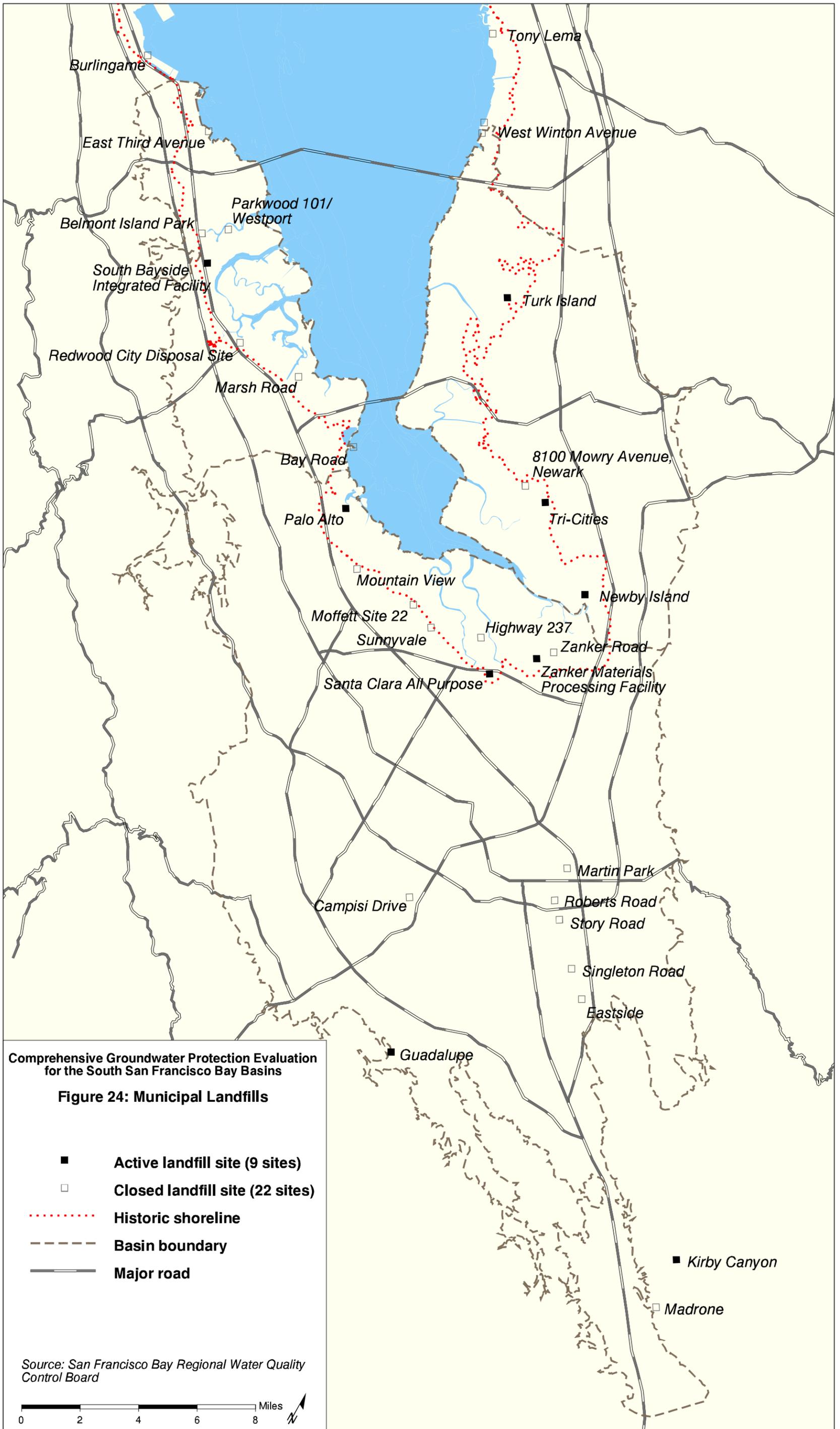
Slic case sites (plume not shown):

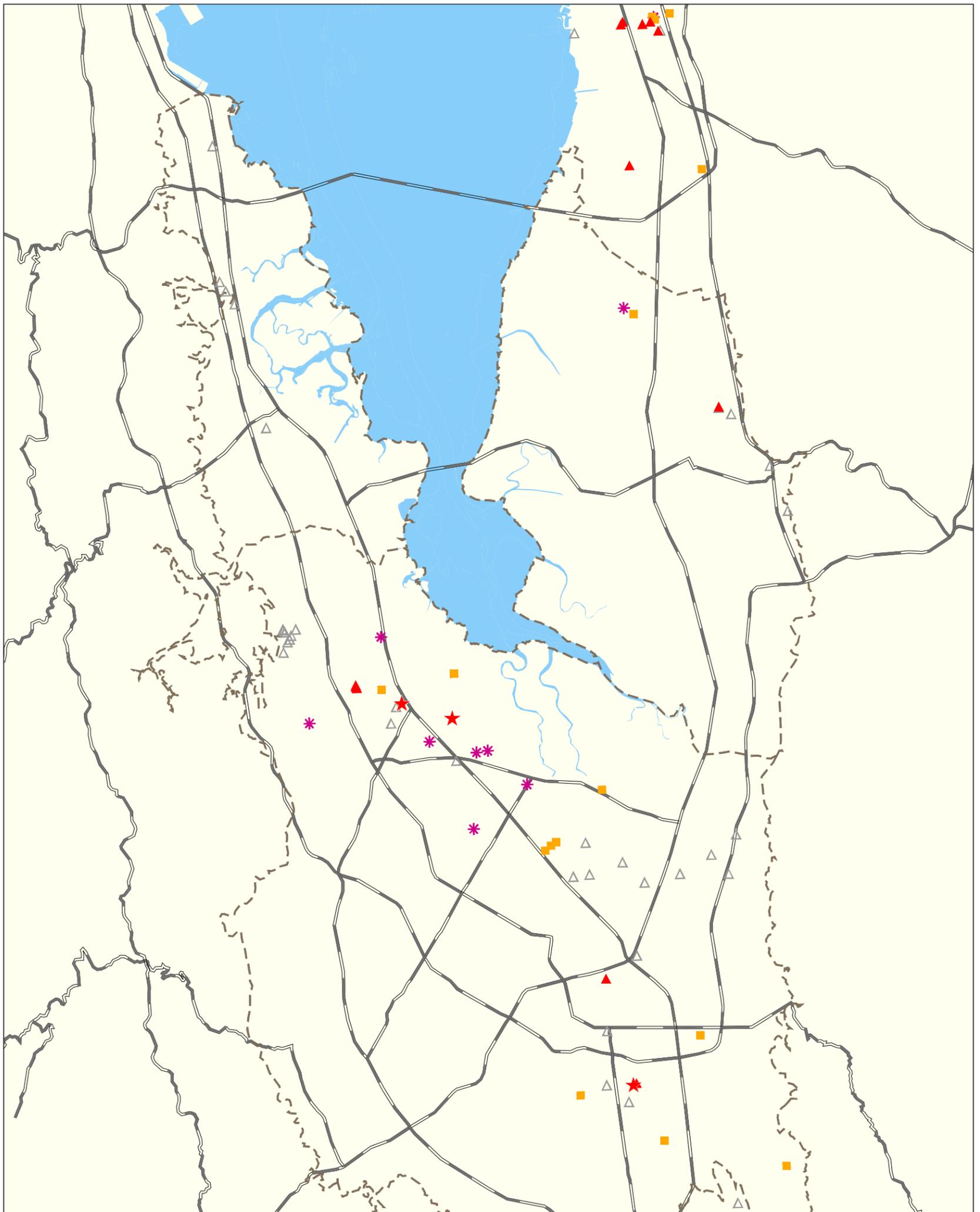
-  Open/active
-  Closed
-  Inactive
-  No action
-  Referred by RWQCB to another agency
-  Unidentified

-  Public drinking water well
-  Irrigation well

Sources: SF Bay Regional Water Quality Control Board; Santa Clara Valley Water District







**Comprehensive Groundwater Protection Evaluation
for the South San Francisco Bay Basins**

Figure 25: US-EPA and CA DTSC Lead Sites

★ US EPA-lead site

DTSC-lead site

▲ Annual Work Plan (active) site

■ Voluntary Cleanup Plan site

*** Preliminary endangerment
assessment in progress**

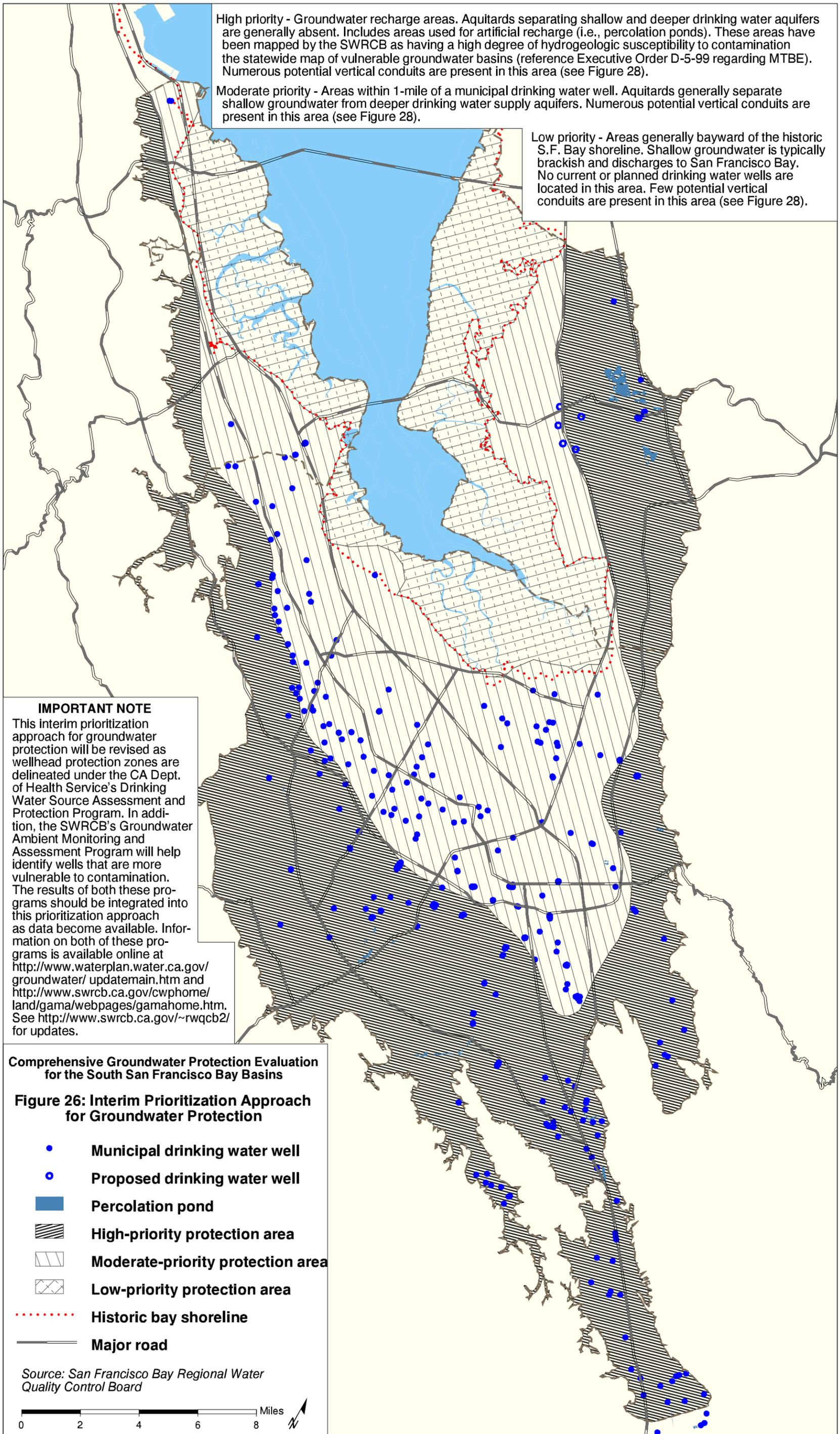
△ Certified (closed) site

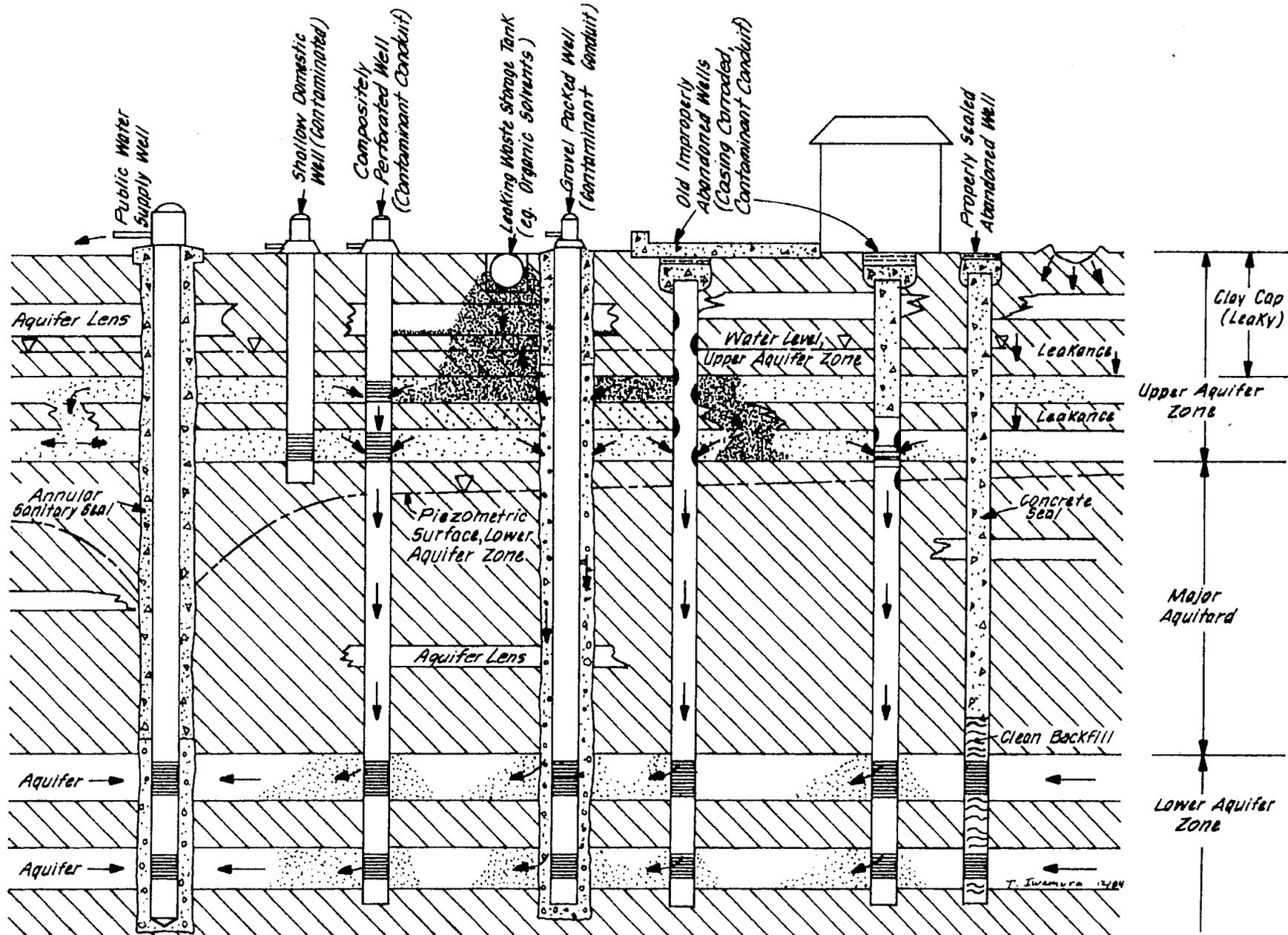
- - - Basin boundary

— Major road

*Source: Department of Toxic Substances Control
Calsites database*

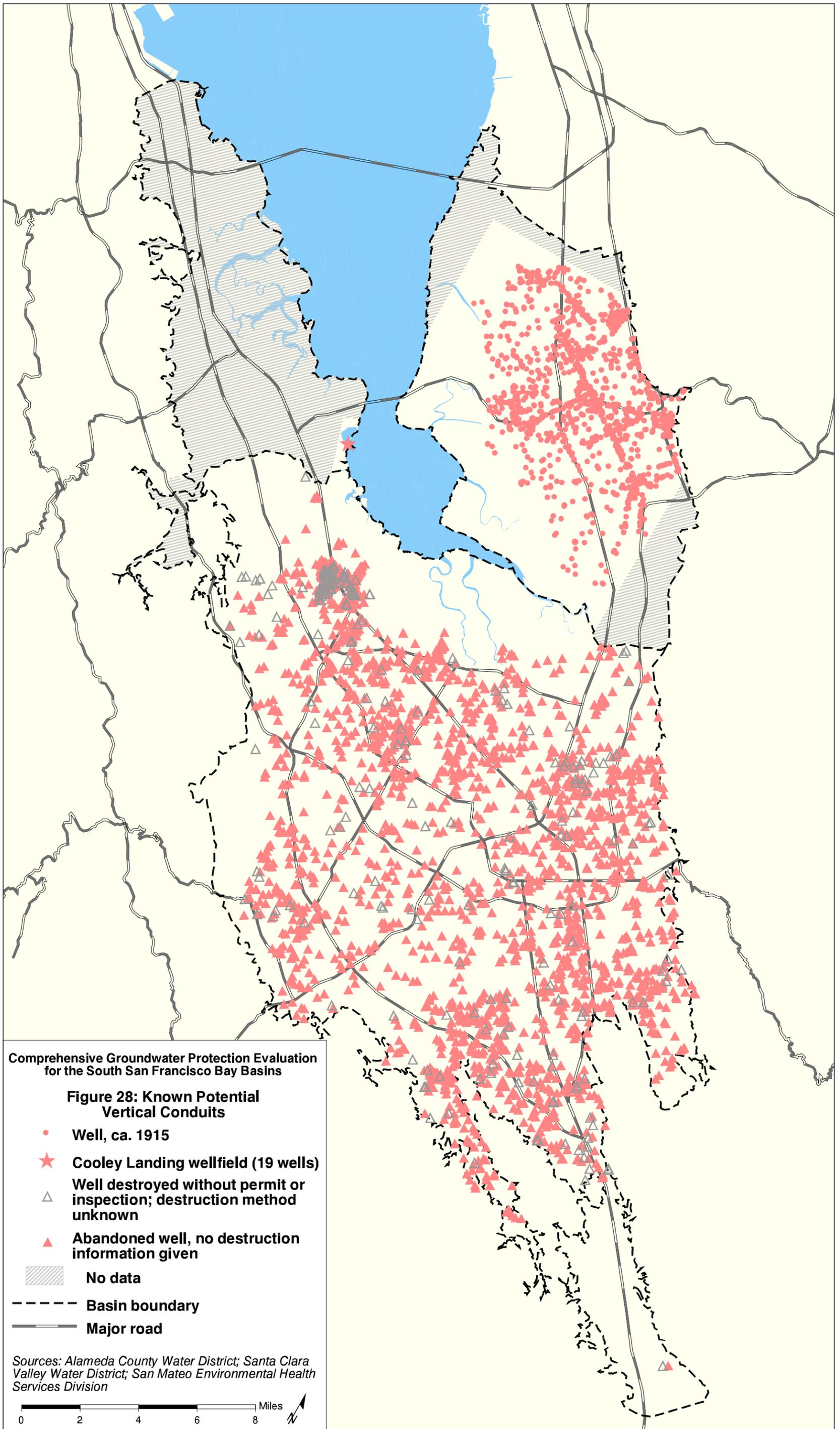






Note: Intensity of dot pattern denotes relative contaminant concentration

Figure 27: Schematic Cross Section Illustrating Potential Vertical Conduit Conditions (Source: Iwamura 1995)



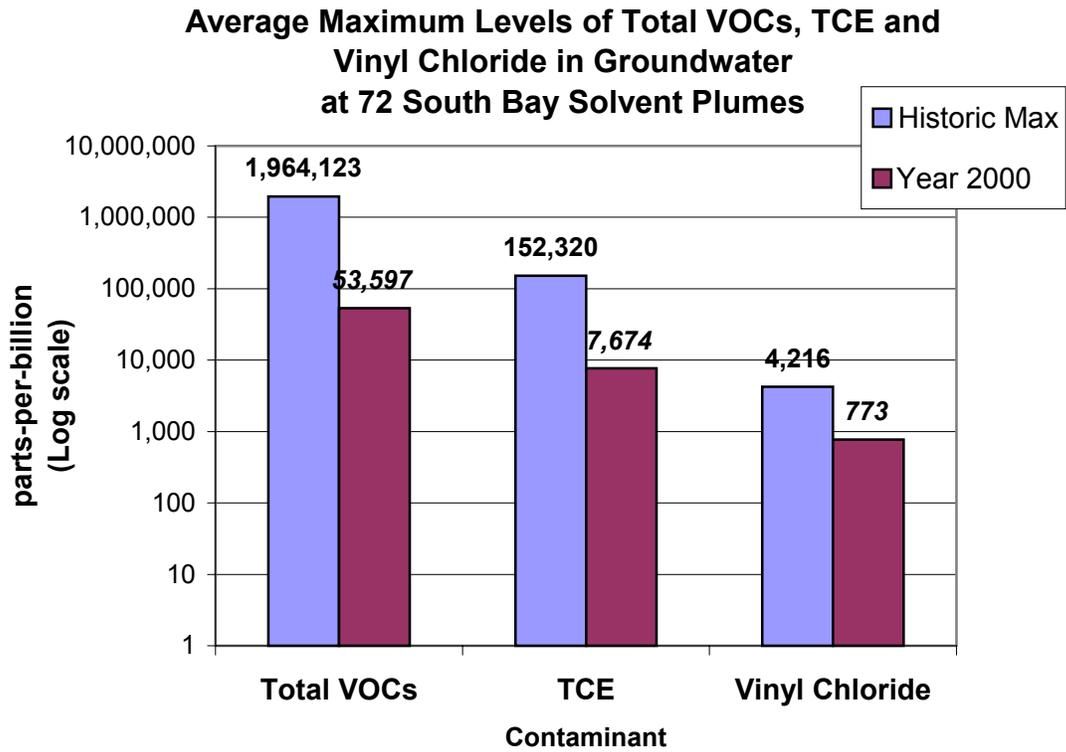


Figure 29: Average Maximum Levels of Total CVOCs, TCE, and Vinyl Chloride in Groundwater at South Bay Solvent Plumes

Maximum Levels of TCE in Groundwater at 74 South Bay Sites

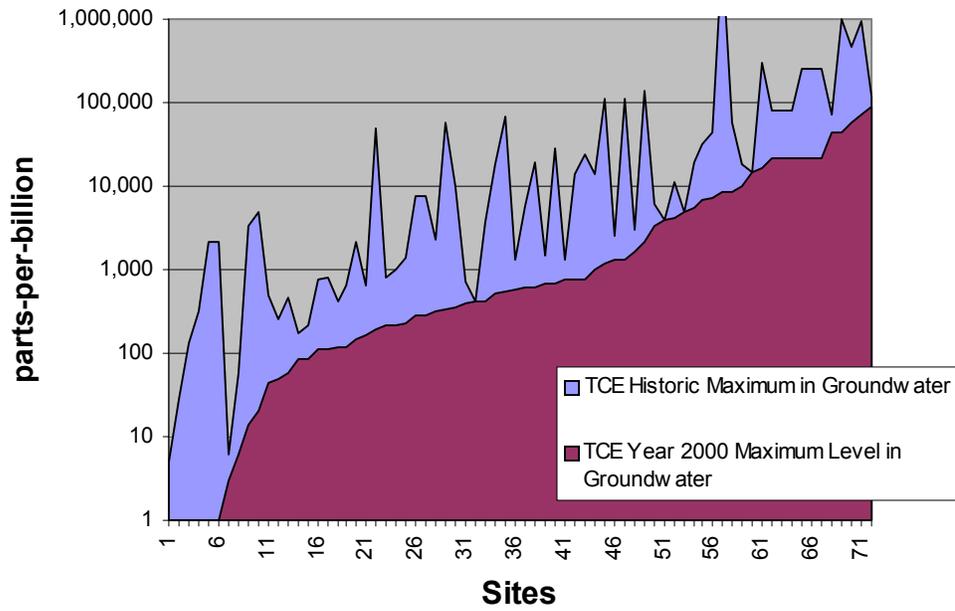
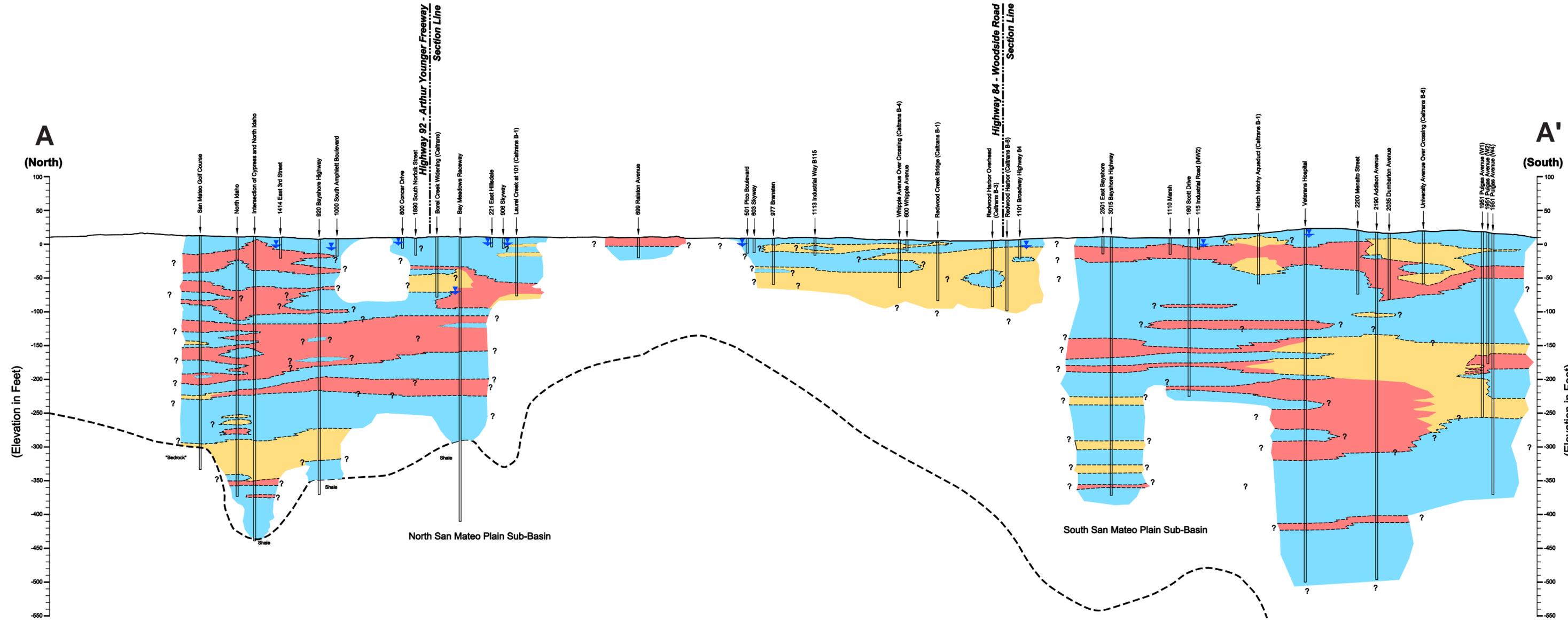
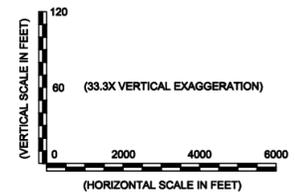


Figure 30. Maximum Levels of TCE in Groundwater at South Bay Sites

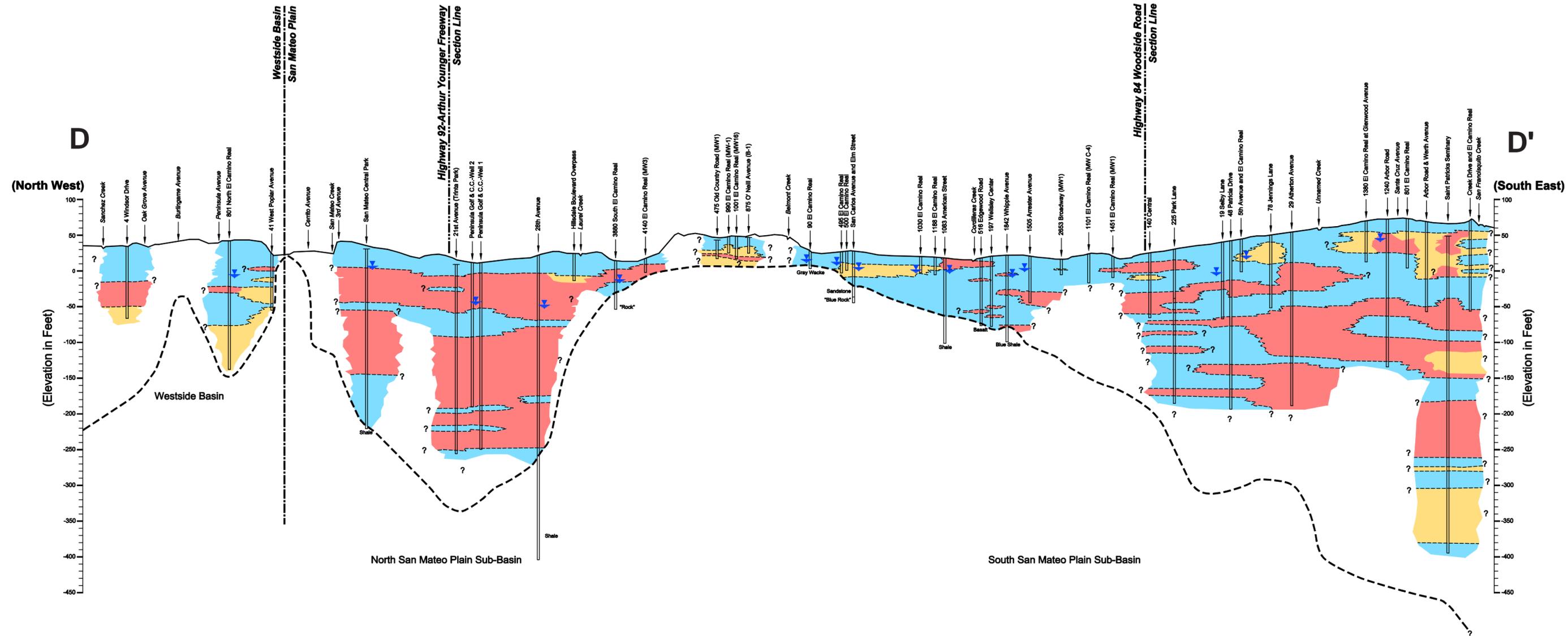


EXPLANATION:

- 320 E. 19th Ave. → WELL NAME DESIGNATION
- CONTACT LINE
- WELL/BOREHOLE
- - - - APPROXIMATE TOP OF BEDROCK
- ↓ GROUNDWATER ELEVATION
- CLAY/SILT
- SAND
- GRAVEL
- BEDROCK

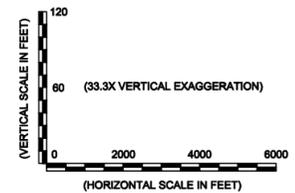


**Geologic Cross-Section
Bayshore Highway**

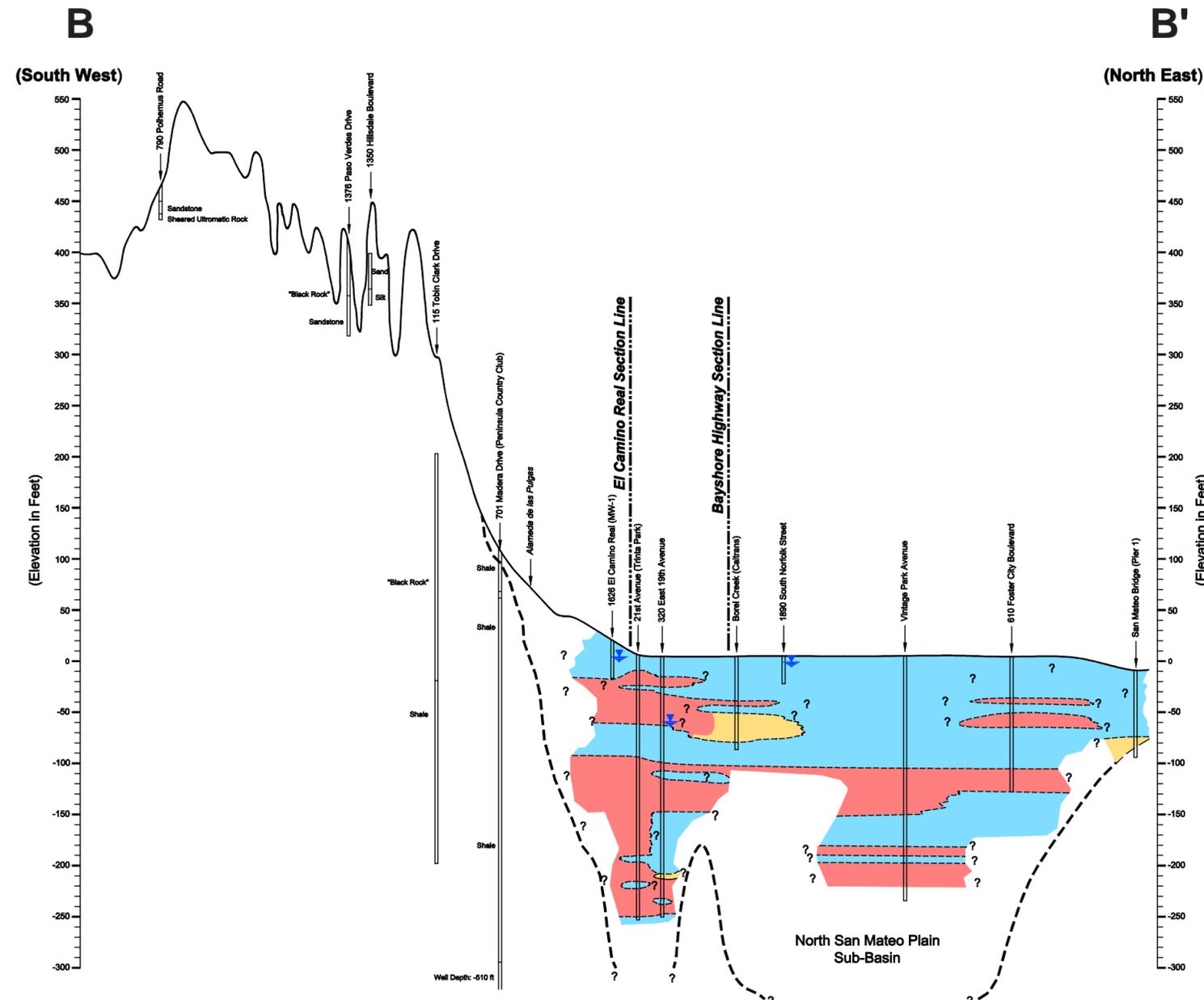


EXPLANATION:

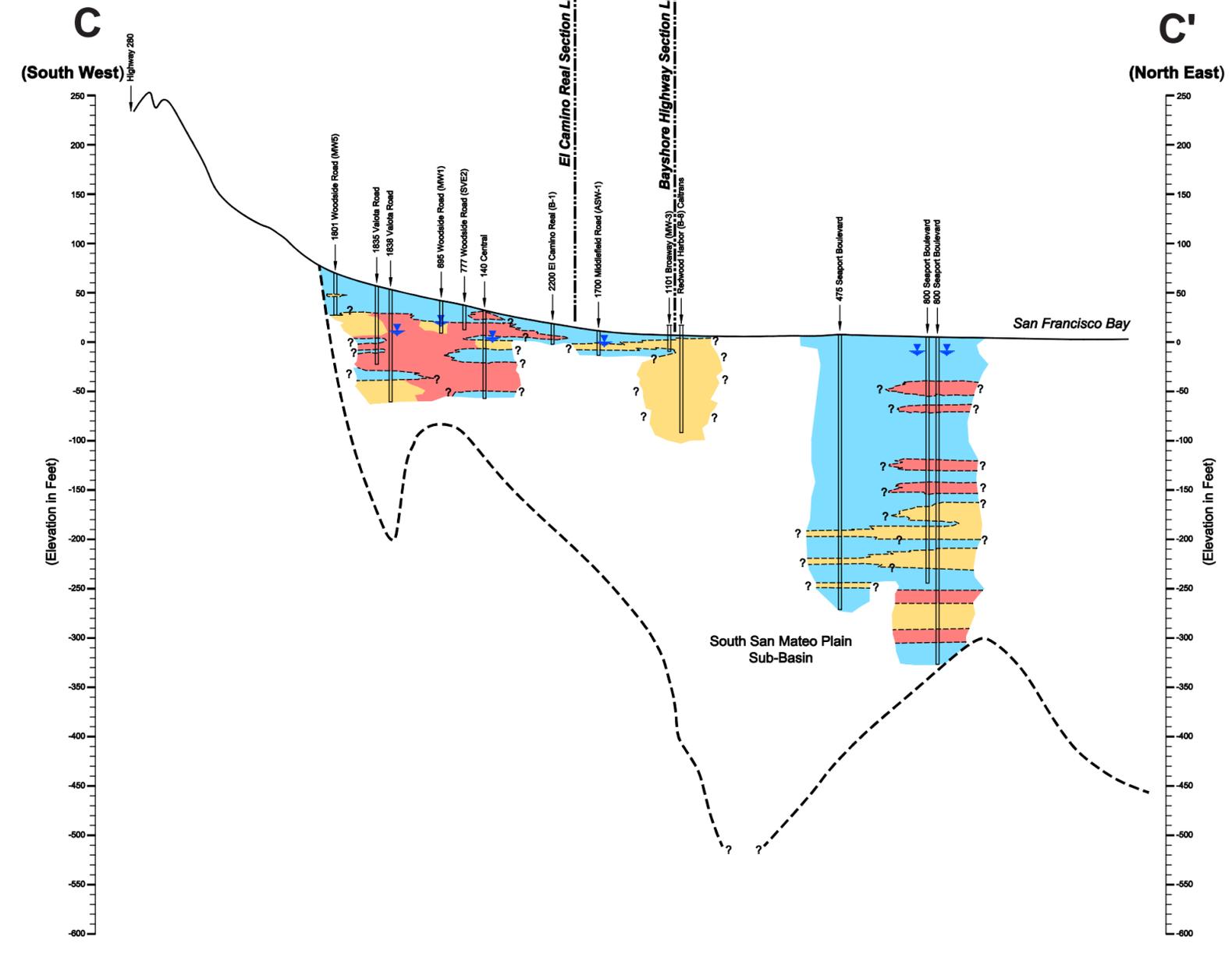
- 320 E - 19th Ave. → WELL NAME DESIGNATION
- CONTACT LINE
- WELL/BOREHOLE
- - - - - APPROXIMATE TOP OF BEDROCK
- ↓ GROUNDWATER ELEVATION
- CLAY/SILT
- SAND
- GRAVEL
- BEDROCK



**Geologic Cross-Section
El Camino Real - Highway 82**



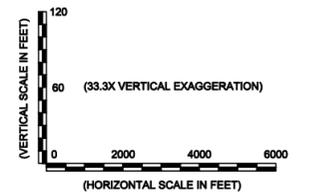
**Geologic Cross-Section
Highway 92 - Arthur Younger Freeway**



**Geologic Cross-Section
Highway 84 - Woodside Road**

EXPLANATION:

- 320 E. 18th Ave. → WELL NAME DESIGNATION
- CONTACT LINE
- WELL/BOREHOLE
- - - - - APPROXIMATE TOP OF BEDROCK
- ↓ GROUNDWATER ELEVATION
- CLAY/SILT
- SAND
- GRAVEL
- BEDROCK



**A Comprehensive Groundwater
Protection Evaluation for
South San Francisco Bay Basins**

APPENDICES A-I

LIST OF APPENDICES

- APPENDIX A. List of Attendees at May 2000 Stakeholder Meetings, San Francisco Bay Regional Water Quality Control Board (*available upon request*)
- APPENDIX B. South Bay Geology
- APPENDIX C. Geology of the San Francisquito Cone Area
- APPENDIX D. Federal Groundwater Protection and Cleanup Programs
- APPENDIX E. State and Local Groundwater Protection and Cleanup Programs
- APPENDIX F. Contact Information for South Bay General Plans and Groundwater Protection Strategies in South Bay General Plans
- APPENDIX G. Guidelines for the Identification, Location, and Evaluation of Deep Well Conduits
- APPENDIX H. An Evaluation of the Potential for Exfiltration from the City of Sunnyvale Sewer System
- APPENDIX I. Response to Stakeholder Comments

APPENDIX A

List of Attendees at the Spring 2000 Stakeholder Meetings
San Francisco Bay Regional Water Quality Control Board
Available upon request

APPENDIX B

South Bay Geology

The Coast Ranges are dominated by northwest trending, folded and faulted sedimentary formations ranging from the Jurassic period (160 million years ago) to the Pleistocene epoch (about 2 million to 10,000 years ago). These ranges were formed by uplift and mountain-making processes as the North American plate collided with the Pacific Ocean plate. Many of the faults that exist in the area are no longer active. However, other significant and not so significant active faults do exist. The more prominent of the active, regional northwesterly trending faults include the San Andreas fault in the Santa Cruz Mountains and the Hayward and Calaveras faults in the Diablo Range. These major faults are strike-slip faults (lateral movement).

The major valley areas trend northwesterly, and continue northwesterly beneath San Francisco Bay. These are the result of an intermontane structural depression, formed by the block being downfaulted to create the depression. The valley areas are now being filled by alluvial deposits washing in from the Santa Cruz Mountains and the Diablo Range. These alluvial deposits comprise the groundwater basins of the study area. In the Santa Clara Valley, the maximum depth of the alluvial materials is in excess of 1,500 feet.

This complex structural regime, coupled with erosion when the Pleistocene sea level was low enough that the Pacific shoreline was close to the Farallon Islands, has resulted in a highly irregular bedrock contact under the alluvial fill. Some faults cross the groundwater basins, or parts of the groundwater basins, and can form barriers to, or pathways for, groundwater movement. Recent studies (Ikehara, et. al., 1998) indicate that a northern extension of the Silver Creek fault may be operating as a groundwater barrier. Current geologic investigations may provide information about the groundwater effects of other faults cutting through the water bearing alluvium.

The depth of the contact between the base of the alluvial valley fill and the underlying bedrock is highly variable and identified with certainty in only a few locations. Under parts of the San Mateo Plain, the bedrock elevation is as little as 100 feet below sea level; this increases to 880 feet below sea level at San Francisquito Creek which is the southern border of the San Mateo Plain and the border with Palo Alto. In Palo Alto, near Page Mill and El Camino, bedrock was not reached in a drill hole 1,147 feet deep (Pampeyan, 1993). In Sunnyvale and San Jose, the USGS installed compaction wells to a depth of 1,000 feet and did not encounter bedrock (Poland and Ireland, 1988; Meade, 1967 and 1968). In downtown San Jose, depth to bedrock is in excess of 1,300 feet. At Moffett Field, Franciscan Complex bedrock is encountered at 1,400 feet. There is geophysical evidence of deep alluvial-filled basins in the Evergreen area of San Jose, in Palo Alto, and beneath the alluvial fan in Cupertino. The clearest example of the steep buried bedrock surface is where the Alameda plain abuts the Coyote Hills (Atwater, Hedel, and Helley, 1977). These bedrock hills extend above the alluvium and bay mud adjacent to the shoreline. A deeper basin exists between the Coyote Hills and the Diablo Range mountain front. These deeper parts of the basin can hold substantial reserves of groundwater.

B.1 Stratigraphy

Similar formations form the Santa Cruz Mountains and the Diablo Range, and they underlay the valley fill areas of the groundwater basins. The discussion of the formations will start with the oldest formation and end with the youngest. These are divided into two broad groups:

1. Mesozoic formations that date back to about 160 million years ago to 70 million years ago
2. Younger Cenozoic formations that range from about 70 million years old to the present.

The Mesozoic members include the Franciscan Group and its serpentine member and Cretaceous sedimentary formations. The Cenozoic members include Tertiary volcanics, Tertiary sedimentary

formations, Santa Clara Formation, old alluvium, and young alluvium. The Stratigraphy section is revised from Iwamura, 1999.

B.2 Mesozoic Formations

B.2.1 Franciscan Group

The Franciscan Group is a complex mixture of rock units that are sheared, contorted, and faulted by high pressure and relatively low temperature since burial. These impacts suggest a very active tectonic history since deposition. The Franciscan is composed largely of submarine-deposited volcanic rocks, serpentine, and silica carbonate (collectively often referred to as ophiolites). These are highly altered remnants of volcanic arc rock deposits that are the result of regional collision of tectonic plates. The group also consists of marine-deposited lithic sandstone, shale, and chert, some of which have metamorphosed to schists. Though most of the large bodies of serpentine within the Franciscan Group occur along the southeastern boundaries of the Santa Clara Valley in the Diablo Range, smaller but significant bodies of serpentine have pervasively intruded the Franciscan throughout (in small, unmappable units for small-scale maps). However, it is the serpentine unit that controls the mineral quality of waters that drain from the Franciscan Group terrain. Runoff water usually contains magnesium bicarbonate, as the serpentine has high magnesium content. Soils that have developed from weathered serpentine are toxic to most plants.

Because of the high magnesium content in serpentine-derived soils, plants have difficulty absorbing the calcium they need. However, there are a few characteristic plant species that have adapted and are the exceptions. One example is a type of ceanothus in the foothill areas referred to as ceanothus ferrisae, or more commonly known as Coyote ceanothus. Heavy metals such as mercury, chromium, and nickel are also present in soils and may present problems. Waters draining from serpentine often leave white evaporation lines along the pool edges that are the mineral magnesite, which is a magnesium carbonate. Thick veins of magnesite-filled fractures were formerly mined in the high area of the Diablo Range at the border with Stanislaus County.

Several significant mercury mines and numerous mercury prospects are located within the serpentine associated with silica carbonate rock throughout the coast ranges of California. Asbestos is formed from the recrystallization of sheared serpentine. Asbestos fibers have been detected in water samples collected from the Santa Clara Valley Water District. Limestone mining operation for portland cement occurs within the Calera Limestone member of the Franciscan Group in the Permanente Creek drainage. Small manganese deposits associated with Franciscan chert deposits (layered siliceous rock precipitated in a shallow marine setting, associated with ancient volcanic activities) have been noted in the Upper Penitencia Creek drainage area.

B.2.2 Cretaceous Sedimentary Formations

The Cretaceous sedimentary formations, also referred to as the Great Valley Sequence, consist of a regularly bedded series of micaceous sandstone, siltstone, and shale with locally thick layers of conglomerate. Today, only erosional remnants of the Cretaceous formations occur as a continuous northwesterly band in the south-central portion of Santa Clara County, east of Coyote Valley and the Llagas Basin. Discontinuous bands occur along the western foothills of the Diablo Range, east of Santa Clara Valley, and along the western edge of the county in the Santa Cruz Mountains. Individual Cretaceous formations include the Berryessa formation, Chico formation, Oakland conglomerate, and Del Valle formation.

The mineral quality of runoff water from the Cretaceous terrain can be variable, but would usually be a calcium-bicarbonate-containing water. Deep-seated connate water springs from this marine formation can

be expected to be salty, but the concentration can be moderated by mixing with meteoric (surface) water as it rises to the surface.

B.3 Cenozoic Formations

B.3.1 Tertiary Sedimentary Formations

After the Franciscan Group and Cretaceous sedimentary formations had been accreted to the westward advancing North American continent, and as mountain-making processes continued, certain areas became depressed and became inland marine waterways and coastal embayments. Tertiary sedimentary formations were deposited in these depressed marine basins. These deposits consist of sandstone (often fossiliferous), shale, siliceous shales, chert, and some conglomerate and minor limestone deposits. These deposits have been divided into the San Lorenzo, Butano, Vaqueros, Temblor, Monterey, Briones, and Purisima formations.

Toward the end of the Tertiary period, the area began to rise due to acceleration of mountain-making processes, and the inland seas and embayments receded. Some of the late Tertiary formations, which were mostly marine deposits, have their upper portions deposited as subaerial (continental) fluvial deposits. These include the Purisima formation and, in adjacent counties, the Santa Margarita formation. The general distribution of Tertiary sedimentary formations occur as discontinuous, northwest-trending slivers of bedded formations along both east and west sides of the valley areas and along the upper crestline of the Santa Cruz Mountains.

Meager oil and gas deposits are hosted in the Tertiary sedimentary formations. The two defined oil fields are the Sargent, in a down-faulted block between the San Andreas and the Sargent faults in the southwestern portion of Santa Clara County, and Moody Gulch, above Lexington Reservoir. Though these oil fields are generally inactive today, they have the potential to produce brines for disposal if or when the fields become active again. The chert (siliceous bedded rock) in the Monterey formation is quarried for roadfill, as it can be hard and durable.

Runoff from Tertiary rocks is generally expected to be similar in mineral character as those from the Cretaceous sedimentary rocks, but in some rock units, particularly the organic, siliceous marine shales, a higher sulfate content would be expected. Sulfates may also be higher in some of the continental tertiary units should they contain secondary sulfate minerals, chiefly gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). The presence of chert in the Monterey formation may contribute trace amounts of manganese to the runoffs.

B.3.2 Santa Clara Formation

The Santa Clara formation is a subaerially deposited fluvial, unconsolidated to lightly consolidated unit of bedded conglomerate, sandstone, siltstone, mudstone, and compacted siltstone and claystone. These sediments were deposited during the late Tertiary period through the Pleistocene epoch of the Quaternary period. This interval generally spans from about 2 million years to 10,000 years ago. This was a period of continued uplift and mountain building in the Coast Ranges. The uplift rejuvenated streams, and huge gravel deposits were laid down in the valleys. In Santa Clara and San Mateo Counties, these deposits are adjacent to the valley floor. Equivalent deposits in adjacent counties include the Livermore gravels and the San Benito gravels.

The Santa Clara formation can be distinguished from younger alluvial deposits by its being broadly folded, with dips of beds as high as 70° east from the horizontal. The formations younger than the Santa Clara formation are undeformed. The Santa Clara formation is considered to be partly water bearing. The

portion that outcrops above the edges of the valley is generally considered to be non-water-bearing. However, it may provide meager quantities of groundwater to domestic wells located in some of the canyon areas. Stevens Creek Dam and Reservoir are founded on the Santa Clara formation with no discernable leakage through the formation. The portion of the formation that is considered to be water bearing is that which dips beneath the younger alluvial deposits in the large valley areas.

Because of the general softness of the members of this formation, rock outcroppings are rare, except for some substantial outcropping of the conglomerate beds in some stream canyon areas. The gently-rounded Santa Clara formation terrain is covered by grassy sod and low-elevation trees and brushes. Where the surface grassy sod cover has been disturbed, significant erosion can occur, which may contribute substantial amounts of brown silts to the streams. Sometimes, erosional gashes will begin on hillsides if rainfall is intense and of long duration.

Gravel quarries for road fill and other fill materials have been operated in this formation. Due to the high clay content of the gravels in the foothills, extensive washing is needed to make the gravels suitable for aggregate.

The mineral character of the runoffs from this formation is expected to be a calcium-bicarbonate-type water. Significant turbidity can be expected during large storms.

B.3.3 Old Alluvium

Within the drainages, the Old Alluvium occurs in small mountain valleys. It more predominantly occurs along the elevated edges of the main valley floors as terrace deposits or older abandoned alluvial fans. These alluvial units are generally areas where the streams are presently downcutting because the sediment yields from the drainages today are far lower than in the most recent geologic past (Pleistocene) when the overall regional precipitation was much higher.

The Old Alluvium consists of unconsolidated gravel, sand, silt, and clay. The Qoa is considered to be water-bearing and can provide domestic-use groundwater to mountain valley residents and is an important water-bearing formation in the large valley areas. Surficially, it also has the appearance of the Santa Clara Formation, but because it is relatively young, the unit is undeformed. These deposits range in age from about 1 million years to 8,000 years before present.

Runoff from this formation is expected to be a calcium-bicarbonate-type water. As runoffs recharge this unit, they would tend to pick up calcium. The original runoffs from the drainages dominated by the Franciscan Group would be a magnesium-bicarbonate-type water. Infiltration and percolation through the old alluvium (and also through the young alluvium) would tend to be modified to a magnesium-calcium-bicarbonate- or to a calcium-magnesium-bicarbonate-type water through the process of base exchange.

B.3.4 Young Alluvium

Like the old alluvium, the young alluvium occurs as small, limited deposits within the mountain valley. However, it predominantly covers the large valley areas. The young alluvium consists of unconsolidated gravel, sand, silt, and clay, and occurs where it is actively being accumulated at present. This unit is considered to be water bearing and can be an important source of groundwater in the mountain valleys should it achieve a significant thickness, and is an important water-bearing unit of the major groundwater basins. The young alluvium ranges in age from about 10,000 years before present to the present.

The young alluvium deposits are the major source of aggregate materials. They can be quarried for other fill material and were used in the past for making bricks from the sandy clay unit. The surficial portions of

this unit are generally fertile and have better subsurface drainage characteristics than the old alluvium and Santa Clara Formation. As a consequence, the young alluvium can support a variety of growth and crops.

Runoff waters from the young alluvium, like the old alluvium, are expected to be a calcium-bicarbonate-type water. Infiltrating waters would pick up calcium and, if groundwater percolates through this unit for miles, the groundwater would eventually become a calcium-bicarbonate type. In mountainous areas where organic materials have accumulated to form peat deposits in a swampland environment, effluent seepage into streams may contain higher levels of dissolved organic carbon, iron, and total phosphorus.

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APPENDIX C

Geology of the San Francisquito Cone Area

Most studies in the San Mateo Plain have focused on the San Francisquito Cone. The first study was done in 1932 by Killingsworth and Hyde in response to drastically dropping water levels in wells in the area from Atherton to Palo Alto. Their goal was to identify the characteristics of the groundwater basin under San Francisquito Creek and to address the feasibility of water supply in the following years. Other than for the San Francisquito Cone, few studies have examined the northern part of the San Mateo Plain Basin.

Based on available well logs and field investigation, Killingsworth and Hyde identified two separate aquifers, one lower, and one upper, both composed of gravels, sands, and clays derived from the Santa Cruz Mountains. The lower aquifer (composed of "Santa Clara sands and gravels") used to be part of a larger alluvial fan that was connected to the alluvial deposits found in Portola Valley. This "old" alluvial fan was truncated by The San Andreas and Pulgas faults in the Pleistocene age.

The central block, between the San Andreas Fault and the Pulgas Fault, was uplifted in relation to the adjacent two blocks and consequently attacked by erosion. The old alluvial deposits on the central block were transported downhill toward the San Francisco Bay and were deposited unconformably on top of the old alluvial deposits east of the Pulgas Fault. These relatively younger alluvial deposits built the upper aquifer zone. The old alluvial deposits of Killingsworth and Hyde are differentiated in Pampeyan's (1993) geologic map of the Palo Alto and part of the Redwood Point quadrangles into the Santa Clara Formation of Pliocene and lower Pleistocene age and older alluvium of Pleistocene age.

The Holocene, upper Pleistocene, and Pleistocene alluvium are separated by a thick continuous clay layer that pinches out to the west. Helley and others (1979) referred to this clay layer as the Pleistocene Bay Mud, with an age ranging from 70,000 to 120,000 years (Figure 3). Along the Pulgas Fault, the sediments of the Santa Clara Formation are exposed at the surface due to upward dragging along the fault plain (Killingsworth and Hyde, 1932). There, gravels from the Santa Clara Formation are connected with the gravels and sands of the Quaternary alluvium and cannot be differentiated (Killingsworth and Hyde [1932]; Helley, et. al., [1979]).

Based on cross sections, Killingsworth and Hyde (1932) noticed that the gravels are thickest near the base of the foothills and extend in small streamers out under San Francisco Bay. These streamers range from 1 foot to greater than 20 feet in thickness (Erler and Kalinowski, 1993). Some of these streamers may extend as far north as the mouth on Redwood Creek (Poland and Garrett, 1943). Within the Holocene and late Pleistocene alluvium, Erler and Kalinowski (1993) identified two clearly distinguishable aquifer zones, a shallow "A" aquifer ranging between 5 and 36 feet below ground surface and a deeper "B" aquifer ranging from 34 to more than 60 feet below ground surface.

Killingsworth and Hyde (1932) identified Waverly Street in Palo Alto as an approximate northern limit of the area in which gravels predominate. Overall, the gravel strata have a definite dip to the north and if projected to the surface in their present attitude they would outcrop in the vicinity of Lagunita, at the Stanford Campus. Locally, the dipping may vary. Erler and Kalinowski (1993) noted that in the area of the Lincoln Willow property, the A aquifer zone appears to dip to the east.

Killingsworth and Hyde (1932) differentiated the clays described in the well logs and divided the field into two groups, the yellow clays and the blue clays. They described the yellow clays as merely the fine-grained material of the alluvial cone interbedded with the gravels and sands. This agrees with Helley and other's (1979) depositional model of alluvial deposits. The thickness of these clays is up to 50 feet

The blue clays, also known as bay muds, vary in lithology from a pebbly clay to a silty clay. In some places the blue clay has small subangular to sub-rounded pebbles of chert 0.25 to 1 inch in diameter (Killingsworth and Hyde, 1932; Erler Kalinowski, 1993) that are scattered throughout the formation, and there is occasional gradation of the clays into sandy clay. Root casts are common. With greater depth, root

casts are less common and the clays become mottled with light-brown, rusted colored, or light gray material. These color changes reflect the development of a soil profile. The bay muds thin out to the west and interfinger with the yellow clays. Close to the San Francisco Bay, they build the aquitard between the lower and the upper aquifer zones. They are also found under the lower aquifer, starting at depths of 320 feet and continuing to 500 feet.

The interfingering of the bay muds with the yellow clays has only been observed to a depth of 450 feet. No one has penetrated this blue clay deep enough to determine whether gravels underlie it, but as reported by various drillers, it is encountered much closer to the surface in the greater part of the Atherton district.

As in many alluvial fans, the San Francisquito Cone contains both unconfined and confined aquifers. Before pumping in the region began, three water-level phenomena were observed: an unconfined surficial water-bearing zone, an upper confined aquifer, and a lower confined aquifer. All three water-bearing zones were saturated, and the water level in the upper and lower aquifers most likely coincided.

The water surface in both the upper and lower water aquifers gently sloped toward the Bay. By 1932 the groundwater flow direction had been reversed from the San Francisco Bay inland, and different water levels could be noticed for the upper and the lower aquifers. The water level in the upper aquifer was above mean sea level, while in the lower aquifer it ranged between -45 and -60 feet mean sea level. Killingsworth and Hyde estimated that 7,218 acre-feet of water had been extracted in the area during the water year 1930 to 1931.

Erler and Kalinowski (1993) determined the general groundwater gradient for the area close to Willow Road and Bayfront Expressway to be to the northwest and to range from 0.0015 feet per foot to 0.028 feet per foot. They estimated the transmissivity and the hydraulic conductivity for the channel deposits to be 28,000 to 70,000 gallons per day/ft. and 1.65×10^{-1} to 4.27×10^{-1} centimeters per second, respectively. For the fine-grained material, the transmissivity was estimated to be 300 gallons per day per foot. and the hydraulic conductivity to be 1.48×10^{-2} centimeters per second. The groundwater flow in the A zone ranges from 2 to 10 feet per day.

APPENDIX D

Federal Groundwater Protection and Cleanup Programs

The EPA has the regulatory lead for the National Priorities List (NPL) Superfund sites as a result of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). They also oversee groundwater protection and cleanup programs via the Resource Conservation and Recovery Act (RCRA) and Safe Drinking Water Act, as described below.

D.1 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is a federal law that was enacted in 1980 and amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). CERCLA was established for the purpose of remediating hazardous waste sites. CERCLA established a “Superfund” to be used by the Environmental Protection Agency (EPA) to respond to releases of hazardous substances at certain sites, including primarily sites on the National Priorities List (NPL). Sites listed on the NPL are considered the worst sites in the country and are compiled with input from the states. CERCLA also authorizes the EPA to take enforcement actions to require responsible parties to remediate sites. SARA, which amended CERCLA, included the Defense Environmental Restoration Program (DERP), 10 U.S.C. §§2701 et seq. Section 120 of CERCLA specified that all federal agencies must comply with CERCLA to the same extent as any private party. DERP established specific requirements for the Department of Defense, including environmental restoration requirements, authority to pay for state support services, and a requirement to pay for state permit fees and charges.

CERCLA authorized the president of the United States to carry out its mandates. The president has delegated this authority primarily to EPA, but also to other federal agencies for property under their control.

Under CERCLA, remedial actions selected by the EPA or other delegated federal agency for sites listed on the NPL, other fund-financed sites, and federal facilities must be protective of human health and the environment. If CERCLA hazardous substances are to remain onsite, the remedial action must attain “legally applicable or relevant and appropriate” requirements.

CERCLA applies to the cleanup of “hazardous substances” and “pollutants or contaminants” as defined in CERCLA. If the substance is not a CERCLA hazardous substance, CERCLA requirements may not apply. The terms “hazardous substance” and “pollutants or contaminants” are defined in CERCLA Section 101 and specifically exclude petroleum. Because petroleum is excluded from CERCLA, the cleanup of petroleum that has, for example, leaked from an underground tank would not be subject to CERCLA unless the petroleum has commingled with a CERCLA hazardous substance.

Furthermore, a number of pesticides are not listed as CERCLA hazardous substances.

Instead, even if a site is on the NPL, the Regional Water Board may take separate enforcement action to require cleanup of wastes that are not subject to CERCLA, such as tank cleanups. In such situations, the Regional Board could issue a cleanup and abatement order, or other appropriate enforcement order, in the same way it does for any other site.

D.2 Resource Conservation and Recovery Act

In 1965, the Solid Waste Disposal Act was enacted by the federal government to improve solid waste disposal methods. The Solid Waste Disposal Act established economic incentives for states to develop planning, training, and research and demonstration projects for the management of solid waste. It was amended in 1970 by the Resource Recovery Act, which provided the Environmental Protection Agency with funding for resource recovery programs. Given that the Solid Waste Disposal Act has little impact on the management and ultimate disposal of hazardous waste, in 1976 Congress enacted the Resource Conservation and Recovery Act (RCRA), which established a system for managing non-hazardous and hazardous wastes from the point of origin to the point of final disposition (i.e., cradle to grave).

The goals set by RCRA are:

- To protect human health and the environment from the hazards posed by waste disposal
- To conserve energy and natural resources through waste recycling and recovery
- To reduce or eliminate, as expeditiously as possible, the amount of waste generated, including hazardous waste
- To ensure that wastes are managed in a manner that is protective of human health and the environment.

To achieve these goals, RCRA establishes three distinct yet interrelated programs. These programs include the Subtitle D Solid Waste Program, the Subtitle C Hazardous Waste Program, and the Subtitle I Underground Storage Tank Program. The Solid Waste Program, under RCRA Subtitle D, encourages states to develop comprehensive plans to manage non-hazardous industrial solid waste and municipal solid waste, sets criteria for municipal solid waste, sets criteria for municipal solid-waste landfills and other solid-waste disposal facilities, and prohibits the open dumping of solid waste. The Hazardous Waste Program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal – in effect, from “cradle to grave.” Finally, the Underground Storage Tank Program, under RCRA Subtitle I, regulates underground tanks storing hazardous substances and petroleum products.

Although RCRA creates the framework for the proper management of hazardous and non-hazardous solid waste, it does not address the problems of hazardous waste found at inactive or abandoned sites or those resulting from spills that require emergency response. These problems are addressed by a different act, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly called Superfund, which was enacted in 1980.

D.3 Safe Drinking Water Act

The Environmental Protection Agency (EPA) is the primary agency coordinating groundwater protection at the federal level. Congress passed the Safe Drinking Water Act in 1974 to protect public health by regulating the nation’s public drinking-water supply. The 1986 amendments to the Act established the Wellhead Protection Program, which required the EPA to approve the state’s wellhead protection programs. The 1996 amendments expanded the law by requiring states to complete source water assessments for all public water systems serving more than 15 service connections or for non-community water systems serving more than 25 people.

The California Department of Health Services (DHS), Division of Drinking Water and Environmental Management is the lead agency for developing and implementing the Source Water Assessment Program (SWAP), which in California is referred to as the Drinking Water Source Assessment and Protection (DWSAP) program. The DWSAP program will satisfy the mandates of both the 1986 and 1996 Safe Drinking Water Act amendments.

The Safe Drinking Water Act also includes the Sole Source Aquifer Program and the Underground Injection Control Program. The Sole Source Aquifer Program protects an area’s groundwater resource by requiring EPA review of any proposed projects within the designated area that are receiving federal financial assistance. All proposed projects receiving federal funds are subject to review to ensure they do not endanger the water source. There are no such designations in the South Bay basins. The Underground Injection Control Program works with state and local governments to oversee underground injection of waste in order to prevent contamination of drinking-water resources.

APPENDIX E

State and Local Groundwater Protection and Cleanup Programs

The following is a list of Web addresses for the state and local agencies and programs responsible for groundwater protection and cleanup in the South Bay Basins:

1. San Francisco Bay Regional Water Quality Control Board: www.swrcb.ca.gov/rwqcb2
2. Department of Toxic Substances Control: www.dtsc.ca.gov
3. California Department of Health Services: www.dhs.ca.gov
4. California Department of Water Resources: www.drw.water.ca.gov
5. Alameda County Water District: www.acwd.org
6. Santa Clara Valley Water District: www.scvwd.dst.ca.us
7. San Mateo County Environmental Health Services Division: www.smhealth.org
8. Certified Unified Program Agency: www.calcupa.net
9. Groundwater Ambient Monitoring Assessment Program : www.swrcb.ca.gov/cwphome/gama
10. Comprehensive Groundwater Quality Monitoring Program : www.swrcb.ca.gov/cwphome/gama
11. City and County General Plans: www.ceres.ca.gov/planning

E.1 California Regional Water Quality Control Board

California's major laws regulating cleanup of pollution sites are in the Health and Safety Code and the Water Code. The nature of these pollutants and their effects on human health and the environment has long involved multi-agency oversight for the cleanup of these sites. In addition to the state agencies, several county and city agencies participate in regulatory activities. The state agencies usually have the lead in overseeing the cleanup of these sites.

E.1.1 Leaking Underground Storage Tanks

In the early 1980s, pollutants from leaking underground storage tanks were found to be affecting some drinking-water wells in the Santa Clara Valley area. Considering that drinking water in this area is obtained largely from wells tapping extensive underlying aquifers, these discharges were seen as an immediate health and environmental threat. Given the discovery that soil and groundwater pollution from leaking underground storage tanks (USTs) were the source of this threat, local, state, and federal lawmakers moved rapidly to enact laws governing the operation of USTs insofar as they could threaten groundwater resources.

California was at the forefront of crafting what essentially became the nation's first UST law (Chapter 6.7 of the Health and Safety Code) addressing the threat of discharges from underground storage tanks to groundwater. This legislation was largely accomplished through the cooperative efforts of the Santa Clara Valley Water District and legislator Byron Sher. This law authorized local agencies to regulate UST design, construction, monitoring, repair, leak reporting, and response measures. Federal legislation patterned on California's approach followed in 1984.

The UST Program is unique, because the Health and Safety Code, Division 20, Chapters 6.7 and 6.75 gives local agencies the authority to oversee investigation and cleanup of UST leak sites. The Corrective Action regulations (CCR, Title 23, Chapter 16, Article 11) use the term "regulatory agency" in recognition of the fact that local agencies have the option to oversee site investigation and cleanup, in addition to their statutory mandate to oversee leak reporting and tank closure. Local agencies now have independent authority under UST laws to require investigations and cleanup. The Regional Board still retains its Water Code authority to approve case closure. However, the Regional Board has authorized a few local implementing agencies (LIAs) to close fuel leak cases where groundwater has not been polluted and future groundwater impacts are not expected. Some local agencies also provide oversight for underground fuel storage tank cases under a Local Oversight Program (LOP) contract with the State Water Board.

Four agencies oversee cleanup of fuel USTs within the South Bay study area. These are the Regional Water Quality Control Board, the San Mateo Environmental Health Division, the Santa Clara Valley Water District, and the Alameda County Water District.

Currently there are 1,335 open fuel UST cases and 1,849 closed fuel UST cases in the study area. Largely as a result of vigorous oversight efforts by the responsible agencies, groundwater contaminants from these leaking fuel USTs have had minimal effects on municipal and domestic wells in the South Bay basins. However, a small handful of municipal and domestic wells has been affected by methyl tertiary butyl ether (MTBE) from leaking UST sites, including wells in San Jose (the south San Jose retailer well), South San Francisco, and Loma Prieta School (Santa Clara County). In each case, MTBE levels were below MCL levels or have since dropped below MCL levels. Two other factors have also limited the impacts of leaking USTs: the tendency of most fuel constituents (with the exception of MTBE) to bind to the soil matrix and then biodegrade, and the prevalence of tight soils and relatively slow groundwater flow rates in many shallow zones around the region.

E.1.2 Guidelines for Investigation and Cleanup of MTBE and Other Ether-Based Oxygenates

In March 2000, the State Board released Guidelines for Investigation and Cleanup of MTBE and Other Ether-Based Oxygenates (Final Draft, March 27, 2000) in response to Executive Order D-5-99 and Senate Bill 989 (Sher, Chapter 812, Statutes of 1999). It is intended to assist managers and staff at state and local regulatory agencies with the task of overseeing the investigation and cleanup of sites where there have been or may have been releases of MTBE-laden petroleum. The document serves as a basis for reporting to Cal/EPA and the legislature regarding progress made on cleaning up MTBE.

The essence of the document is that the standard approach for dealing with petroleum releases employed over the past decade will not suffice for MTBE, because unlike traditional petroleum constituents such as benzene, MTBE moves quickly to pollute water and is slow to degrade in the subsurface environment. Response time is critical for MTBE. A quick response to a release greatly increases the ability to check the spread of the MTBE and to clean up the mass of the release. Because time is critical, regulators will need to prioritize their cases and give first attention to those that pose the greatest risk to groundwater. It is also expected that there will be more need for vertical definition of MTBE plumes and more reliance on active cleanup technologies, such as soil vapor extraction, in situ groundwater remediation, and groundwater pump and treat systems, than there has been for non-MTBE petroleum.

For a copy of the Guidelines for Investigation and Cleanup of MTBE and Other Ether-Based Oxygenates, please visit the State Board website at: www.swrcb.ca.gov/cwphome/ust/docs/mtbe/index.html.

E.1.3 Underground Storage Tank Cleanup Programs

There are several new initiatives and programs under way that directly affect cleanup of underground storage tanks (USTs) in the South Bay Basins. These programs are a result of the UST Cleanup Program maturing and evolving from one of individual case management to that of identifying high-risk sites and marshalling each regulatory agency's efforts in those areas where they will be most protective of the South Bay's groundwater resource. The most significant of these programs are:

Reopening Closed Cases. The State Board is developing guidance on reopening closed cases. The Regional Board has provided comments to the State Board regarding this issue. Essentially, we have said that this is not an item to approach lightly. We have suggested screening criteria to be used to determine which, if any, cases should be reopened.

Monitoring Active Service Stations. The Regional Board has instituted a pilot test with the Santa Clara Valley Water District to perform environmental monitoring at operating service stations that are not currently in the UST cleanup program. The Santa Clara Valley Water District (District) has recently completed a report titled, "An Evaluation of MTBE Occurrence at Fuel Leak Sites With Operating Gasoline USTs," dated May 2000, which indicates that undetected MTBE releases may be occurring at currently upgraded operating UST facilities. The report indicates that as many as 13 of the 16 sites in the study group have undetected MTBE releases that appear to be from the currently upgraded UST system and not from historic releases. If this trend

of undetected releases is found to be consistent across a larger spectrum of sites, then Regional Board staff believes that undetected MTBE releases from operating and upgraded UST facilities are a greater threat to groundwater resources than earlier believed.

GIS Integration. Geographic information systems (GIS) are a significant part of the Regional Boards MTBE guidelines implementation. GeoTracker is the interface to the Geographic Environmental Information Management System (GEIMS), a State Board data warehouse which tracks regulatory data about underground fuel tanks, fuel pipelines, and public drinking water supplies. GeoTracker is an interface to GEIMS and is a web-based tool that will be of use to the public and local agencies for a case-by-case review of data. The Regional Board has developed a protocol using this publicly available GIS software to enhance the state's efforts. Soon we are expected to have full GIS functionality for presenting and querying all LUFT data at each caseworker's desktop. Regional Board staff will not only be able to look at individual sites and surrounding affected wells, but will also be able to view their site in the context of a groundwater basin or watershed. This will allow integration of groundwater and surface water data to arrive at more rational and global environmental decision-making, rather than looking at only a single issue.

E.1.4 Spills, Leaks, Investigation, and Cleanup (SLIC)

SLIC is the program term used by the State Board and Regional Boards to define those sites with groundwater polluted by chemicals other than petroleum hydrocarbons that are used as fuels. These chemicals include, but are not limited to, polyaromatic hydrocarbons, volatile organic chemicals (VOCs), PCBs, metals, and pesticides.

The SLIC program involves the Regional Board and some local agencies that have elected to participate, including Alameda County Water District and San Mateo County Environmental Health Division. The SLIC program encompasses all unauthorized releases of pollutants to soil and groundwater that are not regulated by other programs such as the leaking UST program. Board policy for the SLIC program can be found in State Board Resolution 92-49 as amended and in the Water Quality Control Plan for the San Francisco Bay Basin (or Basin Plan) – see especially pages 4-52 through 4-65. There are no implementing regulations. Relevant Web site addresses include:

- Regional Board groundwater policy: <http://www.swrcb.ca.gov/~rwqcb2/gdwtrdef/gdwtrdef.htm>
- SLIC staff contacts at the Regional Board: www.swrcb.ca.gov/~rwqcb2/gdwtrdef/SLICPage97/slicpage97.htm

In the South Bay basins, the SLIC program focuses on solvent releases to groundwater. At numerous sites not covered in the federal Superfund or leaking UST programs, solvents have been used in a variety of industrial processes and have been released to soil and groundwater. Chlorinated solvent releases have produced more significant groundwater pollution plumes compared with non-chlorinated solvent releases. There are about 190 active SLIC cases in the South Bay basins (SMS database Nov. 27, 2000).

Notable SLIC sites in the South Bay basins include: FMC in Newark, Ashland Chemical in Newark, Hewlett-Packard in Mountain View, United Technologies in San Jose, Velcon Filters in San Jose, Mohawk Labs in Sunnyvale, and the Purex site in Belmont. The Regional Board has required active groundwater remediation at most significant SLIC sites. In the future, we expect to see greater use of innovative remediation methods (e.g., enhanced biodegradation), monitored natural attenuation, and formal risk management plans at SLIC sites.

E.1.5 Municipal Landfills

In California, municipal landfills are regulated jointly by the State Board and the California Integrated Waste Management Board (CIWMB). In general, the State Board takes responsibility for water-quality protection and cleanup, while the CIWMB takes responsibility for public health and day-to-day landfill operations.

Implementing regulations are found in the California Code of Regulations, Division 2, Title 27, Subdivision 1, Chapters 1 through 7, which are collectively referred to as Title 27.

Title 27 regulations establish a classification system for landfills and include requirements for siting, construction, operation, monitoring, cleanup, and closure. Title 27 regulations must also be equivalent to the federal municipal solid waste (MSW) requirements, known as “Subtitle D” (Subpart 257 and 258, Title 40, Code of Federal Regulations). Subtitle D establishes minimum standards for design, operation, location, closure, and postclosure at public and private landfills receiving MSW.

The State Board, the Waste Management Board, and the Environmental Protection Agency regulations, policies, and guidelines can be found on the Internet at the following addresses:

Landfill-Related Websites

Agency	Subject	Address
San Francisco Bay Regional Water Quality Control Board	Regional Board home page	http://www.swrcb.ca.gov/~rwqcb2/
State Water Resources Control Board	Land Disposal Program (Chapter 15) home page	http://www.swrcb.ca.gov/cwphome/chap15
U.S. Environmental Protection Agency	Office of Solid Waste, Municipal Solid Waste Landfill Guidance	http://www.epa.gov/epaoswer/non-hw/muncpl/landfill.htm
California Integrated Waste Management Board	CIWMB home page	http://www.ciwmb.ca.gov/
U.S. Environmental Protection Agency	Code of Federal Regulations, Subchapter I, Solid Wastes	http://www.epa.gov/docs/epacfr40/chapt-I.info/subch-I.htm

There are a total of thirty active and closed municipal landfills regulated by the Regional Board located within the Niles Cone, Santa Clara Valley, and San Mateo Plain Basins. These landfills generally contain MSW, and in some cases may contain construction and demolition debris, household hazardous waste, petroleum-impacted soil, and other wastes. These wastes pose a threat to water quality because they can leach pollutants upon contact with water and other residual landfill liquids. Furthermore, municipal landfills can threaten to cause erosion and sedimentation damage to streams and creeks if surface water runoff is not managed properly. Therefore, many of these landfills operate under permits issued by the Regional Board that require control and containment systems, monitoring, and interim and final landfill covers.

Regional Board permits for municipal landfills are called Waste Discharge Requirements (WDRs) and may be issued to active, inactive, public, or private landfills, depending on the severity of the threat to water quality. WDRs typically require monitoring programs for surface water, groundwater, and leachate containment to detect leaks before they migrate off-site.

The Regional Board may issue an enforcement order requiring source control, delineation of impacts, and remedial or corrective action. Enforcement orders such as Cleanup and Abatement Orders or Site Cleanup Requirements are issued pursuant to the Regional Board’s authority under the Porter Cologne Water Quality Control Act. Corrective action regulations specific to municipal landfills are found in Title 27, Subchapter 3.

E.1.6 Multi-site Cooperative Agreement

Since 1987, the Regional Board has managed the investigation and development of cleanup plans for 21 federal EPA Superfund sites in the Santa Clara Valley. Under the Multi-site Cooperative Agreement, the Regional Board agreed to regulate the sites according to federal EPA Superfund procedures, as well as appropriate California laws and regulations. In exchange, the federal EPA would use the state Remedial Action Plan as part of the federal Record of Decision under CERCLA or Superfund. All of the 21 sites have had final Record of Decisions in place for at least five years.

E.1.7 Aboveground Tank Program

The Aboveground Petroleum Storage Act (APSA), commonly referred to as the Aboveground Tank (AGT) Program, was enacted in 1990 in response to petroleum spills and releases from aboveground tanks and associated piping. APSA was enacted in direct response to the 1988 spill of 400,000 gallons from the Shell Oil Refinery in Martinez. The goal of the AGT Program is to protect vegetation, wildlife, surface water, human health, and groundwater from the damaging effects of petroleum releases by ensuring safe operation of aboveground petroleum storage facilities. The goals are to be achieved by implementing a program to:

1. Work with Certified Unified Program Agencies (CUPAs) to identify facilities that are subject to APSA
2. Review Spill Prevention Control and Countermeasure (SPCC) Plans prepared by dischargers
3. Require the installation of release-detection systems where necessary
4. Require investigations and corrective actions where releases have occurred
5. Inspect the facilities on a regular basis to ensure implementation of APSA requirements.

APSA requires owners or operators of aboveground petroleum storage tank facilities to:

1. File a Storage Statement and pay a facility fee
2. Prepare and implement a federal SPCC Plan
3. Report to the Regional Board if a release occurs of greater than one barrel (42 gallons)
4. Reimburse staff costs to oversee cleanup and abatement of releases
5. Install a release-detection (leak-detection) monitoring system if the tank facility has the potential to impact surface water, sensitive ecosystems, or groundwater.

The groundwater protection elements of the AGT program include preparation and proper implementation of SPCC Plans and implementation of release-detection monitoring. If a release occurs at an AGT site, investigation and remediation are conducted under the AGT cost-recovery program.

SPCC Plans. An SPCC Plan is a carefully thought-out plan, prepared in accordance with detailed U.S. Environmental Protection Agency (EPA) guidelines, that discusses procedures, methods, and equipment at the facility designed to prevent discharges of petroleum from reaching navigable waters. Because California designates groundwater as a source of navigable waters, implementation of the SPCC requirements is an important element of groundwater protection from releases by aboveground petroleum storage facilities.

Release Detection Monitoring. APSA requires owners and operators of petroleum facilities to install a tank bottom or line release-detection systems at the request of the executive officer. Such systems are placed where leaks may not be visible so that a release can be detected before impacts to groundwater, surface water, or sensitive ecosystems occur. Leak-detection technologies that ensure a release is identified before reaching groundwater are preferred.

Investigations and Remedial Actions. Staff is involved in determining whether petroleum releases have occurred at aboveground tank facilities. When releases that have impacted soil and groundwater or that may

be threatening surface waters are identified, the facility is placed into the AGT cost-recovery program. The Regional Board adopts orders with schedules for performing investigations and remedial actions.

There are approximately 184 aboveground petroleum storage facilities within the South Bay study area that have filed Storage Statements and paid fees to the State Board. Releases of petroleum hydrocarbons have been confirmed, and cleanup and abatement of these releases is occurring at six of these facilities. The following table is a breakdown of the number of facilities by groundwater basin:

Aboveground Petroleum Storage Tank Facilities in the South Bay Basins

Agency	Storage Statement/Fee	Cleanup And Abatement
Alameda County Water District	46	1
San Mateo Environmental Health Division	32	0
Santa Clara Valley Water District	106	5
TOTAL	184	6

The AGT Program Web site is: www.swrcb.ca.gov/~rwqcb2/Aboveground_Tanks/aboveground_tanks.html

E.2 Department of Toxic Substances Control

The Department of Toxic Substances Control (DTSC) is responsible for regulating hazardous-waste facilities and overseeing the cleanup of hazardous-waste sites. It is also responsible for investigating and cleaning up, or overseeing the investigation and cleanup of, properties contaminated by the release of toxic substances. In addition, DTSC is involved in other programs dealing with toxic substances, for example, pollution prevention, cleanup activities associated with illegal clandestine drug laboratories, and evaluating environmental technologies.

The California hazardous waste control laws giving authority to DTSC are found in the California Health and Safety Code – Division 20. Chapter 6.5, Hazardous Waste Control Law, extends the federal Resource Recovery and Conservation Act (RCRA); the state is authorized to enforce RCRA. The California Code of Regulations, Title 22, Division 4.5, Environmental Health Standards for the Management of Hazardous Waste, incorporates and extends the Code of Federal Regulations, Title 40, Parts 260 to 282. The California Code is compatible with the federal code.

The California Health and Safety Code, Chapter 6.8, Hazardous Substance Account, provides DTSC with authority to respond to releases of hazardous substances, and for state funds to be used in the cleanup of contaminated sites. Petroleum products are excluded from the list of hazardous substances. Chapter 6.8 extends the federal laws, CERCLA and SARA, and the National Contingency Plan, Code of Federal Regulations, Title 40, Parts 300 to 399.

DTSC has its headquarters in Sacramento and information on the organization, including relevant laws and regulations, can be found on its Web site, <http://www.dtsc.ca.gov>. As well as headquarters offices, there are four regional offices; the Northern California Region Office, located in Berkeley, covers the South San Francisco Bay Basin. DTSC has two programs that consider potential or actual impact to groundwater: the Site Mitigation Program, which administers Chapter 6.8, and the Hazardous Waste Management Program, which administers Chapter 6.5.

The Site Mitigation Program oversees investigation and remedial activities at sites where past activities may have released hazardous substances (products or wastes) and these substances now pose a threat to public health or the environment, including contaminant migration to ground or surface water. The sites may be industrial, commercial, or residential, and be owned by private parties or federal, state, or local governments.

DTSC can issue Imminent and/or Substantial Endangerment Orders to force owners to investigate and remediate contamination on the property, or can negotiate Consent Agreements. In many cases, where property owners want to clean up sites, possibly for redevelopment, DTSC will enter into a Voluntary Cleanup Agreement with the owner of the site, or proponent of a development, to conduct investigation and remedial activities. Other voluntary mechanisms for DTSC oversight of remedial actions are also available, such as Prospective Purchaser Agreements, the new Brownfields Loan Program, and the Expedited Removal Action program.

For sites where there has been a release of hazardous substances to soil, and this represents a threat to public health, but not to groundwater, DTSC would be the appropriate regulatory agency. At sites where soil and ground and/or surface waters are contaminated, or where there is a significant threat of water contamination, DTSC and the Regional Board have separate but overlapping regulatory authority. In the past, for sites in the South San Francisco Bay Basin, overlapping regulatory oversight has been minimal.

The DTSC maintains a database, CALSITES, listing all sites known or suspected to have had releases of hazardous substances. For the South Bay, approximately 350 sites are listed, of which approximately 70 are being investigated, remediated, or monitored. The remainder is sites that have been cleaned up and the remediation certified, or are sites that have been referred to other agencies. This list is not accessible through the Internet. The files on each site, identified by address or business name, can be reviewed by appointment at the DTSC regional office in Berkeley.

E.3 California Department of Health Services

The Drinking Water Program (DWP) falls within the California Department of Health Services and is part of the department’s Division of Drinking Water and Environmental Management. DWP monitors and regulates public water supplies (including municipal wells), with some support from county health departments for smaller systems. Good coordination between DWP and the agencies overseeing groundwater pollution sites is critical to protecting existing groundwater users. There are about 1,000 municipal wells in the San Francisco Bay Basin, with the great majority located in Santa Clara Valley and the rest of the South Bay basins.

For further information, see DWP’s Web site at <http://www.dhs.ca.gov/ps/ddwem> or call (510) 540-2160.

The California Department of Health Services (DHS), Division of Drinking Water and Environmental Management is the lead agency for developing and implementing the Source Water Assessment Program (SWAP), which in California is referred to as the Drinking Water Source Assessment and Protection (DWSAP) program. The DWSAP program will satisfy the mandates of both the 1986 and 1996 Safe Drinking Water Act amendments. For further information on DHS’ DWSAP program, go to <http://www.dhs.ca.gov/ps/ddwem/dwsap/DWSAPindex.htm>.

The goals of the DWSAP program are outlined below.

Goals of the DWSAP Program

Goal	Comments
Protection and benefit of public water systems of the state.	The focus of the program is information gathering and attention to activities that may affect drinking-water quality, to enable communities and public water systems to better protect and manage the surface water and groundwater resources of the state.
Improve drinking-water quality and support effective management of water resources.	The assessments can be used to develop protection strategies that are more economical and desirable than monitoring and treatment of drinking-water supplies.

Inform communities and drinking-water systems of contaminants and possible contaminating activities that may affect drinking-water quality or the ability to permit new drinking-water sources.

As communities and public water systems gather information about activities that have contaminated or may contaminate drinking-water sources, they will be able to make better decisions about how to protect and manage existing and future drinking-water sources.

Encourage a proactive approach to protecting drinking-water sources and enable protection activities by communities and drinking-water systems.

Water suppliers, communities, planners and the public at large are encouraged to actively manage and plan activities around drinking-water sources and within their delineated protection areas and zones to reduce or eliminate the threat of contamination.

Refine and target the monitoring requirements for drinking-water sources.

State and federal regulations require water suppliers to monitor for a long list of inorganic and organic chemicals. With proper identification of PCAs, monitoring requirements can be targeted to the needs of the drinking-water source. The result is enhanced public health protection with a potential saving in monitoring costs.

Similarly, regulations require monitoring for microbiological contaminants, some of which may be targeted to specific PCAs. Regulatory limits on other parameters such as turbidity must also be met by drinking-water systems. To the extent that these “non-chemical” constituents can be controlled by effective assessment and protection programs, they may bring about monitoring and/or treatment relief. Reductions in organic matter in a drinking-water source may also result in lower concentrations of disinfection byproducts.

Focus cleanup and pollution prevention efforts on serious threats to surface and groundwater sources of drinking water.

By identifying activities that may pose greater health risks than others to drinking water sources, communities and agencies may be able to prioritize their environmental activities. For example, hazardous waste cleanup, pollution prevention efforts, and other activities of environmental and public health significance that directly improve or protect drinking-water supplies may be addressed earlier or allocated more resources than others that are not related to drinking-water supplies.

Meet federal requirements for establishing wellhead protection and drinking water source assessment programs.

Compliance with requirements ensures that the California program meets the minimum national standard for source-water protection, and is necessary in order to receive future federal source-water protection funds.

Assist in meeting other regulatory requirements.

Information that is obtained in the DSWAP Program will be of assistance to state and local agencies, communities and public water systems in meeting various regulatory requirements. Examples include the requirements of the California Environmental Quality Act (CEQA) and upcoming federal regulatory requirements, such as the Ground Water Rule and the Enhanced Surface Water Treatment Rule.

The minimum requirements of the DSWAP program for groundwater sources are as follows:

- Determine the location (latitude, longitude) of the groundwater well using a global positioning system (GPS), or equivalent accuracy (within 25 meters).
- Identify recharge area boundaries to determine the source area.

- Delineate protection zones based on three different times of travel (the time for groundwater to travel from a point in the aquifer to a pumping well): Zone A (two-year), Zone B5 (five-year), and Zone B10 (10-year).
- Evaluate the physical barrier effectiveness (PBE) in preventing contaminants from reaching the well (e.g., distance to closest sewer line, surface seal, well construction).
- Inventory potentially contaminating activities (PCAs) in the source area that include activities associated with commercial, industrial, residential, municipal, agricultural, and rural operations.
- Rank and prioritize PCAs to identify to which the source is most vulnerable.
- Prepare an assessment map that shows the well location, source area, and protection zones.
- Prepare an assessment summary including a vulnerability summary that describes the PCAs to which the source is most vulnerable.
- Notify the public in the annual Consumer Confidence Report prepared by the public water supplier.

Although DHS is responsible for performing these assessments, some public water systems may also choose to perform more complex drinking-water source assessments. The water purveyors in the Niles Cone and Santa Clara Valley Basins are working in coordination with DHS to complete their DWSAP requirements. DHS is the local primacy agency in the San Mateo Plain Basin and will be completing the DSWAP requirements for the water purveyors in that basin. All assessments must be completed by May 2003. In addition, DHS will incorporate the DWSAP assessment procedures into the permit requirements for new drinking-water sources.

The DWSAP program also includes an element of groundwater protection. This aspect of the program is through the state's recommendations to encourage voluntary drinking-water source protection. Recommendations include technical assistance, financial assistance, and training to develop local protection programs; identification of management strategies that can be used to protect the water supply from contaminants associated with the PCAs; and criteria for developing contingency plans in the event that an alternative water supply is needed.

E.4 California Department of Water Resources

The Department of Water Resources can be contacted at its Web site: <http://www.dwr.water.ca.gov/>. DWR Bulletins/Publications, from 1955 to 1995, are listed at: <http://rubicon.water.ca.gov/b17095.fdr/bulletavail.html>.

Although the California Legislature created the Department of Water Resources (DWR) in 1956 to plan and guide the development of the state's water resources, its origin can be traced back to earlier years. In 1949, the California Legislature enacted legislation that, among other things, directed the Department of Public Works to investigate and survey conditions of damage to the quality of underground water caused by improperly constructed, abandoned, or defective wells and to report to the appropriate regional water pollution control board its recommendations for minimum standards of well construction.

Water Code Section 231 currently delegates these investigation and reporting responsibilities to the Department of Water Resources. In part, the Department of Water Resources is responsible for advising the Legislature and appropriate state agencies on the maintenance of groundwater quality, including protection against adverse effects caused by improper well construction or the abandonment of wells. This responsibility applies to all wells, irrespective of purpose.

During the years and organizational evolutions that followed, although the primary focus of the Department of Water Resources remained on groundwater protection through the identification of improperly constructed or abandoned wells, the scope of its responsibilities expanded to include flood control, design and construction of water facilities, and dam safety.

Today, with a staff of approximately 2,700 and a \$1 billion annual budget, the DWR administers increasingly complex programs involving flood control for the Central Valley, dam safety for more than 1,200 dams statewide, local assistance projects, water management strategies, water quality improvement, and water supply data collection and studies. DWR staff provides technical and financial assistance to local water communities, works with a number of governmental and wildlife agencies on environmental issues and projects, manages State Water Project and Reclamation Board lands, educates the public about California's water resources, and operates and maintains the State Water Project, one of the largest water development and distribution systems in the nation.

E.5 Alameda County Water District

The Alameda County Water District can be contacted at its Web site: <http://www.acwd.org> or by phone at: (510) 659-1970.

E.5.1 Background

The Alameda County Water District (ACWD) was created by a vote of area residents in December 1913, thereby becoming the first water district in California to be formed under the County Water District Act enacted earlier that year. A five-member board of directors, elected at large, governs it.

In the years preceding the vote, local farmers and residents had become concerned about water companies and agencies exporting water from both Alameda Creek and local groundwater to nearby communities such as Oakland and San Francisco. The result of these exports was that the groundwater table was falling at a rapid rate. The voters hoped, in establishing the District, to regain control over local water supplies, to protect the underground water in the Niles Cone Groundwater Basin, and to conserve the waters of Alameda Creek.

ACWD now has several sources of supply, including water purchased from the State Water Project (SWP) (via the South Bay Aqueduct) and the San Francisco Public Utilities Commission (SFPUC) (via the Hetch Hetchy aqueduct system). But groundwater remains an important component of its supply, currently furnishing 35 percent of the water the District distributes. In dry years, groundwater has contributed over 60 percent of the supply. Thus, conservation and preservation of the groundwater basin continues to be a vitally important program for the District.

Policy Statement. It is the policy of the ACWD to efficiently protect and manage the Niles Cone Groundwater Basin to ensure a reliable supply of high-quality water that satisfies present and future municipal, industrial, recreational, and agricultural water needs in the District service area. ACWD will develop and implement appropriate programs within the service area to protect and manage the groundwater basin as a long-term source of water supply for the District. It will also actively protect the groundwater basin from activities outside the service area that may negatively affect the water quality and/or water supply of the basin.

Objectives. The purpose of this policy is to protect and improve the District's groundwater resources for the benefit of both the District's customers and private well owners by taking actions designed to meet the following objectives:

1. Increase groundwater replenishment capability.
2. Increase the usable storage capacity of the groundwater basin.
3. Operate the basin to provide: (1) a reliable water supply to meet baseload and peak distribution system demands, (2) an emergency source of supply, and (3) reserve storage to augment dry year supplies.
4. Protect groundwater quality from degradation from any and all sources, including: saline water intrusion, wastewater discharges, recycled water use, urban and agricultural runoff, or chemical contamination.

5. Improve groundwater quality by (1) removing salts and other contaminants from affected areas of the basin, and (2) improving the water quality of source water used for groundwater recharge.

The specific groundwater management programs that have been developed and implemented by the District to achieve these policy objectives are listed below.

Summary Of ACWD Groundwater Management Programs

Groundwater Program	Description
Water Supply Management	Planning, managing, and optimizing the District’s sources of supply: watershed runoff, SWP water for recharge, SWP water for treatment, SFPUC water for blending, and water banking.
Groundwater Replenishment	Operation of the District groundwater recharge facilities to optimize 1) capture of local runoff, 2) replacement of water extracted from production and ARP wells, and 3) maintenance of groundwater levels to prevent saltwater intrusion.
Watershed Protection and Monitoring	Assisting in the protection and monitoring of the watershed to optimize the quality of runoff water available for the District water supply.
Basin Monitoring	Sampling and measuring wells to assess and evaluate 1) groundwater quality, 2) water pressures within the basin, and 3) the direction of groundwater flow.
Wellhead Protection Program	Identify sensitive recharge and groundwater areas, maintain an inventory of potential threats within these areas, assess the vulnerability of source water, and develop management strategies to minimize the potential for groundwater quality impacts.
Aquifer Reclamation Program	Pump brackish water from degraded aquifers in order to 1) increase useable basin storage, 2) improve overall water quality, 3) prevent movement of brackish water toward the District production wells, and 4) provide (future) supply augmentation through treatment to potable water standards.
Groundwater Protection Program	Maintain an active role in 1) assisting with the identification of potential groundwater contamination, 2) implementing monitoring systems at hazardous-materials storage sites, and 3) providing technical oversight for investigations and cleanups at hazardous-materials spill sites.
Well Ordinance Administration	As enforcing agency for municipal ordinances governing construction, repair, or destruction of wells, the District provides inspection services, collects fees, and performs field searches for abandoned wells that could act as a conduit for contamination of groundwater.

E.5.2 Jurisdiction

The District conducts groundwater management and protection activities under the statutory authority granted to the District under: the County Water District Law (commencing with Section 30000 of the Water Code); the Replenishment Assessment Act of the Alameda County Water District (Section 4, Chapter 1942 of the Statutes of 1961, as amended in 1970 and 1973), which grants additional powers to the District to prevent pollution, contamination, or diminution of the quantity of the groundwater supply; local well ordinances (Fremont No. 950, as amended; Newark No. 136; and Union City No. 109-73); agreements with other agencies; and local hazardous-materials ordinances.

E.5.3 Groundwater Protection and Cleanup

The District takes an aggressive role in:

1. Assisting regulatory agencies and industry in identifying sources of potential groundwater contamination
2. Implementing monitoring systems at hazardous materials storage sites
3. Providing technical oversight for the investigation and cleanup operations at Leaking Underground Fuel Tank (LUFT) and Spills, Leaks, Investigation, and Cleanup (SLIC) sites to assure the protection of the groundwater basin.

Coordination with federal, state, county, and city agencies similarly involved is key to the success of the District's groundwater protection program. This program's objectives are to protect the basin from future water-quality degradation by ensuring that existing LUFT and SLIC sites are remediated and that future chemical releases are quickly identified and controlled.

Since 1988, the District informally provided assistance to the Regional Board in overseeing the investigation and remediation at LUFT and SLIC sites. In order to memorialize the terms of this participation and to further strengthen the coordination between the Regional Board and the District, the agencies entered into a Cooperative Agreement on June 27, 1996. The District entered into similar Cooperative Agreements with the Cities of Fremont, Newark, and Union City on March 25, 1997; June 26, 1997; and August 12, 1997 to further strengthen the interagency coordination and cost-effective implementation of groundwater protection within the cities. The District also recently entered into an agreement with the city of Hayward on July 27, 2000 to work cooperatively on sites that threaten or affect water quality in Hayward Detachment areas (properties detached from the District and annexed to the city of Hayward).

Currently, as of May 29, 2001, the District has a total of 328 Leaking Underground Fuel Tanks (LUFT) cases; 155 of these cases have been closed and 173 LUFT cases are open. The District is the lead agency for all open LUFT cases except for three LUFT cases for which the Regional Board is the lead agency. There are also a total of 114 Spills, Leaks, Investigation, and Cleanup (SLIC) cases; 48 of these cases have been closed and 66 are open. The District is the lead agency for 48 open SLIC cases and the Regional Board is the lead agency for the remaining 18 cases.

E.5.4 Well Permitting Program

The District well ordinances specify that no person shall construct, repair, reconstruct, destroy, or abandon any well unless a written permit has been obtained from the District. Written permits required by the ordinance are issued by the District subject to the conditions set forth by the District. To ensure compliance with established state standards and local special conditions, inspections are conducted for all permitted work.

Fees are established and adopted by the District's Board of Directors on an annual basis by resolution to cover the majority of field inspection costs. Before a permit is issued, the applicant must deposit with the District

cash or check in a sufficient sum to cover the fee. All governmental agencies must apply, except that no permit fee is charged unless the proposed work will constitute an undue burden to the District. The permittee must notify and schedule with the District at least five days in advance prior to the start of any work permitted under the ordinance.

The well ordinances regulate all work on wells and boreholes associated with the following four categories of drilling activities: (1) water wells; (2) geotechnical investigations; (3) chemical investigations; and (4) cathodic protection wells. Definitions and additional information for each of these drilling activities are described below.

Water Wells. A water well is defined as "...any artificial excavation constructed by any method for the purpose of extracting water from, or injecting water into, the underground" (DWR, 1981). For new construction, additional information may be required, such as the location of septic systems, sewer lines, or other possible sources of contamination. A review process is conducted on each new well to insure compliance with current construction standards and the District's supplemental standards.

Existing wells must be maintained in an active state in which water samples can be obtained. All openings at the surface must be sealed to prohibit contamination from entering the well. The area surrounding the well must be clean from debris and accessible at all times. If a well is a public nuisance, corrective action must be taken by the well owner immediately to correct the problem. If action is not taken, the District may abate the problem at the well owner's expense.

Repairing or reconstructing a well requires a permit. Additional information such as drawings may be required before a permit is issued. A review will be conducted to insure that any repair or reconstruction will not jeopardize the accessibility to the well for ultimate destruction.

Well destruction permits include specifications on the requirements for destroying a well. Specifications are determined by the depth, diameter, and location of the well, with the intent of separating the water-bearing zones. This is accomplished by ripping or perforating the well casing in the interval across the non-water-bearing zones. Establishing the ripped or perforated zones can be determined from the Drillers Report (log), well data sheet, water level data, or the geologic cross sections. Also, adjacent wells may provide some information as well as the physical features of the subject well.

Geotechnical Investigations. Geotechnical investigations are defined as any artificial excavation constructed by any method for the purpose of determining subsurface geological or hydrological conditions. Although excavations are included under the ordinance, the District currently only requires permits for geotechnical work that involves the use of drilling equipment or hand augers. Generally, the destruction of borings is required at the end of each day. Borings are not allowed to remain open overnight unless the drill rig stays over the borehole and water has not been encountered. For groundwater monitoring of piezometers or slope-indicator wells, construction and destruction diagrams may be required to insure interconnection of water-bearing zone does not occur.

Chemical Investigations. Chemical investigations are defined the same as geotechnical investigations except that soil and/or water samples are also collected and analyzed for potential contaminants. The conditions for exploratory borings, monitoring wells, and destruction of monitoring wells are identical to geotechnical investigations.

Cathodic Protection Wells. Cathodic protection wells are defined as any artificial excavation in excess of 50 feet constructed by any method for the purpose of installing equipment or facilities for the protection electrically of metallic equipment in contact with the ground, commonly referred to as cathodic protection (DWR, 1991). Construction diagrams are usually required to insure that the interconnection of water-bearing zones does not occur. The length of the anode bed is of primary concern and must be placed within one single aquifer. Each well destruction permit has a set of destruction specifications attached. The specifications are

established to destroy the well in such a manner as to insure that the well will not become a contributing factor to the degradation of the groundwater basin or become a public nuisance.

Noncompliance. Any well constructed, repaired, reconstructed or destroyed, including cathodic protection wells and exploratory holes, contrary to the terms and conditions of the ordinances or permit issued is in violation of the well ordinances. The ordinances provide the District with enforcement authority and the ability to restrict water supply to new developments that are in violation of the District's ordinances. In addition, the District can abate wells and hold the owner liable for all costs incurred.

Well Records. Well records are maintained on all wells within the District's jurisdiction. These records provide information on each well, and the information is managed in a computer database. Assignment of a well number to new wells is a critical part of tracking the status of each well and is a local responsibility delegated by the state. Following is a description of these activities:

Issued Well Permits. Permits are issued as required by the ordinances. Each permit is the base record for each new well and all permits are archived.

Well Data Sheets. Well data sheets are created for each well and include basic and non-confidential information about the well. This information includes well number, owner's name, address, location, depth, diameter, pump size, and yield. Well numbers are assigned by the District and are based on the location of the well and are determined by township and range coordinates. Previously, the well locations were developed by the District's inspector when the well was completed and were referenced to features that do not change over time, such as centerlines of street right-of-ways. Currently, well location coordinates are determined with a Global Positioning System.

Drillers Reports. Water Well Drillers Reports are required to be completed by the California Department of Water Resources (DWR) as well as the District's permit requirement for each new well. The various geologic formations are described within the drillers report as well as additional construction information. These reports are submitted by the drilling contractor and are kept confidential pursuant to state law. After the District assigns a well number, the drillers report is sent to the DWR and it is integrated into their well system.

E.5.5 Niles Cone Well Destruction Program

Improperly constructed wells drilled in the early 1900s increased the rate of saltwater intrusion caused by overpumping. The District's well destruction program is believed to be the most comprehensive such program in California. Each water well, cathodic protection well, or monitoring well needs to be properly destroyed because they constitute a potential major threat to the groundwater basin. Wells not properly destroyed may also constitute a public nuisance and a threat to the safety of the public. The District has developed a well destruction program, outlined below, in cooperation with the cities to address these threats.

When land use changes are proposed for properties, the cities require the property owners or developers to obtain a letter from the District indicating whether wells are located within the boundaries of the development. This requirement gives the District the opportunity to conduct a search for wells before development occurs. The process is as follows:

Notification From Cities. Copies of correspondence from or submitted to the city related to a development project, rezoning application, building permit, demolition permit, underground tank removal, or property transfer are sent to the District for review and comment.

Record and Field Check. A record check is conducted for each submittal to determine if any wells exist on the property. The District's computer database, well data sheets, well logs, a 1959 well map, 1954 aerials, 1925 Sanborn maps, and 1915 well maps are all reviewed for the existence of a well on

the property. In addition, a site visit is conducted to verify that all wells have been located or properly destroyed.

Notification from the District. For each submittal, the District sends a written response to the city, developer, engineer, or contractor. If wells are not identified on the property, a brief letter is sent stating that wells were not located within the boundaries of the proposed development. If a well(s) is located within the development, the District's letter includes a site sketch indicating the location of the well(s) and requires that the well(s) be brought into compliance with the well ordinance or properly destroyed prior to development. The letter also states that the District reserves the right to refuse water service within the development until the well issues are resolved. The destruction of abandoned wells then becomes a condition for approval of the proposed development or land use change by the city building or planning departments.

Completion Correspondence. If a well is destroyed in response to the District's notification, a completion notice is sent to the city and the developer or other concerned parties.

E.5.6 Niles Cone Groundwater Basin – Ambient Groundwater Monitoring and Saltwater Intrusion Protection Programs

Weekly Groundwater Monitoring Program. The District performs weekly water level measurements of approximately 30 representative wells to monitor changes in groundwater levels in each major aquifer. This frequency of monitoring water levels allows weekly decisions to be made for overall water production, provides data for quarterly water level summaries for the District's Board of Directors, and provides a complete and current data set for the District's numerical computer model to simulate future scenarios for groundwater basin management.

The quarterly report summarizes the water elevation data from five key wells and well production data from the AHF and BHF sub-basins. Comparisons in water level data are made with the previous year and with those in 1962 (initiation of artificial recharge). Comparisons in production data are also made with the previous year. This report provides an indication of water levels in the AHF sub-basin, the Forebay region of the BHF sub-basin, and the Newark, Centerville-Fremont, and Deep Aquifers within the BHF sub-basin. The water level and production data gathered help characterize and identify trends in the storage of groundwater (as indicated by water levels) due to recharge and production well pumping in both sub-basins.

Spring/Fall Groundwater Monitoring Program. A more comprehensive monitoring program consisting of sampling and measuring water levels is performed in the spring and fall of each year to assess the groundwater quality, water pressures within the basin, and direction of groundwater flow. The Spring/Fall Groundwater Monitoring Program was initiated in 1962, with the Spring Program conducted primarily in March and the Fall Program conducted primarily in September when groundwater levels are typically at their highest and lowest levels of the year, respectively. Following completion of the Fall Program monitoring efforts, the District issues a Groundwater Monitoring Report, and a summary of the report is presented to its Board of Directors. The report describes the fall data acquisition effort, presents the water elevation and water quality data, gives an interpretation of the data, and provides conclusions and recommendations.

The Spring/Fall Groundwater Monitoring Program serves the following purposes:

- To visit wells owned by the District, Alameda County Flood Control and Water Conservation District, DWR, and private owners to evaluate their status
- To conduct water level measurements and collect water samples
- To update the District's database of water level and water quality information
- To describe the movement of groundwater
- To characterize groundwater quality within the groundwater basin.

During the Fall 2000 Groundwater Monitoring Program, 290 wells within the District's service area were visited. Water levels were measured in 207 wells, and water samples were collected for chloride, total dissolved solids, and hardness analyses from 131 wells. The status of each well, water elevation levels, and chloride results are summarized in the appendix of each year's Groundwater Monitoring Report.

In addition to the Weekly and Spring/Fall Monitoring Programs, production wells are monitored regularly for a wide variety of water quality parameters specified by state and federal regulations. The groundwater recharge area is also monitored daily for water level fluctuations to track percolation rates and to schedule water imports.

Monitoring Well Construction Project. Many privately owned water wells that the District has utilized in the past for monitoring basin water levels and saltwater intrusion have been destroyed due to property development or are no longer accessible. Since these wells are critical to the management of the District's groundwater basin, replacement monitoring wells have been included in the Capital Improvement Program. From 1997 through 1999, 32 monitoring wells have been installed as part of the Monitoring Well Construction Project. A total of approximately 60 wells are expected to be installed by 2007 to provide additional geologic information, to replace destroyed wells, and to improve water-sample and water-level data acquisition through efficiently located and appropriately designed wells.

Aquifer Reclamation Program and Salinity Barrier Project. The goal of the District's Aquifer Reclamation Program is to remove entrapped brackish water from degraded portions of Below Hayward Fault aquifers, to increase usable groundwater basin storage, to improve overall water quality, and to prevent the movement of saline water toward production wells. Pumped water from a combination of nine Aquifer Reclamation Program wells (three Newark Aquifer wells, five Centerville-Fremont Aquifer wells, and one Deep Aquifer well) is discharged to flood control channels in accordance with an NPDES permit. Operation of this program depends on the annual availability of water supplies to replace the water that is pumped out of the aquifers. Some of the wells used in this program will supply water to a desalination facility to supplement the District's drinking-water supply in 2002. The District is planning to initially construct a 5 mgd, and ultimately a 10 mgd, reverse-osmosis desalination facility to produce a low-TDS potable water supply from high-TDS groundwater.

Operation of the groundwater basin significantly below sea level during long drought periods was previously seen by the District as an unavoidable necessity. To ensure that new seawater intrusion from San Francisco Bay would not enter the aquifers during such times, the District, in cooperation with the Department of Water Resources, initiated the Salinity Barrier Project in the late 1970s. The plan was to install 14 extraction wells strategically located to create an alignment just inland of the salt evaporator ponds, running parallel along the entire stretch of the District's coastline. Simultaneous pumping of the wells would create a trough in piezometric head along the alignment to prevent inland migration of saline water originating from the Bay and evaporator ponds. In addition to preventing new seawater intrusion, the Salinity Barrier Project's operation was planned as a potential augmentation of the Aquifer Reclamation Program during non-drought periods for mitigating historic seawater intrusion in the interior part of the basin. By the late 1980s, five of the 14 wells were constructed.

In the course of comprehensive water supply and facilities planning in the 1990s, the District determined that operation of the basin below sea level during drought periods is no longer a necessary or desirable strategy relative to other water supply options that have since become available to the District. Because the basin is not likely to be operated significantly below sea level during drought periods, the Salinity Barrier Project is not likely to be needed to prevent new seawater intrusion. However, groundwater modeling results indicate that operating Salinity Barrier Project wells as part of the Aquifer Reclamation Program, especially during wet periods with high piezometric head, may accelerate the mitigation of remaining brackish water in the aquifers. More modeling work is planned to determine whether the water quality improvement would justify activation of the Salinity Barrier Project wells.

E.5.7 American Water Works Association Research Foundation Project

ACWD and Lawrence Livermore National Laboratory (LLNL) are wrapping up a groundwater research project sponsored by the American Water Works Association Research Foundation (AWWARF). The main objective of the study is to demonstrate the usefulness of isotopic tracers and age-dating techniques for characterization of groundwater flow and solute transport in a dynamic flow regime that includes artificial recharge facilities and high-capacity production well fields. A draft final report was completed in March 2001, and a final report suitable for publication is expected to be submitted to AWWARF by the end of 2001.

The project commenced in 1997 with an initial study that involved measurement of the natural background content of selected isotopes and dissolved gases. Tritium, helium, deuterium, Oxygen-18, Carbon-13, and Carbon-14 were among the targeted isotopes in the initial study. With the tritium-helium data, the average age of groundwater in the production wells was determined to vary between three and 30 years, with higher ages coinciding with deeper aquifer layers. Dissolved gases were collected to determine the amount of dissolved air in the water samples (required for an accurate age determination) and to estimate the age of the water at the time it was recharged. Carbon-14 data was also considered in the determination of groundwater age, while Carbon-13 data provided insight on processes affecting dissolved inorganic carbon content.

The Carbon-13 data suggest that dissolution of carbonates and the microbial conversion of organic carbon to carbon dioxide are occurring in the study area. By examination of deuterium and Oxygen-18, ACWD and LLNL also attempted to ascertain in groundwater samples evidence of where the water originated (inland or near the Pacific Coast) at the time of precipitation. The source water for the recharge ponds includes both state water supplies (a remote source that originates in the Sierra Nevada) and drainage of the Alameda Creek watershed (a local source). Discernment of sources was not achieved with much confidence due to mixing of deeper and shallower groundwater in long-screened wells, mixing and long retention times in ponds, and possible mixing of surface water sources in the upstream portion of Alameda Creek.

Tracer experiments, the most important part of this project, followed the initial study. Tracers were added to selected ACWD recharge ponds, and groundwater was subsequently monitored to track the progress of the tracer as it migrated through the aquifers. Tracers consisted of non-toxic, non-reactive rare isotopes of xenon and neon. ACWD and LLNL learned a great deal from the tracer experiments. In the Above Hayward Fault (AHF) portion of the basin, the time for the “first molecule” of tracer to reach the AHF well field is relatively quick, but the amount of total mass recovered at the well field in one year is small. Retention in the recharge ponds played an important role on the shape of the breakthrough curves. ACWD also learned that the water in many of the ponds Below Hayward Fault (BHF) do not reach the Mowry Wellfield within a two-year period, potentially bypassing the well field or reaching the well field through a long, circuitous route.

The ponds and groundwater monitoring wells were also sampled for general water chemistry, trace metals, and organics. There were notable differences between recharge pond water quality and groundwater quality. Groundwater had generally lower nitrate and total organic carbon. In addition, male-specific coliphage, a virus of bacteria and used in this study as an indicator of fecal contamination, was not present over the detection limit in all targeted wells. These results indicate that although the recharge water in the creek and ponds is favorable to begin with, a certain degree of water quality improvement occurs in the pond sediments or the vadose zone through which the pond water passes to recharge the aquifers.

E.6 Santa Clara Valley Water District

The Santa Clara Valley Water District (SCVWD) can be contacted at its Web site: <http://www.scvwd.dst.ca.us> or by phone at (408) 265-2600.

E.6.1 Background

The Santa Clara Valley Water Conservation District, the forerunner of the Santa Clara Valley Water District (SCVWD), was formed in 1929 by public vote under the provisions of the Water Conservation Act of 1929 (Jones Act). The original purpose of the SCVWD was to alleviate land surface subsidence in and around San Jose by constructing large dams to capture winter runoff and using that water to recharge groundwater aquifers. The SCVWD was merged with other water districts in Santa Clara County over the years.

Today, the SCVWD provides wholesale water supply and flood management for all of Santa Clara County. This responsibility includes managing the groundwater basin for quality and quantity. In a typical year, groundwater supplies near half of the water used in the county, and the SCVWD relies on the groundwater basin to meet water supply needs in dry years. Thus, groundwater protection and conservation continue to be high-priority programs for the SCVWD.

E.6.2 Jurisdiction

The SCVWD conducts groundwater management and protection activities under authority of the Santa Clara Valley Water SCVWD Act, California Water Code Appendix, Chapter 60, local ordinances adopted pursuant to authority granted by the SCVWD Act, and agreements with other agencies. The SCVWD Act provides the SCVWD with the authority to levy and collect groundwater production charges and to use the revenues that are collected for the protection and augmentation of water supplies. The SCVWD has adopted two ordinances that support their groundwater management activities. Ordinance 90-1 regulates wells and adopts water contamination hazard standards, and Ordinance 83-2 prohibits pollution of SCVWD water supplies. In addition, the SCVWD entered into agreements with local cities, the county, the Regional Water Quality Control Boards, and the State Water Resources Control Board to provide regulatory oversight for the investigation and cleanup of leaking underground storage tank sties.

E.6.3 Groundwater Protection and Cleanup

The SCVWD takes an aggressive role in:

- Working with local cities and the county to identify and locate sources of contamination
- Evaluating potential and existing and potential threats to groundwater quality
- Implementing programs to protect and enhance groundwater quality.

Specific SCVWD groundwater protection programs are discussed below.

Well Construction and Destruction Programs

Well Ordinance. The SCVWD Well Ordinance Program protects the County's groundwater resources by ensuring that wells and other deep excavations are constructed, maintained and destroyed so that they will not allow the vertical transport of waters of poor quality into the drinking-water aquifers. To meet this goal, the Well Ordinance Program:

- Develops standards for the proper construction, maintenance, and destruction of wells and other deep excavations
- Educates the public, including contractors, consultants and other government agencies about the Well Ordinance and the well standards
- Verifies that wells are properly constructed, maintained, and destroyed using a permitting and inspection mechanism
- Takes enforcement action against violators of the Well Ordinance
- Maintains a database and well-mapping system to document information about well construction and destruction details, well location, and well permit and well violation status.

The Well Ordinance Program began in 1971, when a SCVWD advisory committee consisting of representatives of local agencies, the SCVWD, and the Association of Drilling Contractors was established. The committee was charged with the development of well construction standards and standards for the proper sealing of abandoned wells. The Board adopted standards for well destruction and construction in October 1972 and January 1975, respectively. In 1975, the SCVWD Board of Directors passed the first SCVWD Well Ordinance.

Both the standards and the Well Ordinance have undergone numerous revisions. The Board passed SCVWD Well Ordinance 90-1 in April 1990. The most recent version of the well standards, "Standards for the Construction and Destruction of Wells and Other Deep Excavations in Santa Clara County," was adopted by the Board in July 1989. These documents address the permitting and proper construction and destruction of wells and other deep excavations, including water supply wells, monitoring wells, remedial extraction wells, vadose wells, cathodic protection wells, injection wells, storm water infiltration wells, and elevator shaft pits.

Beginning in 1975, well construction and destruction permits were required by the SCVWD, and the SCVWD began inspecting every well that was constructed. Well destruction activities were first inspected by the SCVWD in 1984. Since the inception of well permitting, the annual number of permits issued has greatly increased. The SCVWD issued from approximately 400 well permits in 1976, the first full year of permitting, to a maximum of approximately 2,544 permits in 1994. As of October 2000, the SCVWD, under the Well Ordinance Program, had permitted and inspected the construction of 2,908 water supply wells, 22,448 monitoring wells, 4,000 exploratory borings, and the destruction of 9,517 wells. The SCVWD is in compliance with Sections 13803 and 13804 of the State Water Code. Therefore, it has the authority to assume the lead role in the enforcement of the State Well Standards, the assignment of State Well Numbers, and the collection of State Drillers Reports for all wells constructed or destroyed in Santa Clara County. The SCVWD has recently converted the paper-based well maps to a GIS-based well mapping system. The GIS contains locations for more than 30,000 active, inactive, abandoned, and destroyed wells in Santa Clara County.

Dry Wells Program. The SCVWD Dry Well Program regulates dry wells to minimize their impacts on groundwater quality. The program includes controlling the installation of new dry wells, requiring the destruction of dry wells that are a contamination threat, and educating the public and local agencies about dry wells.

In Santa Clara County, at least eight serious contamination sites were caused or aggravated by dry wells introducing contamination into the groundwater. One dry well site has a solvent plume more than 2,000 feet long and more than 200 feet deep in a southern recharge area of the county where the only source of drinking water is groundwater. In August 1993, the SCVWD adopted Resolution 93-59 regarding storm water infiltration devices.

Since 1993, owners of dry wells deeper than 10 feet have been required to register their wells with the SCVWD by filing a "Notice to Continue Use." Dry well owners can continue using their wells as long as the well is not an immediate threat to groundwater quality. To date, we have received approximately 20 dry well notices. Local cities, businesses, contractors, and private citizens regularly call for SCVWD guidance on dry wells. The SCVWD continues to issue permits for dry wells deeper than 10 feet and for the destruction of dry wells. SCVWD staff advises the public and planning agencies about the appropriate use of dry wells to mediate storm-water problems.

The Dry Well Program is being incorporated into the Well Ordinance Program. Specific standards for dry wells will be incorporated into the next revision of the well standards. These standards include prohibiting the construction of dry wells greater than 10 feet and defining dry wells to include all shallow drainage wells, not just shallow drainage wells receiving storm water. Incorporating dry wells into the Well Ordinance Program will clarify permitting and construction standards for dry wells, expand the definition of devices covered by

the well standards so that all wells that bypass natural protection processes are subject to standards for protecting groundwater, and simplify the process by which dry wells are permitted.

Abandoned Water Well Destruction Assistance. The SCVWD Abandoned Well Destruction Assistance Program protects the County's groundwater resources by helping property owners properly destroy old, abandoned water supply wells that they have discovered. Due to the agricultural history of the county and to subsequent post-World War II development, many former water supply wells were abandoned and buried, and remain today as potential vertical conduits that may transport contaminants into the SCVWD's deep water supply aquifers. Some estimates indicate that there may be as many as 10,000 abandoned water supply wells within the boundaries of the Santa Clara Valley Basin. Because there are no official records of these wells, the SCVWD has little knowledge of their existence or their locations.

In the mid-1980s, the SCVWD took a proactive stance on active and abandoned water supply wells found within known contamination plumes. At that time, with assistance from the Regional Board, the SCVWD actively searched for and destroyed known active wells and abandoned wells. However, when abandoned water wells were discovered in areas not threatened by known groundwater contamination, they were not included in the SCVWD's well destruction efforts. Instead, they were treated as well violations under the Well Ordinance Program, and the SCVWD proceeded with enforcement action to force the property owner to properly destroy the well.

Unfortunately, this enforcement action often took months to complete. Property owners often did not have the \$3,000 to \$15,000 dollars needed to destroy the well and had to secure loans to complete the destruction. Many property owners had negative feelings about the SCVWD after the enforcement action, especially because most property owners had no previous knowledge of the well, and when they discovered the well, they were the first to inform the SCVWD of its existence.

SCVWD staff believed that though a well was found on an owner's property (and according to the Well Ordinance, the property owner is responsible for destroying it), the owner was not actually responsible for the well's current status (abandoned and buried), and because destruction of the well was in the best interest of the SCVWD, the SCVWD should destroy the well.

Therefore, in 1994, the SCVWD initiated the Abandoned Well Destruction Assistance Program to aid property owners who happen to discover an abandoned water supply well on their property. Under the Abandoned Well Destruction Program, the SCVWD destroys abandoned water wells if: 1) the property owner had no previous knowledge of the well, 2) the well was not registered with the SCVWD, 3) the well has no surface features that would have obviously indicated its presence, and 4) the property owner enters into a Right of Entry Agreement with the SCVWD.

Since the program's inception in 1994, the SCVWD has destroyed 108 abandoned wells under the Abandoned Well Destruction Program. Most of these wells were first discovered and reported to the SCVWD because they were flowing under artesian pressure. Staff will continue to implement the program. Each year, staff receives reports of approximately 20 wells that meet program criteria, and staff expect that this trend to continue.

Leaking Underground Storage Tank Oversight Program. The SCVWD provides regulatory oversight of the investigation and cleanup of fuel releases from USTs for most of Santa Clara County. In the early 1980s, several drinking-water wells in the county had been shut down as a result of contamination by chlorinated solvents. In 1983, the state Legislature enacted the UST Law (Chapter 6.7 of the Health and Safety Code) authorizing local agencies to regulate the design, construction, monitoring, repair, leak reporting and response, and closure of USTs. In 1986, the SCVWD Board of Directors decided to implement a leaking UST oversight program for petroleum fuels, in coordination with the San Francisco Regional Water Quality Control Board (Regional Board). In 1987, the SCVWD entered into an informal agreement with the Regional Board to create a pilot oversight program. In 1988, the SCVWD and the county of Santa Clara entered into a

contract with the State Water Resources Control Board to implement one of the State's first Local Oversight Programs. This allowed the SCVWD to be reimbursed with state and federal funds for costs associated with operation of the program.

The SCVWD only provides regulatory oversight on investigation and cleanup of USTs that have leaked. UST tank removals, leak prevention, and monitoring activities in the county are overseen by one of 10 other agencies, usually the local fire department. If there is evidence of a leak or if contamination is detected, the local agency notifies the SCVWD and the Regional Board. The SCVWD reviews the data to confirm releases and determine if the release poses a threat to human health and safety, the environment, or water resources. If there is a threat, a caseworker requests additional investigation and cleanup. As of January 2000, a total of 2,250 fuel leak cases have been reported in the county, the majority of which have affected groundwater. Approximately 1,460 (65 percent) of reported leak cases have been closed. About 700 cases are currently within the SCVWD's UST program. About 70 cases receive Regional Board oversight.

The presence of MTBE in gasoline has precipitated additional changes in the UST regulatory process and how sites are investigated and cleaned up. Since 1993, MTBE and other oxygenates have emerged as significant contaminants at fuel leak sites within the county, causing increased concern for the protection of drinking-water production aquifers. MTBE has been blended into gasoline in high percentages (up to 15 percent by volume) beginning in the winter of 1992 with the intent to significantly improve air quality. MTBE is a recalcitrant chemical in groundwater meaning that it does not undergo significant breakdown (biodegradation) in groundwater. As a result, MTBE contamination can migrate considerable distances in groundwater and may impact wells miles downgradient. MTBE has been detected at more than 330 current fuel leak cases in the county. Concentrations at these sites range from 5 parts per billion to more than 1 million parts per billion. The SCVWD has taken a progressive and vigilant approach to protecting groundwater resources from MTBE contamination through the use of GIS to manage and analyze both UST site and regional information and in demanding a more intense and detailed level of work be performed at MTBE release sites.

The SCVWD is also very concerned regarding the increasing occurrence of MTBE at operating gasoline stations, which poses a significant threat to municipal drinking-water wells within the county. In 1999, the SCVWD conducted a \$1,000,000 project to determine the occurrence of MTBE at operating gasoline stations. Despite the fact that gasoline stations have been upgraded to meet stringent requirements, it is clear that faulty installations, poor maintenance and poor facility operation practices are resulting in leaks, and that improvements in the management of USTs are needed to prevent widespread contamination of groundwater. The SCVWD has committed additional resources to gain a more extensive understanding of the groundwater basin, groundwater flow patterns, and groundwater pumping trends. This improved understanding will allow for better decisions regarding the level of oversight necessary at sites, how much investigation is required to properly understand the nature and extent of contamination at sites, the level of cleanup necessary to protect groundwater resources, and the effectiveness of the program in preventing significant short-term and long-term water quality degradation.

Toxic Cleanup Program. The SCVWD performs peer review of cases where toxic chemicals have contaminated groundwater and provides water use and geologic information available to the public and environmental consultants. SCVWD staff also provide expert technical assistance to the regulatory agencies (Santa Clara County, San Francisco and Central Coast Regional Boards, Department of Toxic Substances Control, and the federal Environmental Protection Agency) responsible for the oversight of investigation and cleanup at non-fuel contaminated sites within Santa Clara County.

The SCVWD has records of over 700 releases of non-fuel related cases involving the release of solvents, metals, pesticides, and a variety of other chemicals in Santa Clara County. The San Francisco Regional Water Quality Control Board provides regulatory oversight on over 600 cases in the northern half of the county. The California Department of Toxic Substances Control provides oversight of 17 cases, and the federal EPA provides oversight of 11 cases. SCVWD staff actively tracks and peer-reviews the most serious of these cases

(primarily the Superfund sites). Staff provides review and comment on Site Cleanup Requirements and Cleanup and Abatement Orders prepared by the Regional Boards and investigation and cleanup reports prepared for these sites. The SCVWD provides geologic and technical expertise to responsible parties (site owners and operators) and their consultants. Staff also regularly participates in various committees and public meetings to ensure groundwater protection is properly addressed.

E.6.4 Saltwater Intrusion Protection

Whenever there is a large saline water body adjacent to freshwater aquifers, as in the case of the San Francisco Bay, the potential for pollution of those freshwater aquifers exists. Intrusion of saltwater into a freshwater aquifer degrades the water for most beneficial uses and, when severe, can render it virtually unusable. Salty water can corrode holes in well casings and travel vertically to other aquifers not previously impacted. Once freshwater aquifers are rendered useless by a severe case of saltwater contamination or intrusion, it is almost impossible to reclaim them.

Comparison of older mineral analyses of groundwater from wells in the San Francisco bayfront area in Santa Clara and Alameda counties, some dating back to 1907 with more-recent data shows that saltwater intrusion has occurred in the upper aquifer. With much higher water demands after World War II and the occurrence of land subsidence, saltwater intrusion conditions became aggravated and encompassed a substantial area of the baylands – the area adjacent to the southern San Francisco Bay. The Bayshore Freeway (U.S. Route 101) and Nimitz Freeway (Interstate 880) delineate the southern limits of this area.

SCVWD Saltwater Intrusion Prevention Program. SCVWD staff undertook a comprehensive field canvassing effort from 1980 to 1984. Defective wells (those thought responsible for allowing seawater to invade freshwater aquifers) fronting the San Francisco Bay were located and cataloged. Thirty-nine “culprit” wells were located. In 1985, the SCVWD pursued properly destroying the 39 “culprit” wells through SCVWD Ordinance No. 85-1. This ordinance gives the SCVWD authority to require owners of wells determined to be “public nuisances” to seal and destroy the wells or upgrade them to active or inactive status. Of the 39 potential conduit wells identified, 10 were not located and were presumed destroyed without a permit. The remaining wells were all properly destroyed.

Since the inception of this program, the Board authorized a more comprehensive well sealing program, through which abandoned wells near areas of known chemical contamination can be sealed with SCVWD funds. This program began in October 1984, and was in part a result of general concerns about contamination of useable aquifers by saltwater as well as by industrial chemicals throughout the county. Several wells in the area were included in this parallel program, many of which were not identified as defective or potential conduit wells.

Saltwater Intrusion Monitoring. The SCVWD continues to monitor the extent and severity of saltwater intrusion. The current Saltwater Intrusion Monitoring Program consists of 21 monitoring wells that are sampled quarterly. Five of these wells monitor the status of saltwater intrusion in the lower aquifer zone, while the remaining 16 wells monitor the upper aquifer zone. Originally, the program consisted of 29 wells. Eight of these wells could not be located during recent field investigations and presumably were destroyed. However, work is commencing to replace the lost wells and restore the monitoring program to its original form.

Future Direction. The present status of the Saltwater Intrusion Prevention Program is subject to change, depending upon the future basin operation and groundwater demand in the area. The two economically practical ways to prevent or minimize any further intrusion are management of the groundwater basin and strict enforcement of ordinances on well construction and destruction standards. These approaches have been adopted by the SCVWD and should continue to be implemented.

E.6.5 Ambient Groundwater Monitoring

The SCVWD conducts regular groundwater quality and elevation monitoring to determine groundwater resource conditions. This monitoring provides data to assist the SCVWD in evaluating and managing the groundwater basin.

Groundwater Quality Monitoring Program. By monitoring the quality of the groundwater basin, the SCVWD can discover adverse water quality trends before conditions become severe and intractable, and implement timely remedial action to prevent or correct costly damage. Groundwater quality samples have been collected in Santa Clara County since the 1940s by the SCVWD and by others. The current monitoring well network, which includes about 60 wells, is designed to reflect general areal and vertical groundwater quality conditions in the hydrogeologic units that yield significant amounts of water. Groundwater quality samples are collected biannually and analyzed for general minerals, trace metals, and physical characteristics. The program is being revised to conduct the sampling annually and expand the parameters measured to include volatile organic compounds.

Monitoring results suggest that water quality is excellent to good for all major zones of the groundwater basin. The more common trace constituents, which are considered unwanted impurities when present in high concentrations, were generally not noted in concentrations that adversely affect beneficial uses. Areas with somewhat degraded waters in terms of total mineral salt content have been identified in the Santa Clara Valley, and elevated nitrate concentrations have been observed in the Coyote sub-basin. Special groundwater-monitoring programs have been developed to define the extent and severity of these problems and other specific water quality problems such as MTBE.

Depth-to-Water Monitoring. The SCVWD also conducts regular depth-to-water monitoring to evaluate groundwater supply conditions and formulate policies to ensure adequate water supplies and minimize any adverse impacts. Collecting depth-to-water information has been one of the SCVWD's functions since it was first formed as a water conservation district in 1929. Depth-to-water information has been used to create semiannual groundwater elevation contour maps. Depth-to-water data are also used for subsidence modeling, to generate hydrographs needed to analyze groundwater model simulations, and to provide information to SCVWD customers on current and historical groundwater elevations. Depth-to-water measurements are recorded on a monthly basis for approximately 170 wells and on a quarterly basis for 108 wells.

Nitrate Management Program. In June of 1992, the SCVWD initiated an extensive study to review historical nitrate concentrations, identify potential sources, collect and analyze groundwater samples for nitrate, and develop a set of recommendations for the prevention and control of nitrate-loading in the Llagas sub-basin. The results of the study, completed in February 1996, indicated that nitrate concentrations are generally increasing over time, and elevated concentrations still exist throughout the sub-basin. The SCVWD began the Nitrate Management Program in 1997 to implement the recommendations of the study. The objective of the program is to delineate, track, and manage nitrate contamination in the south county groundwater sub-basins, including the Coyote Valley sub-basin, in order to ensure the sub-basins' viability as a long-term potable water supply. Specific program objectives are (1) reducing the public's exposure to high nitrate concentrations, (2) reducing further loading of nitrate, and (3) monitoring the occurrence of nitrate.

To reduce nitrate exposure, the SCVWD offered free nitrate analysis to all well water users in the Coyote Valley and Llagas groundwater sub-basins. Approximately 60 wells in the Coyote Valley sub-basin and over 500 wells in the Llagas groundwater basin have been tested for nitrate. Over 30 percent of the wells in the Coyote Valley sub-basin contained nitrate concentrations above the drinking-water standard of 45 mg/l nitrate (as nitrate). Along with the results of the testing, residents are mailed a fact sheet describing what nitrate is, where it comes from, what the health effects are, how to prevent further loading, and where to find more information. Currently, the SCVWD is working with the Santa Clara County Department of Environmental Health to produce a well owner's guide. Among other things, the guide will contain information on

recommended sampling, testing, and disinfecting practices, as well as measures to protect against contamination.

To reduce nitrate loading, the SCVWD entered into a contract with a mobile irrigation lab to offer free irrigation evaluations to farmers in order to improve the efficiency of their irrigation systems and irrigation scheduling. By improving the irrigation efficiency and distribution uniformity, the irrigators can reduce the amount of water and nitrate leached beyond the active root zone of the crop and into the groundwater. In addition, the SCVWD conducted a series of irrigation, nutrient, and pesticide management seminars. Over 250 people attended seminars focusing on efficient irrigation and soil testing for nitrate. Approximately 150 free soil nitrate test kits have been prepared and distributed. A series of five fact sheets on nitrogen and water management in agriculture was produced in cooperation with Monterey County Water Resources Agency and the Pajaro Valley Water Management Agency. The SCVWD continues to schedule mobile lab evaluations and agricultural seminars. In addition, the SCVWD is a cooperator on a grant with a soil scientist to establish field trials demonstrating and evaluating the effectiveness of in-field nitrate testing in drip- and sprinkler-irrigated vegetables.

To monitor nitrate occurrence, the SCVWD monitors nitrate concentrations in approximately 60 wells throughout southern Santa Clara County. The monitoring program is designed to track seasonal, areal, vertical, and long-term trends in nitrate concentrations. Over 10 shallow monitoring wells have been installed to complete the monitoring well network.

Land Use and Development Review. The objective of the Land Use and Development Review Program is to evaluate the land use and developments occurring within the county for adverse impacts to watercourses under SCVWD jurisdiction and to other SCVWD facilities. The SCVWD reviews and comments on proposed land development, environmental documents, and city and county general plans. Review of land development proposals includes a determination of direct and indirect impacts to SCVWD facilities, including potential groundwater quality impacts. Indirect impacts could result from increased runoff and flooding due to new impervious surface or introduction of pollutants to a watercourse from construction activities or urban runoff. Direct impacts to watercourses under SCVWD jurisdiction are addressed through the SCVWD's permitting program as defined by Ordinance 83-2. This ordinance allows the SCVWD to investigate whether a proposed project or activity will pollute the water supply or otherwise affect a District facility. The SCVWD may deny or conditionally approve the permit application for the proposed project if adverse effects have been identified.

The California Environmental Quality Act (CEQA) provides the SCVWD an opportunity to comment in areas relevant to the issues listed in Ordinance 83-2. However, cities need to make certain these issues are adequately addressed and treated. The use of Ordinance 83-2 and CEQA generally have not effected adequate attention to these issues. In years past, the SCVWD has relied on local agencies to place conditions on development projects and to include provisions that address SCVWD water supply and flood protection measures. The recent increase in development and land use, coupled with more stringent environmental concerns and requirements imposed by other regulatory agencies, has made it necessary for the SCVWD to shift to a more proactive approach and to undertake greater participation in development planning activities. SCVWD land use and development review staff plan to participate on interagency project teams, general plan review and revision, and development of relevant policies (such as riparian corridor and building setback policies). The program will also seek revisions to Ordinance 83-2 and greater education of land development planning staff and officials.

Wellhead Protection. The SCVWD does not operate a traditional Wellhead Protection Program. However, there are several SCVWD programs designed to (1) delineate sensitive/vulnerable areas of the groundwater basin, (2) identify existing and potential sources of contamination, (3) develop management strategies, and (4) engage the community in groundwater protection. Activities in each of these areas are discussed below.

Delineate Sensitive Areas. In 1999, the SCVWD completed an evaluation of groundwater sensitivity using the U.S. Environmental Protection Agency's DRASTIC method. DRASTIC stands for Depth to water table, net Recharge, Aquifer media, Soil media, Topography, Impact to vadose zone, and hydraulic Conductivity of the aquifer. Separate GIS coverages were completed for each of these factors and were used to assess the relative groundwater vulnerability to contamination across the county. The SCVWD is presenting the DRASTIC model results to the city and county planning departments, so that planners can take groundwater sensitivity into account when reviewing development plans. The DRASTIC model can also be used as a tool to identify areas where more focused studies are needed or to prioritize cleanup activities at contamination sites.

The SCVWD is developing a GIS-based wellhead protection area delineation tool. The tool will be used to create maps showing zones of contribution to public water supply wells. The tool is intended to be used by local public water suppliers conducting their Drinking Water Source Assessments and by regulators trying to assess threats to individual drinking-water supply wells from contamination sites.

Identify Sources of Contamination. Through the DRASTIC model work and other programs, the SCVWD has identified and mapped many of the sources of contamination throughout the County. The SCVWD has mapped more than 30,000 wells, including almost 3,500 abandoned and destroyed wells. All the leaking underground fuel tank sites have been mapped, along with the locations of nearly 700 operating gas tanks. The SCVWD parcel map includes land use by parcel. The SCVWD is in the process of creating and obtaining coverages of dry cleaners, hazardous materials storage facilities, septic system locations, and sewer lines.

Develop Management Strategies. The SCVWD develops management strategies based on threats to groundwater quality identified through sensitivity analysis, identifying sources of contamination, and water quality monitoring results. Management strategies include programs such as the Nitrate Management Program and Leaking Underground Storage Tank Oversight Program discussed above. The SCVWD continues to be active in promoting legislation, regulations, and programs for protecting groundwater resources from a variety of threats.

Community Outreach and Participation. The SCVWD participates in the Groundwater Foundation's Groundwater Guardian Program and was designated as a Groundwater Guardian Affiliate for the year 2000 based on its groundwater protection activities. 2001 Groundwater Guardian activities include recruiting a Groundwater Guardian Community, completing a video on local groundwater management efforts, and publishing a well owner's guide. Other planned outreach activities include sponsoring workshops on groundwater protection strategies, land use planning, best management practices for operating gasoline stations, and nutrient management.

E.7 San Mateo County Environmental Health Services Division

The San Mateo County Environmental Health Services Division (SMCEHSD) can be contacted online: <http://www.smhealth.org/enviro/index.shtml> or by telephone at (650) 363-4305.

Unlike ACWD and SCVWD, the Health Services Division is not a water district. However, it is the regulatory authority for permitting of all environmental health programs within the county, including small water systems, septic systems, water wells, underground storage tanks, contaminant site remediation, hazardous waste generators, hazardous material business plans, storm water discharge compliance, housing and farm labor camps, retail food facilities, vector control, household hazardous waste, medical waste, and solid waste. All these programs involve some component of protection to surface or groundwater resources.

E.7.1 Jurisdiction

The Health Services Division has no formal authority for groundwater management within San Mateo County, but does protect groundwater resources through various programs as outlined above. Regulatory

authority for these various programs comes from myriad sources. Specifically, the Health Services Division Groundwater Protection Program (remedial oversight), under a contract with the State Water Resources Control Board, is the Local Oversight Program (LOP) providing regulatory oversight for the investigation and remediation of leaking underground storage tank sites. Groundwater Protection Program staff also oversees SLIC and other soil- or groundwater-impacted sites based on verbal agreements with the Regional Board and DTSC, under the general authority of the Health and Safety Code. Additionally, the County of San Mateo has maintained some form of well ordinance since the early 1980s. The most recent amendment to Chapter 4.68 – Wells, San Mateo County Ordinance Code was passed by the County Board of Supervisors January 30, 2001.

E.7.2 Groundwater Protection and Cleanup

As outlined above, the Health Services Division Groundwater Protection Program, under a contract with the State Water Resources Control Board, is the LOP providing regulatory oversight for the investigation and remediation of leaking underground storage tank sites. Groundwater Protection Program (GPP) staff also oversees SLIC and other soil- or groundwater-impacted sites based on verbal agreements with the Regional Board and DTSC, under the general authority of the Health and Safety Code.

As of April 1, 2001, there are 477 active leaking underground storage tank remediation sites countywide within the LOP contract, from a total of 1,051 in the program from inception. Additionally, GPP staff also oversees 49 minor surface spills and solvent tank remediation sites on behalf of the Regional Board and DTSC. Of the total of 526 remediation sites under GPP oversight, 248 occur within the area of the San Mateo Plain Groundwater Basin.

GPP staff provides regulatory oversight on investigation and cleanup of USTs that have leaked. UST tank monitoring, leak prevention, and removals are regulated by the Certified Unified Program Agencies (CUPA) program, also within the Health Services Division. By December 2002, GPP staff will likely assume CUPA responsibilities for UST permitting, monitoring, and removal.

Additionally, local efforts to identify groundwater usage and protection strategies have been ongoing since 1993. A compilation of well data throughout the county began with the Westside Basin in 1993 and has slowly progressed south into the San Mateo Plain Basin. Well permitting was implemented by the Health Services Division in 1987, and thus all wells permitted since that time have been documented with construction details. Data retrieved from all well permit files have been entered into a database maintained by County GPP staff. Using a geographic information system software program, well locations are geocoded and eventually located using a Global Positioning System.

E.7.3 Well Permitting Program

The county of San Mateo has maintained some form of well ordinance since the early 1980s. The most recent amendment to Chapter 4.68 – Wells, San Mateo County Ordinance Code was passed by the County Board of Supervisors January 30, 2001. The Health Services Division Land Use Program is the permitting element for both installation and destruction of all agricultural, domestic water supply, and cathodic protection wells within the county, with the exception of the city of Daly City. The Health Services Division GPP is the permitting element for all geotechnical drilling and environmental investigation drilling (borings and monitoring well installation and destruction), with the exception of the city of Daly City. Drilling performed within Daly City is permitted by the city with notification to the county Environmental Health Division.

Important elements of the county well ordinance include the following: The well ordinance generally follows the state well ordinance. All domestic wells installed after April 14, 1987, must have a meter to record the volume of water removed from the well. All domestic wells within the unincorporated county area west of Interstate Highway 280 and north of state Highway 92, regardless of the installation date, must have a meter to record the volume of water removed from the well. Water-quality testing is required for domestic wells, but not for irrigation wells. Domestic wells must yield at least 2.5 gallons per minute. Unless a waiver is obtained,

wells cannot be installed within 50 feet of an existing well, within 50 feet of a sewer line or lateral, or within 100 feet of a septic tank or leachfield. Additionally, based on the San Mateo County Planning Division General Plan, although currently enforceable only by the Local Coastal Plan Ordinance (within the defined coastal zone), no well can be installed within 50 feet of the riparian corridor along a perennial stream, within 50 feet of the high-water point of a perennial stream with no riparian vegetation, within 30 feet of the riparian corridor along an intermittent stream, or within 30 feet of the centerline of an intermittent stream with no riparian vegetation. It is also recognized that within the town of Atherton, a variance from surface construction regulations is required. An Atherton town ordinance requires a flush-to-ground surface well construction, within a Christy box.

E.8 Certified Unified Program Agencies

Six state environmental programs have been consolidated into one program under the authority of a Certified Unified Program Agency (CUPA). A CUPA is a local agency that has been certified by the California EPA to implement these six programs within the local agency's jurisdiction, and can be a county, city, or JPA (Joint Powers Authority). The CUPA program was established under the amendments to the California Health and Safety Code (Chapter 6.11) made by SB 1082 in 1994. Regulations implementing the CUPA program can be found in Title 27 of the California Administrative Code.

The six programs are:

1. Hazardous Waste Generator Program and Onsite Hazardous Waste Treatment activities
2. Aboveground Storage Tank Program Spill Prevention Control and Countermeasure Plan
3. Underground Storage Tank Program
4. Hazardous Materials Release Response Plans and Inventory program
5. Business Plan and Risk Management and Prevention Program
6. The Hazardous Materials Management Plans and the Hazardous Materials Inventory Statement

The Unified Program requires the CUPA in a jurisdiction to consolidate permits, coordinate enforcement of regulations and ordinances, and develop and coordinate a single inspection and enforcement program. The program takes an integrated, multimedia enforcement approach to promote the effective detection, abatement, and deterrence of violations affecting more than one environmental medium or regulatory scheme. Therefore, implementation of each of the six CUPA programs will result in some degree of groundwater protection. For more information on the CUPA programs, please visit the CUPA website at: <http://www.calcupa.net/faqs.html>

E.9 Groundwater Ambient Monitoring Assessment (GAMA) Program

The California Aquifer Susceptibility (CAS) assessment is a collaborative effort between the State Board, the Department of Health Services, the Department of Water Resources, Lawrence Livermore National Laboratory (LLNL), USGS, and local water agencies. It is described by the State Board in the document "Groundwater Ambient Monitoring and Assessment Program, California Aquifer Susceptibility (CAS) Assessment," as follows:

"The State Water Resources Control Board (SWRCB), in coordination with the Department of Health Services (DHS) and the Department of Water Resources (DWR), is implementing the California Aquifer Susceptibility (CAS) assessment to determine the water quality and relative susceptibility of groundwater that serves as a source for public water supplies to potentially contaminating activities (PCAs). CAS is part of the Groundwater Ambient Monitoring and Assessment (GAMA) Program and will employ groundwater age-dating techniques and low-level analyses for volatile organic compounds (VOCs). The fundamental premise of this assessment is that groundwater age can be used as a guide for assessing aquifers in terms of susceptibility. The age of groundwater may be defined as the time since the water was recharged and isolated from the atmosphere. Tritium/helium-3

techniques will be used to determine the mean, integrated age of groundwater samples. The widespread use of regulated chemicals has occurred during the last 50 to 60 years (following World War II). Therefore, groundwater that has recharged during the past 50 years will be considered more susceptible to contamination from various land-use activities. In addition, low-level VOC analysis will be used to identify those public supply wells already impacted by certain contaminating activities, but which are still below action levels. The assessment is designed to sample the approximately 16,000 public supply wells statewide, starting with three focus areas: Sacramento Valley, Livermore Valley, and Orange County. Sampling began in September 2000 and will continue for the next several years over the entire state, depending on the availability of funding.”

Groundwater supply wells are being sampled under CAS study in San Mateo, Santa Clara and Alameda Counties. For more information on the CAS and GAMA programs, please visit the State Board website at: www.swrcb.ca.gov/cwphome/gama.

E.10 Comprehensive Groundwater Quality Monitoring Program

In October 2001, the Governor approved Assembly Bill 599 (AB 599), establishing the Groundwater Quality Monitoring Act of 2001. Introduced by Assembly Member Carol Liu, the goal of AB 599 is to improve comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public.

AB 599 requires that the State Water Resources Control Board (SWRCB), in coordination with an Interagency Task Force (ITF) and Public Advisory Committee (PAC), integrate existing monitoring programs and design new program elements, as necessary, to establish a comprehensive statewide groundwater quality monitoring program.

AB 599 also requires that on or before March 1, 2003, the SWRCB submit a report to the Governor and Legislature, detailing the efforts of the joint activities with the ITF and PAC, and including the following elements:

- A detailed description of a comprehensive groundwater quality monitoring program
- A description of how the program takes maximum advantage of existing information
- An assessment of additional monitoring necessary
- A specific set of recommendations for coordinating existing monitoring programs
- An estimate of funding necessary to implement the program
- Recommendations for an ongoing source of funds
- A prioritized list of actions to increase effectiveness of monitoring efforts

E.11 City and County General Plans

Groundwater pollution prevention strategies and groundwater cleanup programs may be specified in city and county general plans. State law requires that each incorporated city and county adopt “a comprehensive, long-term general plan for its physical development.” The general plan is the official city or county policy regarding the location of housing, business, industry, roads, parks and other land use, protection of the public from noise and other environmental hazards, and conservation of natural resources. The city council or county board of supervisors adopts zoning, subdivision and other ordinances to regulate land uses and to carry out the policies of its general plan. Cities and counties where groundwater is being pumped for drinking water or emergency supply may include specific groundwater pollution prevention and cleanup strategies in their plans to conserve their valuable resource.

Although state law establishes a set of basic issues for consideration in local general plans, each city and county determines the relative importance of each issue to local planning, and decides how they are addressed

in the general plan. As a result, no two cities or counties have plans that are exactly alike in form or content. The following general plan elements and corresponding planning issues are contained in a general plan:

1. Land use: housing, business, industry, open space, education, public buildings and grounds, waste disposal facilities, and others
2. Circulation: major roads, transportation routes, terminals, and public utilities and facilities
3. Housing: housing needs for all economic segments in the community
4. Conservation: natural resources including water, forests, soils, rivers, and mineral deposits
5. Open space: preserving open space for natural resources, outdoor recreation, public health and safety, and agricultural land
6. Noise: noise problems
7. Safety: seismic, geologic, flood, and wildfire hazards

The process of adopting or amending a general plan requires cities and counties to hold public hearings for each proposal. Hearing bodies, such as planning commissions, zoning adjustment boards, and architectural and design review boards, advise or approve plans for future development.

Community plans and specific plans may also be used by cities and counties to plan the future of a particular area at a finer level of detail than that provided in the general plan. A community plan is a portion of the local general plan that focuses on the issues pertinent to a particular area or community within the city or county. Specific plans describe allowable land uses, identify open space, and detail the availability of facilities and financing for a portion of the community.

For more information on general plan requirements in California, please go to <http://www.opr.ca.gov/publications/GeneralPlanning.shtml>. For a compilation of land use documents, including many of the South Bay's General Plans, visit <http://www.ceres.ca.gov/planning/>.

APPENDIX F

Contact Information for South Bay General Plans and Groundwater Protection Strategies in South Bay General Plans

Contact Information for South Bay General Plans

City	Contact Number	Web site Address
Niles Cone Basin		
Fremont	510-494-4515	www.ci.fremont.ca.us
Hayward	510-583-4200	www.ci.hayward.ca.us
Newark	510-794-2330	www.ci.newark.ca.us
Union City	510-675-5327	www.ci.union-city.ca.us
Alameda County	510-670-5400	www.co.alameda.ca.us
Santa Clara Valley Basin		
Campbell	408-866-2100	www.ci.campbell.ca.us
Cupertino	408-777-3308	www.cupertino.org
Los Altos	650-948-2790	www.ci.los-altos.ca.us
Los Altos Hills	650-941-7222 (x223)	www.losaltoshills.ca.gov
Los Gatos	408-399-5729	www.town.los-gatos.ca.us
Milpitas	408-586-3000	www.ci.milpitas.ca.gov
Monte Sereno	408-354-7635	www.montesereno.org
Morgan Hill	408-779-7247	www.morgan-hill.ca.gov
Mountain View	650-903-6311	www.ci.mtnview.ca.us
Palo Alto	650-329-2321	www.city.palo-alto.ca.us
San Jose	408-277-4576	www.ci.san-jose.ca.us
Santa Clara	408-615-2450	www.cho.ci.santa-clara.ca.us
Saratoga	408-868-1235	www.saratoga-ca.com
Sunnyvale	408-730-7444	www.ci.sunnyvale.ca.us
Santa Clara County	408-299-2521	claraweb.co.santa-clara.ca.us
San Mateo Plain Basin		
Atherton	650-802-4207	www.ci.atherton.ca.us
Belmont	650-595-7416	www.belmont.gov
Burlingame	650-558-7250	www.burlingame.org
East Palo Alto	650-853-3100	www.ci.east-palo-alto.ca.us
Foster City	650-286-3225	www.fostercity.org
Hillsborough	650-375-7411	www.hillsborough.net
Menlo Park	650-858-3400	www.ci.menlo-park.ca.us
Redwood City	650-780-7000	www.redwoodcity.org
San Carlos	650-802-4207	www.ci.san-carlos.ca.us
San Mateo	650-522-7212	www.ci.sanmateo.ca.us
San Mateo County	650-363-1825	www.co.sanmateo.ca.us

Groundwater Protection Strategies in South Bay General Plans

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
Niles Cone Basin				
Fremont 1991	Natural Resources p. 9-21-63	Extensive discussion of Niles Cone and Alameda Creek, “potential for contamination by hazardous materials, especially those spilled on the ground or into Alameda Creek, or those leaking from USTs”	Yes	Alameda County Water District; Niles Cone groundwater
	p. 9-21-63	Objective NR 8.3 – Protection from contamination of the Niles Cone aquifer underlying Fremont (source of much of Fremont’s drinking water)		
		Policy NR 8.3.1 – Manage the storage of hazardous materials, and especially underground tanks, to ensure a minimum of leakage or spills: Enforce regulations regarding handling and storage of hazardous materials; periodically review regulations to ensure up-to-date standards; consider the establishment of a buffer between development and recharge areas to prevent contamination of the groundwater supply from urban pollutants		
		The use of reclaimed water for irrigation or other purposes should be managed so as to not have an adverse impact on the Niles Cone: Reclaimed water should either be of sufficient quality or should be in areas of the city where it will not have a negative impact on groundwater		
		Encourage the Water District to monitor water quality in the Niles Cone: periodically consult with the Water District regarding maintenance of water quality in the Niles Cone; continue to inform the Water District of any development proposals which could have a negative effect on groundwater		
Hayward 1986, 1998	Environmental Concerns p. VIII-2, 9, 10, 11	City policy requires...that land use decisions do not create or aggravate problems of groundwater seepage, groundwater loss, or septic tank deficiency	Yes	Purchases all water from the San Francisco Water Department, Hetch Hetchy surface water
		Policy – The city will exercise its responsibility to protect environmental resources: strategy 9 – control waste discharge to avoid contamination of water resources		Plans to install emergency water wells west of the Hayward fault to be used in the event of an earthquake; the city also has emergency ties with Alameda

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
				County Water District and East Bay Municipal Utility District
Newark 1992	Open Space & Conservation p. 6-8	Goal 5 – Conserve and enhance the city water resource and protect development from the impacts of identified flow hazards: support efforts to maintain and enhance the system for delivery of high quality water to meet the city domestic and commercial water needs; cooperate with the ACWD and other appropriate agencies in planning to meet the water needs of the city	Yes	Alameda County Water District, the Tuolumne River in the Sierra Nevada, the Sacramento-San Joaquin Delta, and local groundwater supplies. 60% from groundwater
		Promote water conservation through development standards, building requirements, landscape design guidelines, and other applicable city policies and programs; regulate land use such as auto dismantling, waste disposal facilities, gas stations, and industries using toxic chemicals in areas where oil, gasoline, and toxic substances may enter a waterway or contaminate soil		
Union City	Not available	Not available	Not available	Not available
Alameda County General Plan 1976	Conservation p. 1-69-75	The Niles sub area is the major basin within the Washington Planning Unit; extensive discussion of aquifer characteristics, groundwater recharge, historical saltwater intrusion from over pumping, and a county ordinance to control drilling and sealing of wells	Yes	East Bay Municipal Utility District, the Alameda County Water District, and the city of Hayward
	p. 1-88	Goal – To insure and maintain a continuing supply of high water quality for the citizens of Alameda County. Objectives: To reduce man-caused stream and groundwater pollution and general resource degeneration through cumulative impacts on surface and groundwater systems; to maintain all water resources in their highest quality; to achieve coordination of state, regional and local water management agencies and policies throughout the county		
Santa Clara Valley Basin				
Campbell 1972, 1990	Conservation p. 79	Goal – Prevent the pollution of streams and waters Policy – All applications for development adjacent to Santa Clara Valley Water District property shall be referred to that agency for review Policy – The city shall encourage those types of industry that do not	Yes	Santa Clara Valley Water District

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
		create water and air pollution		
	p. 82	Campbell's major responsibility in the conservation of natural resources lies in the conservation of water... Throughout the valley, the Santa Clara County Flood Control and Water District has set aside land for the replenishment of the aquifers		
Cupertino 1993	Environmental Resources p. 5-12	Goal F – Strive to minimize the quantity and improve the quality of storm water runoff consistent with the protection of groundwater quality and groundwater recharge areas.	Yes	Santa Clara Valley Water District
		Policy 5-25: Groundwater Recharge Sites – Continue to support the Santa Clara County Water District to find and develop groundwater recharge sites within Cupertino's planning area and provide for public recreation at all sites where possible		
		Policy 5-28: Natural Creek Beds – Retain creek beds, riparian corridors, water courses and associated vegetation in their natural state to protect wildlife habitat and recreation potential and assist groundwater percolation.		
Los Altos 1987	Infrastructure and Waste Disposal p. 147-150	Water Supply and Quality, "Water drawn down from underground aquifers may be susceptible to pollutants originating at industrial sites in neighboring communities..."	No	Santa Clara Valley Water District, California Water Service operates 37 wells locally, but imports the majority of drinking water for Los Altos
		Goal 1: Support the provisions of clean, healthful water in quantities sufficient to satisfy current and projected domestic and commercial needs in Los Altos		
		Policies 1: The city shall expect safe drinking water from the California Water Service Company, which meets all federal and state water quality standards for all Los Altos.		
		Groundwater is not described in the general plan		
Los Altos Hills	Conservation p. 68	Groundwater is not described in the general plan	No	Not specified

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
Los Gatos 2000	Conservation/Water Resources p. C-2	Policies: Assess the potential for new development to contaminate surface water and/or groundwater	Yes	Not specified
		Implementing strategies: Coordination – planning efforts should be coordinated with the Santa Clara Valley Water District		
Milpitas 1973, 1994	Public Facilities and Utilities Section 2.5 and 4.4	Identifies water supply, wastewater services, and conservation programs; identifies urban storm water runoff as the leading cause of water pollution	No	San Francisco Water Department and Santa Clara Valley Water District
	Water Quality and Conservation	Groundwater is not described in the general plan		
Monte Sereno 2000	No general plan, municipal code 4.11.030 & 9.04.410	General water pollution prohibition.	No	Not specified
Morgan Hill 1996	Land Use p. III-74 - 76	Policy 29a. New development should not exceed the water supply, and management of water should be made more efficient through appropriate means, such as watershed protection, percolation, reclamation, and conservation	Yes	Not specified
		Policy 29d. Support cooperation among all jurisdictions and agencies pumping water from wells in order to manage the aquifer to preserve the natural ecology of the region, secure the aquifer's utility as a water resource, and ensure the water's quality		
		Policy 29e. Encourage the water district to continue developing programs to assure effective management of water resources, such as well monitoring, percolating of imported water, reclamation, and conservation.		
		Policy 29g. Insure that each South County jurisdiction and agency pumping water from wells takes responsibility for knowing the demand that its well pumping imposes on the direction of flow of water and		

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
		how it affects others that are pumping from the same aquifer in order to prevent adverse impacts on existing groundwater contamination problems.		
		Policy 29h. Develop a coordinated program in South County to track existing water quality, water supply, and water flow monitoring programs or for revisions or consolidation of existing programs		
		Policy 29i. Continue programs to identify and seal abandoned and unused wells as such wells may be prime source for transferring contaminants from the upper to the lower aquifer		
		Policy 29j. Protection streambeds and other appropriate percolation areas		
	Environmental Safety p. VII-10 Hazardous Materials & Waste Management	Policy 3o. Initiate a program to identify and abandon dry wells that have been used to dispose of contaminants		
Mountain View 1992	Environmental Management p. 117 - 119	Policy 15 – Encourage activities that maintain and improve drinking-water quality	Yes	Santa Clara Valley Water District
		Action 15b – Continue to enforce local, state and federal codes to prevent contamination of groundwater resources		
		Action 15c – Provide assistance to state, regional, and federal agencies overseeing cleanup of groundwater contamination in Mountain View		
		Action 15d – Assist the Santa Clara Valley Water District to locate abandoned wells and seal them to prevent the spread of contaminants to deeper-level aquifers that supply drinking water		
Palo Alto 1992	Natural Environment N-12-14	Goal N-4: Water resources that are prudently managed to sustain plant and animal life, support urban activities, and protect public health and safety	Yes	Hetch Hetchy; groundwater as backup supply
		Policy N-18 – Protect Palo Alto’s groundwater from the adverse impacts of urban uses; protection of groundwater supply requires some recharge areas to be conserved as open space rather than covering them all with impervious surfaces like buildings, streets, and parking lots; it		

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
		also means protecting these areas from contaminants from underground storage tanks and inadequate chemical management practices		
		Program N-22 - Work with Santa Clara Valley Water District to identify and keep groundwater recharge areas for use in land use planning and permitting and protection of groundwater resources		
San Jose 1994	Water Resources 92-93	Both the adequacy of supply and the quality of water resources are of concern to the community...Water is a finite resource and local water resources should be conserved, protected from pollution as much as possible, and reclaimed to protect the adequacy of supplies, to limit the dependence on external sources of supply, and to avoid the over-drafting of the underground basin to reduce land subsidence.	Yes	Santa Clara Valley Water District (surface water); Evergreen Well Fields (Wells 2, 3, 4, & 5); SF Water District (surface water); North San Jose Well Fields (Wells 1, 2, 3, and 4); Edenvale Well Field (Wells 11, 12, & 13); Coyote Well field (Wells 21, 22, & 23)
		Urbanization can restrict the recharge of underground water basins by reducing permeable land surfaces and by removing the natural streamside vegetation, which filters out pollutants. Urbanization can also increase the amount of pollutants that find their way into the waterways and underground water basins from storm run-off and from on-site percolation		
		Policy 3. The city should encourage the Santa Clara Valley Water District to restrict public access and recreational uses on water-related lands when water quality could be degraded		
		Policy 5. The city should protect groundwater recharge areas, particularly creeks and creek sides, and riparian corridors		
		Policy 6. When new development is proposed in areas where storm runoff will be directed into creeks upstream from groundwater recharge facilities, the potential for surface water and groundwater contamination should be assessed and appropriate preventative measures should be recommended		
		Policy 7. The city shall require the proper construction and monitoring of facilities storing hazardous materials in order to prevent contamination of the surface water, groundwater, and underlying aquifers. In furtherance of this policy, design standards for such facilities should consider high groundwater tables and/or the potential		

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
		for freshwater or saltwater flooding.		
Santa Clara 1992	Environmental Quality Element 5.4.2	Policy 8. Provide a reliable, safe supply of potable water adequate to meet present and future needs. Support efforts by the Santa Clara Valley Water District to reduce subsidence.	Yes	Groundwater (70% from Santa Clara's 28 wells), imported water from Hetch Hetchy, and Santa Clara Valley Water District (30% imported)
		Policy 9. Promote conservation of water, water importation measures, and recharge of the aquifers, so to ensure an adequate water supply and remain within the allowable quantity of withdrawal or "safe yield" of the groundwater, so not to cause further compaction of aquifers and subsidence of land		
		Programs – (xvii) Continue to monitor the quality of drinking water		
		Programs – (xxii) Prior to approval of a building plan that involves the placement of piles or other design features that may result in degradation of the groundwater, applicants shall be required to gain approval from the Santa Clara Valley Water District regarding the depth and placement of piles or the nature of the design		
Saratoga 1983	Conservation p. 3-38	Water quality in Saratoga has always been considered satisfactory, and contamination of the water table has not, as yet, been a problem. Septic tanks are still used by some developments in the outlying areas of the city and remain a potential problem.	No	San Jose Water Works; Local wells (66%) and streams (12%); surface water is purchased from the Oroville Dam (22%)
Sunnyvale 1996	Environmental Management, Water Resources Sub-element p. 45	City-owned wells – The city currently operates eight wells. Because of the proximity of some wells to known underground contamination or industrial areas, monitoring for organic chemicals in the wells is performed on a monthly basis. The city has the ability to shut down any well without affecting the system's overall ability to deliver water for drinking and emergency purposes.	Yes	Local groundwater wells (10%), imported supplies from the San Francisco Water Department (50%), imported supplies from the Santa Clara Valley water District (40%), and reclaimed water.
		Private wells – ...More than 1,200 old, abandoned agricultural wells are estimated to exist throughout Santa Clara Valley, and less than half can be located by SCVWD... The SCVWD recently adopted an ordinance		

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
		to locate and seal abandoned wells throughout the county		
	p. 69	Goal 3.1B – Ensure that potable and reclaimed water meet all quality and health standards		
		Policy 3.1B.3 – Develop an action plan to respond to and protect from contamination of water supplies		
		Action Statement 3.1B3a – Monitor all known underground contaminations		
		Action Statement 3.1B3b – Ensure responsible parties are taking all reasonable steps to clean up known underground contaminations		
		Action Statement 3.1B3c – Ensure responsible enforcement agencies are taking all reasonable steps to have responsible parties clean up known underground contamination		
		Action Statement 3.1B3d – Ensure all business and industry are complying with the city’s hazardous materials storage ordinances		
		Action Statement 3.1B3g – Work the Santa Clara Valley Water District to identify private wells in the city		
		Action Statement 3.1B3h – Advise owners of private wells of health risks, adequate quality testing, etc., and encourage proper abandonment of the wells where appropriate		
		Action Statement 3.1B3i – Encourage owners of private wells that do not have city water service to properly abandon their wells and hook up to the city’s water system		
Santa Clara County 1994	Resource Conservation Book B, Part 3	The Santa Clara Valley Water District (SCVWD) is responsible for countywide water management, including flood control, conservation, and wholesale water supplier for most of the county’s water retailing service. The overall mission of the SCVWD is to conduct a sound water management program that serves the community.	Yes	Santa Clara Valley Water District
		The threat of land subsidence is the principal constraint upon the amount of water that can be withdrawn from local groundwater basins. A related constraint is the annual amount of artificial recharge and the natural recharge capability of the groundwater basins.		

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
	Water Supply Resources	Strategy #4: Maintain drought contingency and groundwater basin management Policy C-RC17 – Drought contingency plans and groundwater basin management programs should be reviewed and updated to prepare for the likelihood of future periods of short-term drought and to minimize: a. the potential adverse impacts of drought upon households, business, and industry; and b. the possibility of groundwater overdraft and land subsidence.		
	Water Quality & Watershed Management	“Because nearly half the County’s water supply is drawn from groundwater basins, perhaps the area of greatest concern is the potential for direct contamination of those basins.”		
		Description of industrial groundwater contamination in the County.		
		Point source regulations are a part of the County strategy (not specifically listed)		
San Mateo Plain Basin				
Atherton 1990	None	Groundwater is not described in the general plan	No	Not specified
Belmont 1982	Conservation	Groundwater is not described in the general plan	No	Belmont County Water District – purchased from San Francisco Water Department
Burlingame 1973	Conservation	Groundwater is not described in the general plan	No	Not specified
East Palo Alto 1999	Land Use p. 25	See Figure LU-5 Water Districts Groundwater is not described in the general plan	No	East Palo Alto Waterworks District - San Francisco Water Department; Palo Alto Park Mutual Water Company - groundwater and San Francisco

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
				Water Department; O'Connor Tract Mutual Water Company - groundwater
	Conservation & Open Space p. 10; Fig COS-3	"Note: The entire city is a groundwater basin." From COS-3 Groundwater is not described in the general plan		
Foster City 1993	Conservation p. 5-31	Foster City has no supplemental water supplies such as wells or reclaimed water for use in irrigation; "Protection of the quality of Foster City water is partially the responsibility of the city of San Francisco, and partially the responsibility of the Regional Water Quality Control Board which must establish and maintain standards for water quality"	No	Estero Municipal Improvement District (EMID) purchased from San Francisco Water Department
		Groundwater is not described in the general plan		
Hillsborough	Not available	Not available	Not available	Not available
Menlo Park 1994	Public Facilities and Services B-VI-1	Groundwater is not described in the general plan	No	City of Menlo Park Municipal Water Department purchased from San Francisco Water Department; California Water Service Company purchased from San Francisco Water Department, Bear Creek/Gulch; O'Connor Tract Cooperative Water Company - groundwater
Redwood City 1990	Conservation Element p. 10-4	Policy: C-6 – Conserve existing sources of water supplies by increasing reclamation of waste waters for suitable use, and protect the water quantity and quality of underground aquifers as an alternate emergency source of fresh water	Yes	Not specified

City/County Year General Plan was Published	General Plan Element	Groundwater Protection Strategy	Groundwater Protection Strategy (Y/N)	Source of Water Specified in General Plan
San Carlos 1992	Open Space and Conservation Element OSC-10	Groundwater lies near the surface (within 10 feet) in the easterly, low-lying portion of the city. The water table lies deeper in the alluvial approve area. The creeks provide considerable recharge of groundwater. Groundwater in the hills is of variable depth and quantity depending upon the thickness of the soil mantle, slope and bedrock materials. Seeps are a localized hydrologic problem in the hills.	No	California Water Service Company purchased from San Francisco Water Department
San Mateo	Conservation and Open Space Element VI-3	San Mateo Creek is a source of groundwater recharge.	No	California Water Service - San Francisco Water Department (formerly used groundwater until 1975; 6-7 wells were abandoned); San Mateo High School (small water system) - groundwater pumped for pool
San Mateo County 1986	Water Supply p. 10.1P	Goals and Objectives – 10.2 Safeguarding Water Supplies: See to safeguard to productive capacity of groundwater aquifers and storage reservoirs.	Yes	San Francisco Water Department

APPENDIX G

Guidelines for the Identification, Location, and Evaluation of Deep Well Conduits

San Francisco Regional Water Quality Control Board 1986 Staff Memo prepared by Tom Berkins

Identification, Location, and Evaluation of Public Water Supply Wells, Private Wells, Agricultural Wells, Abandoned wells, and Potential Well Conduits

PURPOSE

The purpose of this guideline is to provide information to guide responsible parties to fuel leak, solvent, toxics, and other groundwater contamination sites, and owners of sites with potentially contaminating activities in the identification, location, and evaluation of Public Water Supply Wells, Private Wells, Agricultural Wells, Abandoned wells, and Potential Well Conduits. Water wells in Santa Clara County are susceptible to contamination from a variety of contaminant sources. In addition these wells and improperly destroyed and abandoned wells can serve as for contamination to migrate from shallow aquifers to deep aquifers. These guidelines are based on the scope of investigations and history of contaminant migration at a variety of Superfund, solvent, and fuel leak sites in Santa Clara County. The basis of these guidelines is from the "Berkins Memo", dated July 3, 1986 San Francisco Regional Water Quality Control Boards Memorandum.

INTRODUCTION

Since 1980 groundwater investigations have been required for over 3000 spills and releases of industrial solvents, fuels, and other chemicals in Santa Clara County. Contamination associated with these sites has been detected in over large portions of the shallow aquifer (first encountered groundwater) and in a number of deep (C aquifer or deeper) monitoring and water supply wells to depths exceeding 500 feet. The contamination of the deep aquifer in many instances migrated through improperly abandoned wells and water wells screened across several water bearing units located within the shallow aquifer contamination plumes. It is important to note that contaminants from the shallow aquifer zones (less than 100 feet) can reach deeper aquifer zones (greater than 200 feet) even though there may be a relatively clean aquifer zone and a substantial aquitard in existence between the shallow and deeper aquifers.

The importance of a properly conducted well survey cannot be overly stressed. Extensive investigation of water wells and potential conduits within a minimum of 2000 feet around a groundwater contamination site shall be required. It is important to note that the Santa Clara Valley Water District does not have records of all wells and these records cannot be solely relied upon.

The scope of the investigation to be conducted at each site will depend on the extent of contamination (known and unknown), available information, and the degree of uncertainty.

DISCUSSION ON WELL STANDARDS AND HISTORICAL PRACTICES FOR THE CONSTRUCTION AND DESTRUCTION OF WELLS

The first well standards in California were adopted in 1968. It is important to note that this was a recommended standard and was not required. It is reasonable to conclude that the majority of municipal and domestic water wells installed prior to the promulgation of the well standards are not documented and may not be properly constructed with adequate seals. Wells destroyed prior to 1968 were likely not properly destroyed.

The District through its Ordinance 90-1 administers both the state well standard and the District's well standard designed to deal with specific problems encountered in the Santa Clara Valley.

GUIDELINES FOR CONDUCTING WELL SURVEY

The following steps outline the minimum level of effort that should be considered for a well and potential conduit survey within a 2000 foot radius of a groundwater contamination site.

I. IDENTIFICATION OF WELLS

A. Records of Map Search

Typically, sites located in the Santa Clara Valley have relied solely upon the records of the District to obtain information regarding the location and status of any known wells in the vicinity of a site. However, the District records are incomplete. Thus, the first step of the potential conduit investigation should involve a more thorough search of all available records and maps. The following sources of information should be utilized to gather all available data existing on potential conduits:

1. Santa Clara Valley Water District
 - a. Active well printout
 - b. Well location map
 - c. Inactive well files
 - d. Destroyed well files
 - e. Abandoned well files
 - f. Field canvas for Salt Water Intrusion Prevention Program
2. U.S. Geological Survey
 - a. Library
 - b. Water Resources Division
3. California Department of Water Resources
4. "Groundwater in the Santa Clara Valley, California"—William O. Clark, 1924
5. Local Well Drillers
6. U.S. Department of Agriculture
7. U.S. Army Corps of Engineers
8. City and County Offices
9. Historic Sanborn Insurance Maps

The information obtained from the various sources listed above should be compiled in a technical report. It would be useful to summarize the results of the records and map search in a table, including the following information:

- Well number
- Source of information
- Water quality data
- Water level data
- Total depth
- Screened interval(s)
- Gravel pack interval(s)
- Sanitary seal
- Well construction method(s)

- Date installed
- Top of casing elevation
- Pump information (type, capacity, depth, etc.)
- Log availability (driller's, lithologic, geophysical, and TV)
- Owner
- Status
- Condition
- Comments
- Period of usage
- Pumping rate
- Accessibility
- Location
- Casing (type, diameter(s), etc.)
- Date destroyed, if applicable
- Use (domestic, irrigation, etc.)

It would also be useful to list the wells by status, for example:

- a. Wells officially listed as properly destroyed under a District permit
- b. Active wells, including seasonal or standby wells
- c. Inactive wells
- d. Abandoned wells, location known but method of abandonment unknown
- e. Abandoned wells, location unknown and method of abandonment unknown

B. Aerial Photography Search

Upon completion of the records and map search, a thorough search and review of historical aerial photographs should be conducted. Analysis of aerial photos has proven useful in identifying wells which were previously unknown (i.e., not found in the records or map search). The aerial photo search has also been shown to be useful in locating wells for which records were available but the well location was uncertain. Conducting the aerial photo search after the records search will enable one to better locate wells for which records exist but the location is uncertain. I recommend that all sites conducting the records and map search should also conduct the aerial photo review. The time and effort to be spent in this regard should be determined on a case-by-case basis.

Historical aerial photos should be obtained dating back to the period prior to residential and industrial development at the site. It is also important to obtain aerial photos taken intermittently over time (e.g., 1940, 1945, 1950, 1955, etc.). It would also be preferable to obtain aerial photos taken over a shorter time period during the period of residential growth in the area. Aerial photos with the smallest scale (i.e., greatest resolution) are obviously of much more use than larger scale photos. Oblique photos are very useful since they are usually taken from lower altitudes and, therefore, are in more detail for identifying wells, storage tanks, etc.

The following is a list of sources where aerial photos can be obtained or reviewed:

1. Local aerial surveyors (Aero-Geodetic and Pacific Aerial Surveys)
2. City and County Planning Departments
3. University's library, map room
 - a. U.C. Berkeley and U.C. Santa Cruz
 - b. Stanford University
 - c. University of Santa Clara

- d. Whittier College, Geology Department, "Fairchild Collection"
- e. San Jose State
4. U.S. Geological Survey, Western Mapping Center, Menlo Park
5. U.S. Department of Agriculture, Agriculture Adjustment Administration photos (these may be available at the university libraries).
6. Santa Clara Valley Water District
7. National Archives
8. Soil Conservation Service
9. U.S. Army Corps of Engineers

In general, the aerial photos obtained from the local aerial surveyors and the city/county files will have a greater resolution. However, the university libraries will have a larger collection and will probably cover a greater time period (i.e., photos prior to 1960). It should be understood that it may not be necessary to contact each of the above sources if adequate photo coverage (time period and resolution) can be obtained from one or two sources.

II. LOCATING AND GATHERING ADDITIONAL INFORMATION ON WELLS

A. Door-to-Door and Field Survey

It is likely that a majority of the information requested as part of the records and map search will not be available. In addition, it is also likely that the exact location of some wells will not be known. Thus, it probably will be necessary to conduct a more thorough investigation to determine the exact location of a well and also to gather additional data. A field survey and door-to-door survey are the only methods available to obtain this information. It should also be noted that door-to-door surveys have proven most useful in identifying wells which were not previously known to exist.

At a minimum, I recommend that a door-to-door survey be conducted of all residences, businesses, etc., located within the contamination plume (in all aquifers). It would also be prudent to expand the survey boundary (perhaps 1,000 feet cross-gradient and 2,500 feet downgradient of the known plume) to account for uncertainties associated with historical gradients and unknown extent of the plume.

The person conducting the survey should attempt to gather all the information requested as part of the records and map search (see page 2). It may be useful to develop a form which could be given to each household/business, listing all the requested information. The survey form used in the City of Mountain View is attached for your reference. I recommend that all the information requested as part of the records and map search be included on the survey form. I also recommend taking a picture(s) of the well and/or well site when conducting the survey.

B. Metal Detector/Magnetometer

Based on the results of the door-to-door survey and aerial photo search, it may be possible to identify the general location of a well. In certain cases, the use of a metal detector may prove useful in locating wells which are covered over. The use of a metal detector was instrumental in locating improperly abandoned agricultural wells located under a concrete parking garage in Mountain View. An attempt should be made to uncover any well identified by the metal detector to the extent technically feasible.

The results of the door-to-door survey, including copies of any survey forms, should be documented in a technical report. A map showing the known and/or general location of all identified wells should also be provided.

III. EVALUATION OF POTENTIAL CONDUITS

Based on the results of the well identification and location program, it may then be appropriate to conduct an evaluation to determine a well's potential to act as a conduit. All wells located during the field survey that are found to be in a condition that is adequate for sampling and downhole inspection should be investigated. An attempt should be made to uncover any wells if the general location is known. An attempt should also be made to unplug wells (e.g., remove silt and/or surface concrete plugs which may be present) in order to conduct a proper investigation. Wells which have a potential to be a conduit should be investigated. It may be appropriate to conduct the following investigations on such wells:

- A. Borehole television inspection
- B. Natural gamma log
- C. Water quality and water level sampling

As part of the water quality sampling, the discharger may also want to consider time series sampling. It may also be appropriate to conduct "packer tests" for wells which are screened in more than one aquifer. Pumps which may be present in the wells should be removed to obtain access to the well for depth sounding, geophysical logging, TV inspection, water quality sampling, and water level measurement, as appropriate.

Based on the results of the potential conduit evaluation, it may be necessary to destroy certain wells. If the results of the evaluation indicate that a well is screened in a single discrete aquifer and is not contaminated, it may be useful to utilize that well for future monitoring purposes. General criteria which may be used to decide whether to destroy a well include:

- A. The well is located within the known contamination plume
- B. Groundwater at the well is contaminated
- C. The well is screened and/or gravel packed in more than one aquifer
- D. Well depth

Similar to the identification and location portions of the potential conduit investigation, the results of the evaluation of potential conduits should be submitted in a technical report. The report should include all data, maps, logs, interpretation of logs, etc. In addition, the rationale for excluding any wells from a complete investigation and evaluation should also be provided.

APPENDIX H

An Evaluation of Solvent Leaks Associated with the City of Sunnyvale Sewer System

H.1 City of Sunnyvale Sewer System

The city of Sunnyvale lies in northern Santa Clara County, in the medial and distal portions of the Stevens Creek fan, and in the Basin interior. The city obtains 90 percent of its water from treated surface-water sources; 10 percent is supplied by groundwater. Depth to groundwater ranges from greater than 100 feet at the southern edge of the city to 15 feet at the Central Expressway. Figure 28 presents geographic and groundwater features of the city of Sunnyvale. North of the Central Expressway, groundwater is less than 15 feet below ground at most locations. North of the rail line, many wells penetrating the lower aquifer are artesian, and north of the Central Expressway, nearly all wells penetrating the lower zone are artesian.

In an analysis of shallow groundwater sensitivity to surface contamination conducted by the Santa Clara Valley Water District using EPA's "DRASTIC" methodology, Sunnyvale's aquifers ranged from "low" sensitivity to "medium high," with the less-vulnerable zones lying in the southern half of Sunnyvale, and the more vulnerable zones lying in the shallow groundwater zone in the northern half of the city (Pierno, 1999).

The Sunnyvale sewer system is primarily a residential sanitary sewer system, but also includes five commercial lines serving commercial and industrial facilities. A majority of the sewer system is fewer than 50 years old. Construction details usable in ascertaining the physical potential for exfiltration were not obtained for this evaluation. In the shallow groundwater zone, infiltration is known to occur to a limited extent.

Sunnyvale is home to a large number of high-tech industries, including manufacturers of computer chips, printed circuit boards, and related products. There are also several chemical companies and metal-plating shops in Sunnyvale. To ensure safety from fire and explosion, these industries were required to store solvents in underground tanks. Solvent tanks leaked to soil and groundwater at many installations, resulting in a substantial number of releases in Sunnyvale. The S.F. Regional Board's database of Spills, Leaks, Investigation, and Cleanup (SLICs) lists 119 cases in Sunnyvale as of 2001. The high incidence of solvent use and spills in Sunnyvale suggests an increased potential for past illegal or unregulated discharge to sewers.

Sunnyvale's Industrial Pretreatment Program. The former manager of Sunnyvale's pretreatment program, Rosanna Lacarra, was interviewed in June 2000 to learn the extent to which illegal discharges are now or have previously been a problem. Through this discussion, the following aspects of Sunnyvale's program and the dry-cleaner issue were explained.

- All dry cleaners in Sunnyvale are required to be zero discharge. These facilities are self-contained. In the past, there were three ways that solvent waste was generated from dry cleaners: from condensate (water and perchloroethene vapor condensate collected in a bucket and often dumped to sinks and drains), from exchanging the perchloroethene in the system, and from exchanging the solids accumulated on filters. All of these wastes were presumably manifested and disposed of appropriately, as verified by Sunnyvale's pretreatment program. In the 1970s and earlier, direct discharge of dry-cleaner wastes to the sewer was legal and commonplace.
- Not all dry cleaners in Sunnyvale perform the dry-cleaning process on-site; several dry cleaners take the work to another location outside of Sunnyvale.
- There are no centralized dry cleaners, such as large industrial uniform cleaning facilities, in Sunnyvale, nor do staff members recall any in the past.
- In 1992 and 1993, Sunnyvale's pretreatment inspectors conducted an intensive review of dry cleaners' activities, beyond routine inspections, and concluded that all were in compliance and

none were discharging. One facility had installed a pilot treatment system to handle condensate rather than changing out equipment so it could become self-contained. Inspectors verified that the system worked properly.

- Today, the city's Industrial Pretreatment Program inspects significant industrial users annually, and requires a Solvents Management Plan for facilities using solvents on-site. City pretreatment staff experienced with these facilities contend that significant industrial users are unlikely to be the source of the influent concentrations of solvents (Gallo, 2000).

Lacarra made the city's Industrial Pretreatment Program reports available for review. From a brief review of the reports and further discussion with Lacarra, the following features of Sunnyvale's program history are evident.

- Sunnyvale has aggressively pursued industrial discharge to the sewer system for as long as staff there can recall (all joined the city after 1990). The following examples obtained from reports confirm a history of proactive enforcement.
- In 1985, six industries were referred to the city attorney for prosecution; court action on one case resulted in a 10-day jail term.
- In 1986, the Sunnyvale Pretreatment Program led an interagency committee managing groundwater treatment issues and developing criteria to permit discharge from groundwater treatment systems, aquifer pump tests, etc.
- In 1987, routine sampling efforts produced 1,307 samples.
- In 1987, of 71 industrial dischargers, 57 achieved consistent compliance, seven were found to be in violation of federal regulations, two were referred to the city attorney, legal action was pending on four, and monetary penalties were assessed on one.
- In the 1986-87 fiscal year, \$393,211 was budgeted for the pretreatment program, including 13,542 inspector hours. In 1987-88, \$412,000 was budgeted.
- Sunnyvale does not routinely sample and analyze for VOCs in trunk lines and laterals. VOCs are sampled and analyzed quarterly on influent. This is because the VOC concentrations on influent are well below the local limit for total toxic organics established for its facility. VOC concentrations have typically ranged from non-detect at reporting limits of five parts per billion (ppb) or less to approximately 10 ppb, while the local limit is one part per million (i.e., 1,000 ppb). Sunnyvale does routinely sample trunk lines and laterals for metals, which in the South Bay present a greater permit-compliance challenge.
- Sunnyvale has an Incident Response Plan in place, and staff is trained to implement this plan. Because the Sunnyvale Water Pollution Control Plant is staffed 24 hours a day, seven days a week, any large release of solvents bearing a distinct odor would alert operators, and the Incident Response Plan would be implemented. Inspectors would work their way up trunk lines and laterals sampling manholes with GasTechs and PIDs to locate the source.
- Sunnyvale has had ample capacity, and aggressive identification of infiltration and inflow problems has not been a priority. Plans are nevertheless being made to assess the magnitude of these problems in light of increased daily flows. A rough estimate of infiltration is considered to be 3 to 5 percent of daily flow, which today may mean up to 900,000 gallons per day. At the Sunnyvale landfill, adjacent to the Water Pollution Control Plant, significant infiltration into the main trunk line creates a sufficient cone of depression to capture groundwater from beneath the 90-acre landfill.
- The Sunnyvale sewer system is considerably newer than San Jose's, due to the relatively recent boom in development Sunnyvale experienced in the 1960s and 1970s. There have been relatively few structural problems with the system.

H.2 Implications of Influent Concentrations

A cursory review of current and past data for HVOCs detected on influent sewage was performed. Data from a few years was reviewed to get a general sense of the extent to which these parameters are monitored. HVOC concentrations on influent were reviewed on a few reports, and their implications were discussed with Lacarra. Before embarking on a more comprehensive data collection and compilation effort, a framework must be developed for using the data and arriving at meaningful interpretations. In a somewhat random sampling, the following values provide a sense of the relative historical presence of solvents in the Sunnyvale sewer system.

**Table 1. Selected Historical HVOC Influent Concentrations
 At Sunnyvale Water Pollution Control Plant**

Year	Compound	Influent Conc.	Dry Season Flow, Million Gallons per Day	Mass and Volume per Day	Pounds per Year
1999	TCE, PCE, 1,1,1-TCA	all nd	18 mgd	-	-
1998	TCE	6 ug/l	17.4 mgd	0.87 lb; 0.27 l	317
1994	PCE	nd	~15 mgd	-	-
1986	TCE	17	11 mgd	1.5 lbs; 0.46 l	547 lbs/yr
	PCE	40		3.7 lb; 1.03 l	1,350 lbs/yr
	1,1,1-TCA	28		2.6 lb; 0.87 l	949 lbs/yr

Assumptions: Concentrations are for dry season flow; storm season flow does not increase mass discharged and can be ignored; mass of solvents arriving at POTW in vapor form or adsorbed to solids not accounted for; dry season daily flows are estimated.

There are at least three possible interpretations to the influent concentrations. These are:

- **Direct Discharge Scenario.** An illegal discharge of concentrated solvents is causing the resulting influent concentration.
- **Infiltration Scenario.** Sewer lines in the northern half of Sunnyvale are likely to be at or below the water table, allowing infiltration where loose joints, holes, or other avenues exist. There are numerous large solvent plumes in Sunnyvale. Where sewer lines in which infiltration occurs intercept these plumes, contaminated groundwater may be entering the system and contributing the solvents.
- **Background Scenario.** The influent concentrations may represent the sum of all discharges in the system. Instead of a single discharger illegally dumping a large quantity of solvent, many dischargers may contribute small amounts. Homeowners may be a source of solvent discharge, particularly in older homes equipped with garage sinks. Home auto-maintenance work, home dry cleaning, leather conditioning, stain removal, pesticide disposal, hobbyists, home auto and other specialty painting, and other sources of solvents may contribute a background level similar to that observed in 1998. Home-based service businesses for which equipment is maintained and cleaned in the home, such as painting, exterminating, and janitorial services may also be contributors of solvents to the sewer system. Conscientious homeowners wanting to properly dispose of household hazardous waste should follow container instructions before rinsing contents into home drains and discarding containers in the trash.

The city of Sunnyvale encourages its residents to dispose of their household hazardous waste properly through an intensive public outreach program and conducts monthly household hazardous waste collection events at a facility adjacent to the Sunnyvale Water Pollution Control Plant. The participation rate for Sunnyvale residents is currently about 5 percent, compared to a 3 percent countywide participation rate (Bowers, 2001). In 1999-2000, approximately 900,000 pounds of household hazardous waste was collected throughout Santa Clara County. Households tend to participate on an as-needed

basis, typically when moving, so a 3 percent participation rate does not imply that the balance of households are mishandling their hazardous waste. Nevertheless, some solvents may enter the sewer system through container rinsing, parts washing, and direct dumping.

Of these three scenarios, the largest quantities of solvents can be expected from the point-source scenario. This scenario is also the least likely threat today, due to the well-run permitting and inspection program implemented by the Sunnyvale Pretreatment Program. To the extent that point sources may have been a past issue, this scenario represents a possible continued threat to groundwater for the following reasons:

- Pure-phase solvent discharged to the sewer system is much denser than water; consequently, it sinks to the bottom of the sewer main, settling at sags or pooling at lift stations, and escaping at joints.
- It is likely that a few gallons of pure-phase solvent discharged to the sewer may escape notice by operators at the Water Pollution Control Plant because it would be retained in sags or escape through joints, so it would not arrive at the POTW headworks. Only a soluble fraction would be carried to the headworks. Because the city's National Pollutant Discharge Elimination System (NPDES) permit requirements call for only semi-annual influent monitoring for VOCs, a discharge event may escape notice if peak concentrations of soluble solvents are flushed out between sampling events.

The above interpretation of the possible threat to groundwater is entirely speculative; no direct evidence was encountered to substantiate these scenarios. To determine whether this speculation is reasonable, it would be useful to obtain several case histories from other POTWs in which documented pure-phase solvent releases have been observed to be retained in the sewer mains, and to find out what the corresponding dissolved phase concentrations were at the influent sampling point. The city of Davis experienced an apparent illegal discharge of dry cleaning solvent to the sewer system, which resulted in groundwater contamination. However, perchloroethylene was not detected in wastewater influent (Hanzo, 2001).

The infiltration scenario represents removal of solvents from groundwater. For at least one plume, the sewer system substitutes for an engineered remedial action. VOCs imparted to groundwater at the adjacent Sunnyvale Landfill by landfill gas and leachate are captured by groundwater infiltration into the sewer and headworks. Where sewer mains are entirely below the water table, substantial inflow at faulty joints can be expected. At least some of the numerous solvent plumes in Sunnyvale can also be expected to be intercepted or redirected by sewer mains. In areas of shallow groundwater (north of the Central Expressway), sewer mains may act to redirect plumes by conducting flow in the sand and gravel backfill.

The background scenario represents a continued potential source and threat to groundwater, and is also the most difficult to address. In addition to the city's aggressive Industrial Pretreatment Program, the city operates an active outreach program with a full-time public education specialist conducting programs throughout the year to increase public awareness about the need to restrict inappropriate wastes from the sewer.

Absent better evidence, all three sources can be assumed to play a role. The trend of decreasing concentrations of HVOCs in influent can probably be attributed to improved education, permitting, and enforcement, along with dilution, exfiltration, biodegradation, improved industrial practices, and awareness of the consequences of mishandling solvents.

APPENDIX I

Response to Comments on the December 2001 Stakeholder Draft Report

*“A Comprehensive Groundwater Protection Evaluation
for South San Francisco Bay Basins”*

In the spring of 2000 three stakeholder meetings were held in Fremont, San Jose, and Redwood City. The purpose of these meetings was to explain the ***South Bay Groundwater Protection Evaluation*** project to stakeholders and to gain feedback to help define its purpose and scope. In December 2001, a draft version of the report, titled “A Comprehensive Groundwater Protection Evaluation for the South San Francisco Bay Basins” was distributed to stakeholders for comment.

Following is a summary of stakeholder comments received prior to April 30, 2002 and the Groundwater Committee’s responses to those comments. Where report revisions were deemed appropriate based on the comments, the response indicates the section of the report that was revised and the exact revision(s) made.

1. Patrick Ferraro, Silicon Valley Pollution Prevention Center

Comment: Coyote Valley largest granular alluvium deposited on the bedrock in the Santa Clara Valley and has high capacity for infiltration. Therefore, groundwater protection must supercede any and all land use proposals. Recommends adding stronger language to address these concerns.

Response: We concur with Mr. Ferraro that sensitive groundwater areas warrant additional groundwater protection measures and that the Coyote Valley is a sensitive groundwater area. The following changes were made to the report:

- Added the following recommendation in Tables ES-3 and 20:

General Plan Implementation	Most cities do not take an active role in groundwater protection.	Cities should impose permit requirements for groundwater protection on development in sensitive groundwater areas.	The S.F. Regional Board, local groundwater management agencies, and local planners should work together to identify sensitive groundwater areas and appropriate groundwater protection strategies.
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- Revised the second recommendation in Section 7.4.4 to include local land use agencies, so the second bullet now reads:

DHS should provide the S.F. Regional Board, local groundwater management agencies, and local land use agencies with maps of well locations and delineated protection areas. Regulators, groundwater management agencies, and local land use agencies can then use the information to prioritize cleanup, pollution prevention, and monitoring needs.

- Added a recommendation in Section 7.6 that reads:

The S.F. Regional Board and local groundwater management agencies need to encourage local planners to take a more active role in groundwater protection. Specifically, land use agencies need to be encouraged to impose permit requirements related to groundwater protection for development in sensitive groundwater areas. Examples of permit requirements could be sealing of vertical conduits and restrictions on hazardous materials storage and use.

2. Waste Management, Inc.

Comment: Waste Management (WM) appreciates the opportunity to provide comments on the Draft Comprehensive Groundwater Protection Evaluation for South San Francisco Bay Basins (Report) prepared by the California Regional Water Quality Control Board - San Francisco Bay Region (RWQCB). The Report provides a detailed evaluation of the South Bay groundwater quality issues, and we found it to be very informative. A few minor comments for your consideration are highlighted below:

Section E.3 Project Methods:

“...and groundwater pollution sites (e.g. leaking underground fuels tanks, solvent plumes, and landfills).”

We have two comments regarding the above statement. The inclusion of “landfills” as “groundwater pollution sites” is a broad generalization that is not supported by the data. All “leaking underground fuel tanks” and all “solvent plumes” are pollution sites. Not all “landfills” are “groundwater pollution sites”. In fact, even landfills that are leaking may not be defined as “groundwater pollution sites” in every circumstance. We suggest that you modify the referenced statement to a) delete the reference to landfills per our comment below, or b) be specific in the use of terms and identify “leaking landfills” as “potential groundwater pollution sources”. (Please note that this comment also applies to “Section 1.4 Methods” on page 2, first paragraph, third sentence). Secondly, the statement appears to leave out other groundwater pollution sources presented elsewhere in the Report. Please consider including leaking sanitary sewer lines as part of the referenced statement.

Response: We agree. These sections have been extensively revised such that the above language has been removed.

Comment: Section E.4 Key Findings – Overall Groundwater Quality (second sentence):

“In contrast, there is significant and widespread pollution of the shallow aquifers from leaking fuel and solvent underground storage tanks and from landfills.”

The inclusion of landfills in this summary statement concerning the primary sources of widespread pollution does not appear to be justified. The remainder of the Executive Summary and the main body of the Report indicates that the primary sources of groundwater contamination are from leaking USTs, dry cleaners, saltwater intrusion, and sewer lines. Additionally, review of the SLIC Program list did not identify any landfills sites. In general, the regulations governing landfill operations (siting, construction, operation and monitoring, etc.) greatly reduce the potential for landfills to impact groundwater resources. Identification of landfills as a significant contributor to widespread contamination does not appear to be appropriate. (Note: Comment 2 also applies to Section 8.1 – Overall Groundwater Quality.)

Response: We agree. These sections have been revised (see below) to include all of the major threats indicated in the report. Additionally, landfills have been qualified as “leaking” landfills.

Groundwater quality varies throughout the South Bay Basins, but is generally of very high quality, particularly in deeper aquifer systems. In contrast, there is significant and widespread pollution of the shallow aquifers from a variety of sources, including leaking fuel and solvent tanks (underground and aboveground), historic dry cleaner facilities, leaking sewer lines, agricultural fertilizers, and leaking landfills. Cleanups at these sites are regulated by six different agencies. Investigations are complete, and cleanup is underway at the majority of regulated sites. A wide range of pollutants and /or polluting activities has the potential to degrade water quality in the South Bay Basins, with the major chemical threats being MTBE, solvents, nitrates and salinity (via saltwater intrusion).

Comment: Section 5.13 Municipal Landfills (first paragraph, first sentence):

There appears to be a conflict between the text and Figure 25 as to the number of active and closed landfills.

Response: Thank you. This error has been corrected in the text and in Figure 25. The correct numbers are 9 active landfills and 22 closed landfills.

Comment: Section 5.13 Municipal Landfills (first paragraph, fifth sentence):

This statement identifies landfills as possible sources of erosion and sedimentation damage to streams if surface water runoff is not managed properly. This statement applies to most, if not all, development projects. Since landfills proportionally represent a very small fraction of development projects, should other non-landfill development projects also be identified as possible sources in the Report? Typically, landfills receive more regulatory oversight than most non-landfill development projects and therefore, pose less of a threat to water quality associated to storm water related impacts.

Response: You are correct. However, the report focuses on sites and activities that generally pose chemical threats to groundwater quality. The statement about stormwater runoff potentially causing degradation of surface water bodies is incidental to the primary reason for the landfill discussion. It would not be appropriate to discuss other development projects since they are not typically considered threats to groundwater quality. Section 5.13, now section 5.8, does acknowledge regulatory permitting requirements, which exist precisely because landfills do pose a significant threat to water quality.

Comment: Section 5.13 Municipal Landfills (second paragraph, fourth sentence):

“Both sites are leaking and have installed groundwater collection trenches to intercept pollutants and protect downstream beneficial uses.”

This statement, in reference to the Guadalupe and Kirby Canyon Landfills, requires modification. Both landfills are canyon fills that have portions of their waste disposal areas underlain only by natural geologic materials. These “unlined” areas and were constructed in accordance with applicable regulations present at the time they were developed. Both landfills have groundwater barrier and collection systems for the “unlined” areas. Additionally, both landfills have constructed membrane lining systems since 1993, when Subtitle D and the associated state regulations were implemented.

A review of historic groundwater monitoring data at both sites indicates a historic episode of onsite impacts to groundwater associated with landfill operations, but never any offsite impacts to groundwater. In addition, the most recent analytical monitoring data from both facilities indicate that landfill operations are not impacting groundwater quality onsite nor offsite. The conclusion that both sites are leaking is based on dated information.

Response: You are correct. This section has been revised as follows:

None of the South Bay landfills is known to have contaminated drinking water wells. However, several have leaked and have been required to install groundwater or leachate extraction systems to control the leakage. For example, two active landfills (Guadalupe and Kirby Canyon), which are located upstream of recharge facilities in the Santa Clara Valley, have leaked in the past. As a result, both sites installed groundwater collection trenches to intercept pollutants and protect downstream beneficial uses. Neither site caused any off-site impacts. Current monitoring data indicates that the leaks have stopped.

Comment: Section 5.14 Protection Programs for Municipal Landfills (third paragraph, second sentence):

“Site-specific information and water quality data are not maintained in any database.”

The California Integrated Waste Management Board has recently initiated compilation of a Landfill Facility Compliance Study database.

Response: Thank you. This information has been added to section 5.14, which is now section 6.1.8.

Comment: Section 5.16 Aboveground Petroleum Storage Protection Programs (first paragraph, fourth sentence):

“The program applies to aboveground storage tanks with capacities greater than 10,000 gallons.”

This statement may need revision based on Section 25270.2 (k) of the Aboveground Petroleum Storage Act. We understand that the program applies to facilities storing "petroleum" in a single tank greater than 660 gallons or facilities storing "petroleum" in aboveground tanks or containers with a cumulative storage capacity of greater than 1,320 gallons.

Response: You are correct. Furthermore, the 660-gallon single tank requirement was eliminated when EPA's SPCC regulations were revised in July 2002. The statement in the report has been revised to read “The program applies to aboveground storage tanks or containers with a cumulative capacity greater than 1,320 gallons.”

3. Trish Mulvey, Santa Clara Basin Watershed Management Initiative/San Francisquito Watershed Council

Comment: Please provide a “lead agency” for all the recommendations (Tables ES3-5 and 20-22) or at least identify who will “call the first meeting” to get things started.

Response: In many cases a lead agency is implied under the “Implementation” column heading. The groundwater committee intends to follow up with several of the report recommendations. In doing so, lead agencies and first steps will be further identified as appropriate.

Comment: Where do I look for issues about possible [emerging] contaminants in imported water that is used for groundwater recharge? Where do I look for guidance about issues associated with [the] use of recycled water either specifically associated with indirect potable reuse via groundwater recharge or associated with incidental recharge where recycled water may be used for irrigation in an area of unconfined aquifers?

Response: The two sections below were added to the report:

5.17 Emerging Contaminants

Emerging contaminants, including N-nitrosodimethylamine (NDMA), endocrine disruptors, and pharmaceutically active compounds, may be present in sanitary wastewater, recycled water, imported water, and any other water source that receives sanitary wastewater. Emerging contaminants may pose a threat to groundwater quality when such waters are used for artificial recharge or otherwise intentionally infiltrated. Studies are underway around the world to better understand the occurrence, fate and transport, and health effects of emerging contaminants. SCVWD studies that are either underway or planned include analyzing imported surface water, local surface water, recycled water, and groundwater for emerging contaminants; evaluating the impact of artificial recharge on groundwater quality; studying the fate and transport of NDMA in recycled water; and evaluating potential impacts of streamflow augmentation with recycled water on groundwater quality and stream ecological health.

5.18 Emerging Contaminant Protection Programs

The SCVWD, in addition to performing the studies listed above, is developing a water quality standard for intentional infiltration with recycled water, imported water, local surface water, and storm water runoff. The SCVWD is also evaluating if and to what extent recycled water needs to be treated to meet groundwater protection concerns and users needs for different uses. The water quality standard and the treatment requirements evaluation will address emerging contaminants, as well as more traditional contaminants like salts and nitrate.

<p>Comment: The recommendations on page 56 are excellent to better understand the potential impacts of withdrawing groundwater adjacent to South Bay creeks....What are “next steps” and who will take the lead? Also, please capture the recommendations in the tables of recommendations (ES3-5 and 20-22).</p>
<p>Response: Please note, this section has been extensively revised. This topic will also be the focus of future groundwater committee discussions and the possible formation of a subcommittee workgroup. The recommendations have been included in Tables ES-3 & 4 and Tables 20 & 21.</p>
<p>Comment: On page 56 there is a reference to “A recent report prepared for the SWRCB recommended that the SWRCB work with other state, federal, and local governments and academic institutions to promote improved hydrological and biological data collection and research to improve the management of riparian rights (Moyle and Kondolff, 2000)”. Please include the citation in the references and include the recommendation in the tables of recommendations ES3-5 and 20-22. Also please suggest that this be incorporated in the next edition of the SWRCB Strategic Plan.</p>
<p>Response: Thank you. Please note, this section has been extensively revised. The citation has been added as follows:</p> <p>Moyle, Peter B. and G. Mathais Kandolf, 2000, Fish Bypass Flows for Coastal Watersheds: A Review of Proposed Approaches for the State Water Resources Control Board.</p>
<p>Comment: Please thank Jeff Kapellas and the other staff in your GIS-shop for the excellent graphics. Obviously the images took a lot of work, and they are very helpful.</p>
<p>Response: Thank you!! We will pass your comment on to Jeff!</p>

4. Jim Crowley, Santa Clara Valley Water District

<p>Comment: Sections of the report that address fuel leaks, MTBE, and active service stations should be updated to more properly reflect groundwater quality concerns. It may also be useful to include a map of active service stations in the study area and a list of references pertaining to the issue (page 74). A column could also be added to Table ES-1 summarizing protection measures on the issue.</p>			
<p>Response: Revisions have been made to the appropriate report sections to address these concerns.</p> <ul style="list-style-type: none"> The following language has been added to the Executive Summary and Table ES-4: <p>Operating Gasoline Stations. As part of a Pilot Program by the SF Regional Board and SCVWD, monitoring of active service stations was conducted. Preliminary results indicate that MtBE and other gasoline constituents are detected at up to 60% facilities. Furthermore, at over 40% of the facilities MtBE is present at concentrations significant enough to threaten groundwater. All active service stations should be required to perform environmental monitoring program.</p> <p>Evaluations of the effectiveness of leak detection and monitoring systems at gasoline Underground Storage Tank (UST) facilities indicate that MtBE and other gasoline constituents are detected at up to 60% facilities. The preliminary results of the operating station pilot study indicate that at over 40% of the facilities MtBE concentrations are present at concentrations significant enough to threaten groundwater. Direct environmental or groundwater monitoring is needed to properly detect releases (past and future) of gasoline and its constituents such as Methyl tert Butyl Ether (MtBE) that are not otherwise detected by the UST leak detection system. Releases that are not detected by existing UST system monitoring equipment will continue to pose a significant threat to groundwater supplies and drinking water wells. Several studies listed in the references section show that between 40 to 60 percent of facilities with upgraded or new UST systems have releases that go undetected by the UST monitoring equipment. When releases go undetected and impact groundwater quality, the contamination can, and has, migrated to nearby water supply wells (as was case of the MtBE impact to Great Oaks Water Company well Number 3 in Santa Clara County).</p>			
<p>Threat posed by Operating Gasoline Stations</p>	<p>Studies show that operating gasoline stations with UST's pose a threat to groundwater quality.</p>	<p>Environmental Monitoring should be conducted at operating gasoline stations.</p>	<p>The SF Regional Board should begin to require monitoring of operating gasoline stations not currently performing groundwater monitoring. Legislative action is needed to make this a statewide requirement.</p>

- The following revision has been made to Section 5.2:

Monitoring Active Service Stations. The S.F. Regional Board has instituted a pilot test with the SCVWD to perform environmental monitoring at operating service stations that are not currently in the LUST Cleanup Program. SCVWD investigations indicate that undetected MTBE releases are occurring at currently upgraded operating LUST facilities. The trend of undetected releases was found to be consistent across a larger spectrum of 50 sites. Previous studies and the preliminary results of the Pilot Program indicate that undetected MTBE releases from operating and upgraded LUST facilities are a greater threat to groundwater resources than earlier believed. Preliminary results from the pilot program based upon investigation at 30 active stations indicate that over 40% have concentrations significant enough to threaten groundwater quality such that additional investigation and cleanup are necessary.

- The following revision has been made to Section 6.3:

Active Gasoline Service Stations. Information on the location of active service stations with UST's is generally available and up to date. The Geotracker system incorporates data from all of the CUPA's and local agencies in one location accessible by the public. Studies are underway to identify the threats posed by the storage of gasoline at these facilities and which sites should be put into the LUST program. In addition, changes in leak prevention and monitoring requirements specify enhanced leak detection for UST's located within 1000 feet of public water supply wells.

- The following revision has been made to Section 8.2 and Table 21:

Monitoring Active Service Stations. As part of a Pilot Program by the SF Regional Board and SCVWD, monitoring of active service stations was conducted. The preliminary results of this study, together with other SCVWD studies, indicate that MtBE and other gasoline constituents are detected at up to 60% facilities. Furthermore, at over 40% of the facilities MtBE is present at concentrations significant enough to threaten groundwater. Direct environmental or groundwater monitoring is needed to properly detect releases (past and future) of gasoline and its constituents such as Methyl tert Butyl Ether (MtBE) that are not otherwise detected by the UST leak detection system. Releases that are not detected by existing UST system monitoring equipment will continue to pose a significant threat to groundwater supplies and drinking water wells. Several studies demonstrate that 40 to 60 percent of facilities with upgraded or new UST systems have releases that go undetected by the UST monitoring equipment. When releases go undetected and impact groundwater quality, the contamination can, and has, migrated to nearby water supply wells (as was case of the MtBE impact to Great Oaks Water Company well Number 3 in Santa Clara County).

Threat posed by Operating Gasoline Stations	Studies show that operating gasoline stations with UST's pose a threat to groundwater quality.	Environmental Monitoring should be conducted at operating gasoline stations.	The SF Regional Board should begin to require monitoring of operating gasoline stations not currently performing groundwater monitoring. Legislative action is needed to make this a statewide requirement.
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5. Libby Lucas, League of Women Voters

<p>Comment: The importance of groundwater protection and identification of vulnerable areas, especially in the Coyote Valley, should be highlighted.</p>			
<p>Response: We concur with Ms. Lucas and made the following changes to the report:</p> <ul style="list-style-type: none"> Added the following recommendation in Tables ES-3 and 20: 			
<p>General Plan Implementation</p>	<p>Most cities do not take an active role in groundwater protection.</p>	<p>Cities should impose permit requirements for groundwater protection on development in sensitive groundwater areas.</p>	<p>The S.F. Regional Board, local groundwater management agencies, and local planners should work together to identify sensitive groundwater areas and appropriate groundwater protection strategies.</p>
<ul style="list-style-type: none"> Revised the second recommendation in Section 7.4.4 to include local land use agencies, so the second bullet now reads: <p>DHS should provide the S.F. Regional Board, local groundwater management agencies, and local land use agencies with maps of well locations and delineated protection areas. Regulators, groundwater management agencies, and local land use agencies can then use the information to prioritize cleanup, pollution prevention, and monitoring needs.</p> <ul style="list-style-type: none"> Added a recommendation in Section 7.6 that reads: <p>The S.F. Regional Board and local groundwater management agencies need to encourage local planners to take a more active role in groundwater protection. Specifically, land use agencies need to be encouraged to impose permit requirements related to groundwater protection for development in sensitive groundwater areas. Examples of permit requirements could be sealing of vertical conduits and restrictions on hazardous materials storage and use. </p>			
<p>Comment: Ms. Lucas made a number of recommendations to add geologic maps.</p>			
<p>Response: We have added Tom Iwamura's Coyote Valley geologic cross-section schematic as Figure 8b in the report. We believe the other geologic references provided by Ms. Lucas are superceded by other references included in the report.</p>			

6. Richard McMurtry, Regional Water Quality Control Board, San Francisco Bay

<p>Comment: Is there any possibility in a future effort to look at groundwater management issues as they impact surface water stream ecological health? For example, in order to prevent exfiltration from certain segments of southern Coyote Creek that could result in high water table in adjacent lands, the entire creek is diverted. The groundwater “solution” has destroyed the creek.</p>
<p>Response: We concur that surface water – groundwater interactions warrant additional study and action. This topic will be the focus of future groundwater committee discussions and the possible formation of a committee workgroup.</p>

7. Laura Tom Bose, U.S. Environmental Protection Agency

<p>Comment: For a region where groundwater provides drinking water for almost one million people, this report is a long-needed compilation and analysis. Particularly, its recommendations for further action help direct limited resources to the highest priorities. It is an excellent model of what can be accomplished through regional coordination, for protection of source of drinking water.</p>
<p>Response: Thank you for the encouraging comments!!</p>

8. Elizabeth Janes, U.S. Environmental Protection Agency

Comment: EPA believes that overall, the study areas discussed in the report represent some of the most vulnerable and yet best protected ground water supplies in the west. To this end, EPA wants to support improvements to the good work that has already been done. We appreciate the critical evaluation of existing regulatory and non-regulatory programs as a basis for determining our future role.

On behalf of this office, I have specific questions/comments:

1. Regulation of stormwater disposal. Page 57 says that each individual stormwater drainage well is regulated. It is unclear to me if you are referring to local, state or federal authority.

EPA's authority is a Safe Drinking Water Act regulation applicable to the construction and use of injection wells (drywells, leachfields, and other subsurface conveyances) for stormwater disposal, which is currently being implemented on a very limited basis. But as urban stormwater permits may drive more construction of more injection wells, especially in ground water-reliant areas of the Central Valley, EPA is advising more care in this practice. EPA sees storm water injection wells as beneficial (recharge) and risky (vertical conduit.)

The report indicates that Regional Board 2 has a 1995 policy on stormwater disposal. Please send me a copy of that 1995 policy. After I review it, I will request a meeting with RB storm water staff to see if the draft EPA storm water injection guidance can better reflect the RB position. I am concerned that EPA will not receive inventory information from all the cities in California outside of RB2 if the federal guidance is too strict.

Response: We concur that the recharge of stormwater to soil and shallow groundwater provides both benefits to surface water quality and risks to groundwater quality. The Board's policy on recharge of stormwater is contained in the 1995 Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) on pages IV-53 thru IV-55. We have forwarded a copy of this policy to you. The report mentions actions taken by the Board to implement this policy, including directives in NPDES permits issued to stormwater management agencies. The policy envisions that all shallow drainage wells would be regulated by local enforcing agencies via their well-permitting process, with assistance from the Board and DWR. This regulatory structure is not yet in place throughout the region. We would be glad to meet with EPA staff to discuss the inter-relationship between the Board's policy and EPA's draft storm water injection guidance.

<p>Comment: Study of vertical conduit identification and closure. This topic could be eligible for federal support per the Local Agency Ground Water grant program, if there were a local agency (perhaps amongst your contributors) interested in devoting the resources to write the report. See guidance document issued 4/3/02.</p>
<p>Response: Thank you for the heads-up. We will pursue this avenue of funding with EPA staff and local groundwater agencies.</p>
<p>Comment: Cross-training of all jurisdictions on the identification of endangering practices/discharges. EPA agrees that there are some weaknesses inherent in the motley approach that California has to regulating waste and water issues, and that the Bay area could pilot improvements. Specifically, more efficient use of field inspectors, by cross-training CUPA, LOP staff on water issues (to look for conduits, storm drains, obvious leaks) and pretreatment staff together on the most mobile and/or toxic contaminants, may help spot more problems while they are still in soil. EPA WTR-9 would also consider this an eligible use of its local agency grant funds, if there is a group who would apply to organize and present such training.</p>
<p>Response: We concur that cross-training of staff from different state environmental regulatory programs would be beneficial. We will consider this topic when selecting future topics for our in-house training program.</p>
<p>Comment: Data Coordination: I am representing EPA on the Public Advisory Committee for AB599, which will be making recommendations to SWRCB/legislature on how to improve ground water data sharing statewide. I hope that that forum will shed more light on the value of data integration without sacrificing gains made by individual programs. If any members of the committee who have specific data concerns, or front line experience with the value and limitations of GeoTracker, TurboSWAP, or other programs, and would like to provide that feedback to me, it will help me be a better representative of the regulatory community.</p>
<p>Response: Thank you for the information. Your comment has been shared with committee members. As you know, Sarah Raker is the San Francisco RWQCB coordinator for the AB599 program and has been attending both the Interagency Task Force and Public Advisory Committee meetings. Results of the year-long effort will be presented to the legislature in Spring 2003.</p>

9. Stanford Linear Accelerator Center (SLAC)

Comment: "...we would like to present results of our geologic and hydrologic investigations conducted over the past 40 years at this facility and to provide you with our supporting data, conclusions, and recommendations to be considered when finalizing your document".

"You have recommended modifying the San Mateo Plain Boundaries (*Table ES-3. Recommendations Requiring Coordination Between Agencies*), and we strongly agree. In addition to your recommendations, we would like to make some suggestions regarding the area around SLAC in Menlo Park in southern San Mateo County (Figure 1) that would affect your *Figure 3 (Surficial Geology)*, *Figure 9 (Map of San Mateo Plain Groundwater Basin)*, and *Figure 26 (Interim Prioritization Approach for the South Bay Basins)*. Our documentation and recommendations are as follows".

Recommendations for South San Francisco Bay Document

Figure 3: Surficial Geology

We recommend changing your draft *Figure 3: Surficial Geology* to what is shown on the attached Figure 8. This recommendation is based on:

- the distribution of mapped bedrock units in the SLAC area (Figure 2),
- the low permeability of rock units at SLAC (Figures 3 and 4),
- the elevated TDS of the groundwater at SLAC (Figure 5), and
- the distribution of groundwater production wells in the SLAC area (Figures 6 and 7).

Figure 8 (a modified version of your *Figure 3*) more accurately represents the distribution of Santa Clara Formation in southern San Mateo County based on SLAC's available on-site data as shown on Figure 2.

Figure 9: San Mateo Plain Groundwater Basin

Based on the distribution of bedrock and the Santa Clara Formation shown on Figure 8 (the revised *Figure 3: Surficial Geology*), *Figure 9: San Mateo Plain Groundwater Basin* should be modified to exclude the eastern part of SLAC as shown on Figure 9. We also noticed an error on your map that shows I-280 offset at Alpine Road (see "freeway offset" on Figure 9).

Figure 26: Interim Prioritization Approach for Groundwater Protection

Finally, based on modifications shown on Figures 8 and 9, *Figure 26: Interim Prioritization Approach for Groundwater Protection* should be modified as shown on Figure 10. In San Mateo County, the definition of priority protection areas should reflect the geology and hydrogeology of the San Mateo Plain Groundwater Basin and surrounding bedrock regions. To define the appropriate priority protection areas, the boundaries of the groundwater basin need to accurately reflect the

current understanding of the geology and hydrogeology of the area

Defining the Boundaries of the San Mateo Plain Groundwater Basin

Our data suggest that the majority of the SLAC area, including the eastern end of SLAC, is outside the San Mateo Plain Groundwater Basin. The EP&R group has been working on the SLAC site for over ten years, and we have installed over 80 monitoring and extraction wells. Many of these wells have both geophysical logs and continuous cores that have been described in detail. We have integrated our hydrochemical and hydraulic data with the subsurface data and with the extensive geologic mapping of the SLAC site. With this wealth of information, we developed our own site-specific hydrogeologic model that could provide better information to define the basin boundary in the model portrayed in your document. Specifically, you show much of the eastern end of SLAC to be within the San Mateo Plain Groundwater Basin, and our data suggest that it is outside the basin boundary and is within the bedrock region.

You define groundwater basin boundaries in section 2.1 Groundwater Basin Boundaries:

Groundwater basin boundaries, from a groundwater flow perspective, are generally drawn along barriers to groundwater flow. Most of the South Bay Basin boundaries are artificial and have been established for convenience rather than along “no-flow” boundaries. The only true boundaries that meet this definition in the South Bay are those between alluvium and bedrock.

You have defined the San Mateo Plain Groundwater Basin boundary (as shown on your *Figure 9*) as the contact between the Santa Clara Formation and Tertiary bedrock, rather than the bedrock – alluvium contact in the area around SLAC (see your *Figure 3*). Your *Figure 3* generalizes and misrepresents the distribution of Santa Clara Formation in the SLAC area. Our hydrologic model includes data indicating that most of SLAC is underlain by bedrock with a few isolated, thin veneers of generally unsaturated Santa Clara Formation resting locally on the bedrock. In your description of the Santa Clara Formation in *Appendix B South Bay Geology*, you state:

The Santa Clara Formation is considered to be partly water bearing. The portion that outcrops above the edges of the valley is generally considered to be non-water-bearing.

We agree and recommend changing the boundary of the San Mateo Plain Groundwater Basin to be consistent with this statement. This is supported by:

- the geology and hydrostratigraphy of SLAC (particularly the distribution of the Santa Clara Formation)
- groundwater flow and hydraulic conductivity at SLAC
- the hydrochemistry of groundwater at SLAC
- distribution of off-site groundwater production wells

Much of the data and reasoning for our recommendation are presented in SLAC (2001).

Response: SLAC's recommendations for report revisions are well supported and appropriate. The figures referenced in SLAC's comments have been modified to reflect a more accurate representation of the groundwater basin boundary as recommended by SLAC.

Specifically, the basin boundary revisions apply to Figures 3 (*Surficial Geology*), Figure 9 (*San Mateo Plain Groundwater Basin*), and Figure 26 (*Interim Prioritization Approach for Groundwater Protection*). The San Mateo Plain Groundwater Basin boundary was drawn conservatively along the farthest reaching contact between unconsolidated terrestrial and alluvial sediments and outcropped bedrock, to maximize groundwater protection efforts.

In the vicinity of the SLAC facility, unconsolidated sediments of the Santa Clara Formation (gravel, sand, silt and clay) overlie portions of bedrock. These sediments typically form a thin veneer (< 10 feet thick) overlying bedrock. The hydrogeologic evidence provide by SLAC demonstrates that these sediments yield little if any water, and of poor quality, and are essentially isolated from the larger groundwater basin. Thus we agree that these areas warrant exception from the groundwater basin.

10. Jerry Jones, TYCO/Raychem - East Palo Alto Facility

Comment: Mr. Jones expressed concerned about the existence of “hyper-saline” wedges that occur in the shallow subsurface directly beneath salt evaporator ponds. Specifically, he would like to see this phenomenon discussed in the report in the sections that discuss water quality and saltwater intrusion near the South Bay margins. He would also like to see the phrase “hyper-saline” used to describe these areas, where salinity ranges from 30,000 to 100,000 ppm or 3 to 10%. Hyper-saline waters above good quality aquifers are a looming threat and can also serve as barriers to the flow of freshwater in the shallow subsurface. Mr. Jones believes that several vertical conduits may exist in the bay margin near these hyper-saline zones, such as the former Bear Valley Water Co. (or perhaps Spring Valley Water Co.) wells located along the fill area adjacent the Dumbarton Bridge.

Response: Section 5.5, fourth paragraph has been revised as follows:

There is no ongoing monitoring program in the San Mateo Plain and, therefore, there is minimal data on the extent of saltwater intrusion. A groundwater study conducted at the Raychem facility in Menlo Park, indicates that brackish (total dissolved solids > 10,000 mg/L) to hypersaline (total dissolved solids > 25,000 mg/L) conditions predominate in the shallow aquifers in the area of and immediately adjacent to salt evaporators. Hypersaline conditions can, locally, be found up to 1000 feet inland from the salt evaporators (Hydrofocus, 2002). Nevertheless, the conditions in the deep aquifers are, overall, unknown. Chloride:bromide and chloride:boron ratios for water samples collected from wells screened in the deep aquifers and located close to the bay in East Palo Alto show values substantially lower than those of sea water. However, there have been reports that saltwater from San Francisco Bay has migrated into deeper aquifers as a result of piles being driven into the subsurface for construction of the Dumbarton Bridge. Furthermore, a U.S. Geological Survey study in the Atherton area (Metzger and Fio, 1997), where over one hundred residential wells were installed during the 1987-1992 drought, found slightly saline groundwater near San Francisco Bay. However, these levels were not directly linked to over-pumping in Atherton.

References:

Metzger, L.F. and Fio J.L. (1997): Ground-Water Development and the Effects on Ground-Water Levels and Water Quality in the Town of Atherton, San Mateo County, California; U S. Geological Survey Water-Resources Investigations Report 97-4033.

Hydrofocus (2002): Groundwater Flow System Description and Proposed Flow Model Work Plan, Raychem/TYCO Electronics Site.

11. Mary Rose Cassa, Regional Water Quality Control Board, San Francisco Bay

Comment: The Association for Efficient Environmental Energy Systems, a non-profit organization, has a Geothermal Heating and Cooling Resource Center which provides information and training for all phases of geexchange heating and cooling systems (heat pumps), from plumbing and well installation to homeowner information. Typically a 200-foot bore hole (uncased) is required for installation. Commonly, four to 12 bore holes might be used for a residence, depending on its size. Horizontal installations are also used, but these require a fair amount of property. Clearly, one main concern is the potential for the 200-foot bore holes to serve as vertical conduits. They are grouted with bentonite, but concerns remain about the integrity of the seal. This type of bore hole may not be specifically considered in the vertical conduits section of the Groundwater Committee's report.

Response: The following language has been added to section 7.1 of the report:

Geexchange systems (also known as geothermal heat pumps or ground source heat pumps) are unique mechanical devices that conveniently heat and air condition buildings and heat domestic water at a lower cost. In the winter, a geexchange system collects the earth's natural heat through a configuration of closed pipes, called loops, installed below the surface of the ground or submersed in a pond or lake. Water circulating in the loop carries this heat to the home, where electrically-driven compressors and heat exchangers concentrate the earth's energy and release it inside the home at a higher temperature. In summer, the process is reversed to cool the home. Excess heat is drawn from the home, expelled to the loop, and absorbed by the earth.

Vertical loop systems consist of polyethylene loops up to 400 feet in length, which are placed in 4- to 6-inch bore holes where they act as heat exchangers. All vertical boreholes are grouted with bentonite. Vertical systems are the most common type of system installed on small town lots or in commercial applications. Commonly, four to twelve bore holes might be used for a residence, depending on its size. Horizontal systems are installed in trenches that are approximately 5.5 to 6 feet deep and require 15 to 20 percent more loop pipe because they are affected by the annual fluctuation of the earth's temperature. Other installation configurations include "slinky loops" and pond loops.

For vertical loop systems, the potential exists to penetrate one or more water-bearing zones that may be polluted. Care must be taken to ensure the pollution is not spread and that existing remediation systems are not adversely impacted. This includes ensuring separation is maintained between the pipe and the borehole wall during grouting.

12. Leah Walker, California Department of Health Services

<p>Comment: "...I take exception to the statement on page 54, that "<i>there is no mechanism in place to map the [DWSAP] information and enter it into a master database</i>". We have been working for years on our mapping program and database, and this fact is widely known. The information is not being shared at this time, due to security concerns. But it is our long-term goal to make this information available to other agencies. Thanks for your time."</p>
<p>Response: Thank you. Your comments are acknowledged and the document has been modified as follows (section 7.4.4, third paragraph):</p> <p>"A large amount of information will be collected as the DWSAPs are completed. Information will be collected on well locations (using GPS coordinates), PBEs, well construction, well operation, areas of contribution to individual wells, the presence of PCAs, and well vulnerability. This information will be accessible by reviewing individual assessments, but there is no mechanism in place at this time to make the maps and data available digitally outside of DHS due to security concerns. As a result, the usefulness to groundwater management agencies and regulators may be limited until the security concerns are addressed."</p> <p>Additionally, the recommendation for DHS to make this data available on the internet has been deleted from Table ES-3 and Table 20 because this data will be made available once security concerns are addressed.</p>

13. City of Mountain View, Public Works Department

<p>Comment: Requests that the reference to the Mountain View municipal well be removed from the report statement on page 40, section 7.1.2, fifth paragraph:</p> <p>“Notable examples of abandoned wells that have led to cross aquifer contamination are the IBM Superfund site (San Jose) and the Middlefield-Ellis-Whiseman Superfund site (Mountain View). Solvents released at these facilities contaminated municipal wells to a depth of 510 feet...”</p>
<p>Response: We concur and have revised the paragraph to read:</p> <p>Notable examples of abandoned wells that have led to cross-aquifer contamination are the Fairchild Superfund site (San Jose) and the Middlefield-Ellis-Whiseman Superfund site (Mountain View). Solvents released at the Fairchild facility contaminated a municipal well to a depth of nearly 275 feet. Solvents released at the Middlefield-Ellis-Whiseman site contaminated an agricultural well to a depth of 510 feet. Fate and transport studies have shown that the mechanism for the vertical movement of contaminants was through improperly abandoned wells. The best-documented information of the vertical movement of contaminants through wells in Santa Clara County is in Iwamura (1980).</p>

14. City of Santa Clara, Water Department

- Comment: 1) I do question some of the aspersions cast toward the operations of the sanitary sewer collection systems. The POTWs (Sunnyvale, Palo Alto and San Jose/Santa Clara) all have programs to monitor, inspect and regulate all commercial and industrial discharges to the collection system.
- 2) In section 7.2 (p. 44 – 47) several statements were made that seem speculative and without documentation of examples of actual problems. In fact, the second paragraph of section 7.2.5 states, **“this evaluation has not revealed clear-cut evidence of any large problem or imminent threat to groundwater quality specifically resulting from sewers.”**
- 3) In spite of this statement the report goes on to claim possibilities that a sewer line could “intercept solvent plumes” and, in effect, redistribute solvents through a combination of infiltration and ex-filtration. While theoretically possible, I think this is rather far fetched and of extremely low-risk. Even if such could occur, the dilution factors alone...would reduce any “solvent plume” by at least 4 to 6-log equivalent treatment. As for conduction along bedding materials, the same issue exists with all underground construction...It seems to me that this effect, if it exists, should be demonstrable in some of the local instances of shallow aquifer contamination.
- 4) ...I seriously doubt that any significant amounts of solvents are “pooled within the sewer system” since sewer collection systems are specifically designed to avoid accumulation of materials
- 5) ...We do have several inverted siphons...that would be prime candidates for further study...We would be glad to cooperate with any study...conducted by the RWQCB or SCVWD.
- 6) The recommendation (sections 7.2 and 8.3) to impose more stringent pre-treatment limits...may not be legally defensible. Groundwater protection was not considered by EPA and absent a change in the underlying regulations, could not be used as justification to set more stringent discharge limits.

Response: 1) You are correct. The POTWs (Sunnyvale, Palo Alto and San Jose/Santa Clara) do all have programs to monitor, inspect and regulate all commercial and industrial discharges to the collection system. However, the solvent discharges emphasized in our report are primarily historical, and occurred before many of the programs were initiated. Historical solvent discharges, particularly in pure form, may comprise a continuing threat to groundwater quality.

2) You are correct. Many of the statements in section 7.2 are indeed speculative. This section is intended to evaluate the potential for water quality threats from leaking sewer lines. We do not have substantial case data in the South Bay from which to draw specific examples. We do know of examples from Gilroy, Davis, Merced and Modesto where leaking sewer lines are identified as a probable source of solvent pollution to the groundwater, and are documented in the following reference:

Izzo, Victor J., 1992, Dry Cleaners – A Major Source of PCE in Groundwater, prepared by staff of the Central Valley Regional Water Quality Control Board

3) We agree that the significance of solvent plume “interception” and redistribution by sewer lines is probably much less than solvent exfiltration from sewer lines to groundwater, in terms of overall threats to water quality. Interception of plumes by sewer lines and transport of pollution along more permeable sewer-line backfill is an issue of horizontal conduits, which is not addressed in detail in this report. This section has been revised accordingly.

4) We disagree. We believe that a little pure-phase solvent can easily be pooled in small joints or cracks along sewer lines. Furthermore, it wouldn’t take much, perhaps as little as a quart, pooled in several locations along a few hundred feet of piping to cause significant pollution.

5) Thank you for your offer. We would be glad to work with you in the event a pilot project is initiated.

6) The recommendation in Section 7.2.5 was not intended to imply that pretreatment standards should necessarily be reduced. Rather, it was intended to emphasize the need for more evaluation of the potential for solvent impacts from leaking sewer lines. The wording of this recommendation has been clarified.

15. David Abbott, Todd Engineers

<p>Comment: Would like to see the “bed & banks” issue discussed in the report (e.g., when is water considered surface water vs. groundwater adjacent within alluvium where a stream exists).</p>
<p>Response: The following sub-sections have been added to section 7.5.1 Surface Water Diversion and Groundwater Withdrawal:</p> <p>Riparian Water Rights. The California Water Code (Section 1200) provides property owners with the right to divert water on their own property, including surface water and groundwater that is considered to be a subterranean stream flowing through a known and definite channel. All diverters of both surface and groundwater claiming water under riparian water rights are required to file a Statement of Water Diversion and Use with the SWRCB. Certain physical conditions must be present for groundwater to be subject to riparian rights: (1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel. All other groundwater is considered to be “percolating” groundwater and is not subject to riparian water rights permitting.</p> <p>In the past, the SWRCB has approved diversions from seasonal or perennial surface water bodies, and from groundwater adjacent to surface water bodies, but did not always have a full understanding of the biological and hydrological impacts of the diversions. A recent report prepared for the SWRCB (Moyle and Kondolf, 2000) recommended that the SWRCB work with other state, federal, and local agencies and academic institutions to promote better hydrological and biological data collection and research to improve the management of riparian rights.</p> <p>Riparian zones are commonly dependent upon both surface water and subsurface water. Specific impacts to riparian zones due to modifications in surface-subsurface water interaction include:</p> <ul style="list-style-type: none">• Reduced ability to provide aquatic habitat for invertebrates, fish and other wildlife• Reduced primary productivity, biodiversity, and reproductive success• Stress to riparian vegetation• Changes in nutrient and carbon cycling• Reduced ability to mitigate floods and erosion <p>Effective management of water resources requires an understanding of the role of site-specific riparian zones and their dependence on the interaction of groundwater and surface water. For example, change due to addition of water in summer, when no-flow is normal, results in introduction of shallow-rooted plants and trees that can dislodge during flood events.</p> <p>Wells in Alluvial Areas. One specific concern in the South Bay is the reduction in the availability of water to riparian zones, such as along San Francisquito Creek, due to surface water diversion and/or</p>

pumping of shallow groundwater from wells located along the creek banks. Throughout the study area, many wells were installed in alluvial areas during drought years. Since 1982, the San Mateo County Planning Department has required setbacks of wells from creeks and riparian corridors in the county's coastal zone. In areas where riparian vegetation is absent, new wells must be 50 feet away from the center line of a perennial creek or 30 feet from the center line of a seasonal creek. If there is riparian vegetation present in either a perennial or seasonal creek, the well setback distance is measured from the edge of the riparian vegetation. A similar setback requirement is also being considered for the San Francisquito Creek watershed.

SCVWD well standards require a minimum 50-foot sanitary seal on all water supply wells in Santa Clara County. However, the standards provide for a variance to the sanitary seal depth if (1) a water supply cannot be obtained from a deeper depth and (2) the Santa Clara County Environmental Health Department approves a shallower seal. According to the SCVWD, ecological criteria are not taken into account when wells are placed within streambed alluvium or when sanitary seal depth variances are approved.

The ACWD permits water supply wells within the vicinity of creeks and streams when the wells meet standard construction requirements. Because creeks and streams are considered potential sources of contamination, these requirements include: (1) a setback of 50 feet, (2) a location above known levels of flooding, and (3) a maximum seal depth. The Alameda County Health Department must certify water quality from the well prior to its use.