FINAL DRAFT

North Westside Groundwater Basin Management Plan

City and County of San Francisco

San Francisco
Public Utilities Commission

April 2005

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Executive Summary

As a complement to its local and Tuolumne River surface water systems that are the key components of municipal water supply, San Francisco also has local groundwater supplies. Management of its local groundwater resources, together with its surface water resources, will help to ensure the long-term sustainability of San Francisco's water supply. To specifically address the management of the largest of its groundwater resources, San Francisco has prepared this Groundwater Management Plan for the North Westside Groundwater Basin, that portion of the greater Westside Groundwater Basin that underlies the City and County of San Francisco (see Figure ES-1).

The North Westside Basin Groundwater Management Plan is comprised of a set of 13 interrelated elements that have been formulated to accomplish four management objectives, or goals, that have been established for the North Westside Groundwater Basin. Those overall objectives, or goals, for the Basin include: 1) development of local groundwater as a component of San Francisco Public Utilities Commission (SFPUC) water supplies; 2) avoidance of groundwater overdraft and associated undesirable effects such as seawater intrusion and depletion of local surface water resources; 3) protection of interrelated surface water resources, most notably Lake Merced; and 4) preservation of groundwater quality.

The North Westside Groundwater Basin underlies that portion of the Sunset District in San Francisco from Golden Gate Park to the San Francisco/San Mateo County line, and from the Pacific Ocean to inland bedrock exposures generally associated with Mount Sutro and Mount Davidson. The principal aquifers for water supply in the basin are the Colma and Merced Formations, which are shown in schematic cross-sections in Figure ES-2 (north-south) and ES-3 (east-west). Several thousand feet in total thickness, the Merced Formation has been developed for water supply in its upper and middle units which are on the order of 500 and 600 feet thick, respectively. The shallower Colma Formation is near the surface, and is not clearly distinguishable from the upper Merced Formation. Almost all groundwater development in the overall Westside Basin has been south of the North Westside Basin, in the northern part of San Mateo County, although there was some groundwater development in the Sunset District in the 1930s. In recent years, the substantial use of groundwater from the basin south of San Francisco has been for municipal supply in Daly City, South San Francisco and San Bruno (about 7,000 acre feet per year (afy)), and for golf course and cemetery irrigation (about 3,500 afy). Some of the latter irrigation pumping was reduced, beginning in 2004, when recycled water was made available as a substitute irrigation supply at three private golf courses near Lake Merced.
The most notable feature of the North Westside Groundwater Basin is the Lake Merced complex,

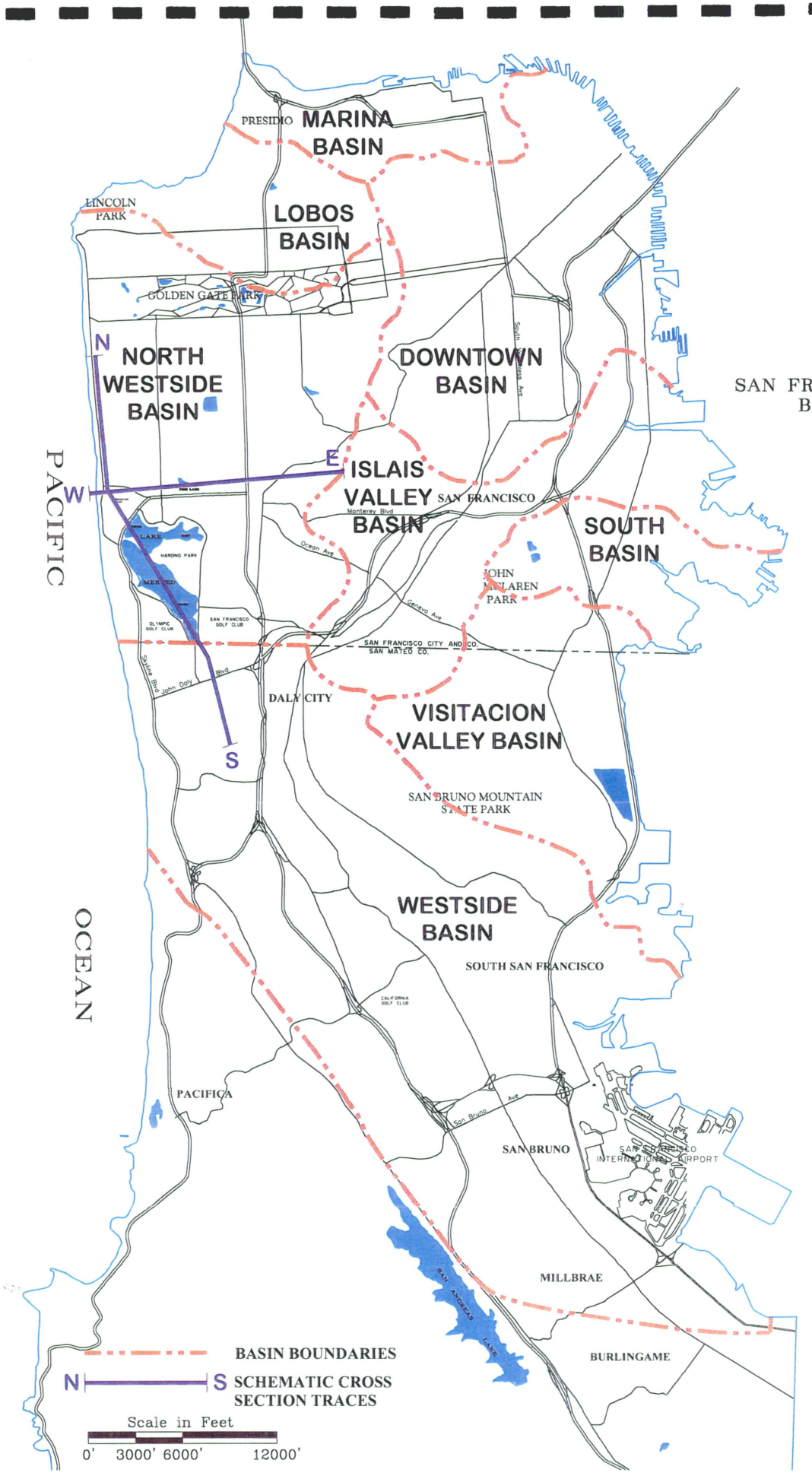

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Figure ES-1
Ground-Water Basins in San Francisco and Northern Peninsula
North Westside Ground-Water Basin Management Plan

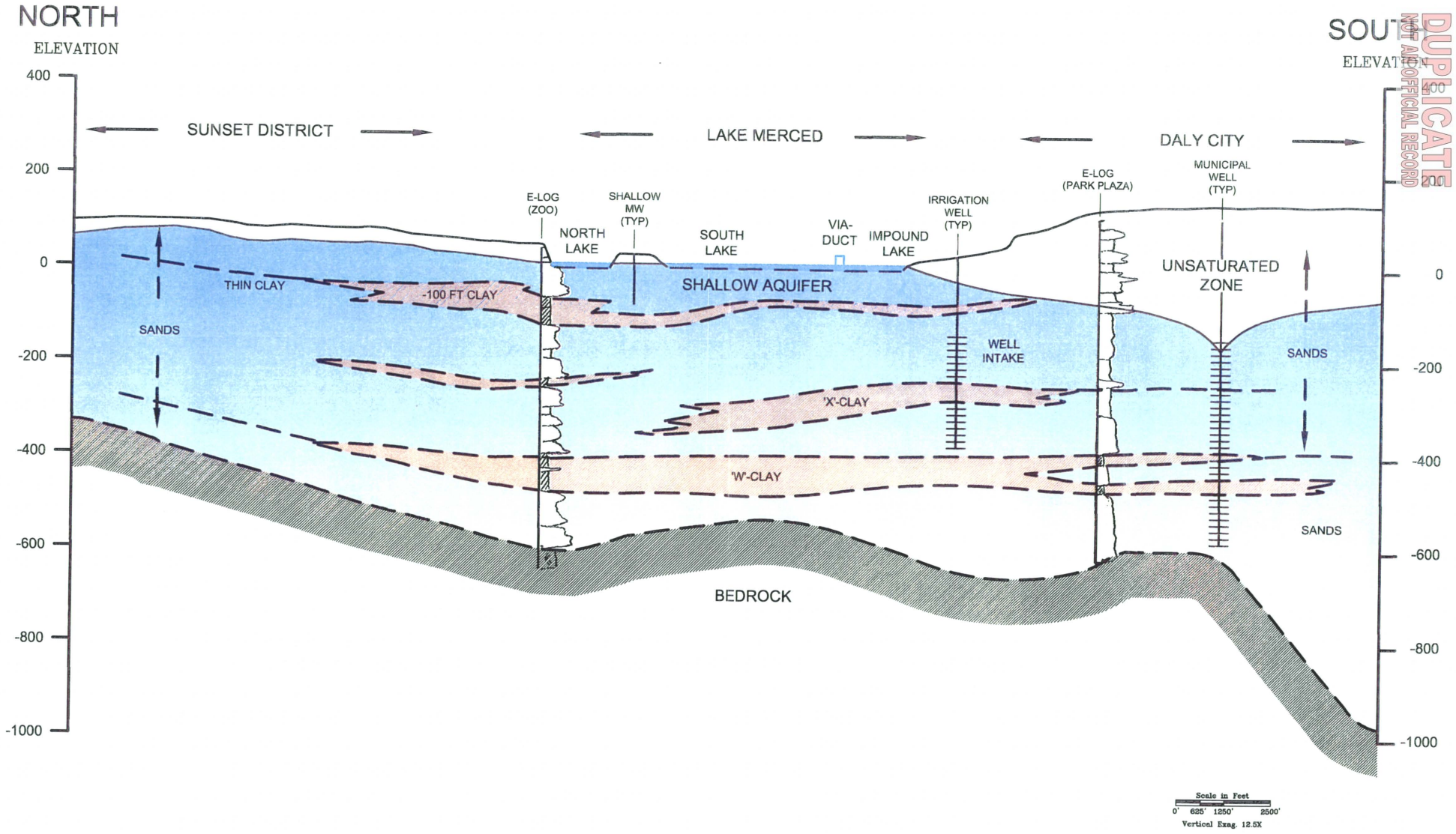

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Figure ES-2
Schematic North-South Cross Section
North Westside Groundwater Basin

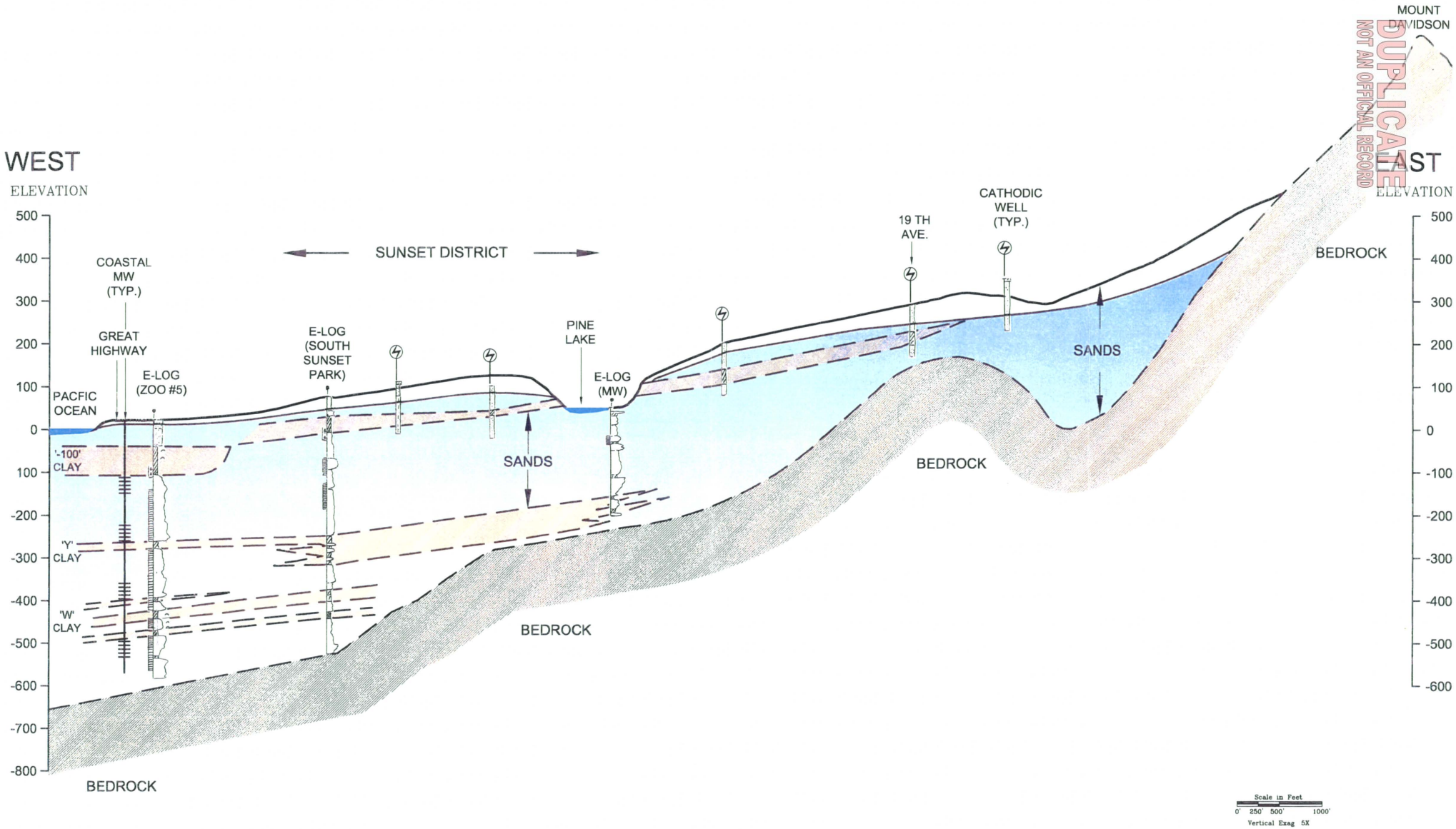

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Figure ES-3
Schematic East-West Cross Section
North Westside Groundwater Basin

a surface expression of the shallow aquifer system. Lake Merced is composed of four lakes: North Lake, East Lake, South Lake, and Impound Lake. Over the last century, Lake Merced has experienced notably significant fluctuations in its level as a result of diversions from the lake for water supply, use of the lake as a regulating reservoir as part of San Francisco's surface water system, and a combination of increased groundwater pumping and increased urbanization effects on the Lake's watershed and local groundwater recharge areas. To a substantial degree, depressed levels of Lake Merced in the last 20 years have been a driving force toward development of this Groundwater Management Plan for the North Westside Groundwater Basin, particularly as related to the objective of the Plan to preserve surface water resources such as Lake Merced.

Two notable concerns related to possible groundwater development in the North Westside Basin, both of which are addressed in this Plan, are potential seawater intrusion and potential adverse impacts on surface water features such as Lake Merced. Several other topics that might be classified as concerns have also been addressed, including: determination of the amount of groundwater being pumped from the basin, potential for additional groundwater development to augment the SFPUC surface water system supply and for emergency supply, interest in potential recycled water use in light of potential health-related and other impacts, needs for additional data on which to base assessments of groundwater conditions, and potential for conjunctive use of surface and groundwater to increase overall water availability, particularly during dry periods. All of these issues are expressly addressed in the management objectives for the basin and in the Plan elements to accomplish those objectives.

To accomplish the management objectives established for the Basin, the Groundwater Management Plan incorporates 13 elements which can be generally grouped into four types: monitoring of surface and groundwater conditions; groundwater exploration and development activities for local water supply; analysis and reporting on groundwater conditions; and other related management actions. In summary, the elements of the Plan are the following.

Plan Element 1 – Monitoring of Groundwater Levels, Quality, Production, and Subsidence – expansion of the existing monitoring of groundwater levels, quality and production to provide the basic data on which to assess the condition of the groundwater basin and to assess the impacts of groundwater production on groundwater levels, groundwater quality, subsidence and on surface waters.

Plan Element 2 – Monitoring and Management of Surface Water Resources – continued and possibly expanded monitoring of surface water levels and quality, most notably at Lake Merced,

to further the understanding of their interaction with groundwater.

Plan Element 3 – Determination of Basin Yield and Avoidance of Overdraft – determination of the yield of the basin on both a regular (average annual) and an intermittent (dry year or emergency) basis in order to accomplish one of the primary objectives for the basin: that it be operated within its yield and thus not be overdrafted, and that it be effectively sustained as an ongoing reliable water supply without depletion of groundwater storage or degradation of quality.

Plan Element 4 – Development of Groundwater to Augment SFPUC Municipal Water Supplies – exploration and development of groundwater for regular and dry period/emergency water supply, including possible development of water supply well sites in Golden Gate Park, in the Sunset District, near Stern Grove (Pine Lake), and in the vicinity of Lake Merced; currently identified potential well sites are listed and described in Appendix 3.

Plan Element 5 – Initiation of Conjunctive Use Operations – future pursuit of a conjunctive use program in the basin as a complement or extension of the conjunctive use activities that have been initiated on a demonstration basis since late 2002 in the southern part of the basin, in Daly City, South San Francisco and San Bruno, subject to agreement with these entities. A conjunctive use program would ideally take advantage of any vacated aquifer storage space by purposely recharging it with surplus surface water when it is available in wet years, thus allowing the stored water to be recaptured by pumping during dry periods when surface water supplies are decreased.

Plan Element 6 – Integration of Recycled Water – incorporation of recycled water as a component of non-potable water supply in the basin, initially for recently initiated golf course irrigation and subsequently for other non-potable uses, in order to reduce groundwater pumping for non-potable uses and thus provide increased groundwater availability for regular as well as dry-period/emergency water supply.

Plan Element 7 – Development and Continuation of Local, State and Federal Agency Relationships – development and continuation of relationships with local, state and federal agencies, primarily to continue cooperative efforts in the overall basin toward integrated data collection, initiation of conjunctive use, and development of supplemental water for augmentation of Lake Merced.

Plan Element 8 – Continuation of Public Education and Water Conservation Program – continuation of public education and water conservation programs, primarily to inform interested groups on technical and related details about surface and groundwater details, to solicit public input to lake management and conjunctive use planning, and to obtain community support for basin management actions. Development of the Groundwater Management Plan included significant public outreach and involvement efforts and included staff presentations, public workshops, email noticing, newspaper advertisements, web posting, and noticing in SFPUC newsletters.

Plan Element 9 – Identification and Management of Recharge Areas and Wellhead Protection Areas – identification and management of recharge and wellhead protection areas.

Plan Element 10 – Identification of Well Construction, Abandonment and Destruction Policies – continued implementation of well construction, abandonment, and destruction policies, pursuant to the San Francisco Well Ordinance.

Plan Element 11 – Identification and Mitigation of Soil and Groundwater Contamination – identification and mitigation of soil and groundwater contamination.

Plan Element 12 – Groundwater Management Reports – preparation of regular and ad-hoc reports to complement a number of technical reports that have been prepared over the last decade on groundwater in the Westside Basin and its interrelationship with Lake Merced.

Plan Element 13 – Provisions to Update the Groundwater Management Plan – provisions to update the Groundwater Management Plan, a recognition that the currently drafted Plan reflects the most updated understanding of the occurrence of groundwater in the basin, but that the Plan's elements could result in knowledge that suggests a change in currently planned management actions. This Plan is intended to be a flexible document which can be updated to modify its existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future groundwater and surface water conditions.

I. Introduction

This Groundwater Management Plan (Plan) is comprised of a number of planned actions related to groundwater supply and the long-term sustainability of groundwater and interrelated surface waters in the North Westside Groundwater Basin. The focus of the Plan is that portion of the overall Westside Groundwater Basin that lies beneath the City and County of San Francisco. However, recognizing that the overall basin extends well south of San Francisco, and further recognizing that there are ongoing cooperative management actions that extend beyond the San Francisco portion of the basin, this Plan has been crafted to recognize and continue to contribute to the integrated management of groundwater by the various pumpers and interested parties in the overall Westside Basin. Although this Plan specifically applies to the North Westside Basin, the objectives and elements of this Plan are consistent with ongoing efforts to manage the overall Westside Basin through the development of basin wide conjunctive use programs and related efforts to manage the Westside Basin in a sustainable fashion.

The San Francisco Public Utilities Commission (SFPUC) is responsible for providing a reliable, high quality, and affordable water supply for the City and County of San Francisco ("San Francisco" or "City"). As such, it is responsible for the operation of an integrated local Bay Area surface water supply system and a remote Tuolumne River surface water supply system (Hetch Hetchy and associated reservoirs) that are the primary components of water supply to San Francisco and a large network of wholesale customers that extend from Daly City, adjacent to San Francisco, south through the Peninsula to Santa Clara County, and up the southeast side of San Francisco Bay through Alameda County to Hayward. A number of the wholesale customers have also developed other water supplies, including local surface water and groundwater, and imported surface water from the State Water Project. Locally in San Francisco, the SFPUC is also responsible for the development and use of groundwater as a complement to the local and Tuolumne River surface water supplies. SFPUC must ensure that management of the North Westside Groundwater Basin is consistent with, and in furtherance of San Francisco's Urban Water Management Plan. It is also responsible for the treatment and discharge of storm water and wastewater within San Francisco, which represents a potential recycled water supply to meet selected nonpotable uses within the overall water demand in and near the City. A separate Recycled Water Plan is currently in development.

Early in its history, San Francisco made use of local groundwater, springs, and spring-fed surface water. By 1913, it was estimated that San Francisco was using approximately 8.5 million gallons per day (mgd) of groundwater from private and City wells, springs, and Lobos Creek, which is

fed by groundwater springs. Prior to the completion of the Calaveras Reservoir on Alameda Creek, part of the San Francisco water supply was from Lake Merced, which was significantly spring fed at the time. Lake Merced was substantially lowered by diversions in the 1920's and early 1930's, the latter as a result of diverting from the lake for emergency water supply during drought conditions from 1929 to 1932. In the 1930's, a well field was installed along 43rd and 44th Avenues, but groundwater was used from those wells for only a short period of time, from late 1930 through mid-1935. Pumping rates were reported to be approximately 5 mgd. After completion of the Hetch Hetchy reservoir and aqueduct in the 1930's, the municipal water supply system began to rely almost exclusively on surface water from local runoff, from the Alameda Creek watershed (into Calaveras Reservoir), and from Hetch Hetchy. While groundwater was once exported to San Francisco from the Pleasanton area, others now use all of that groundwater system, except for the SFPUC's continued supply of groundwater to Castlewood in Alameda County. Local groundwater utilization continues in the City itself. In the mid-1990's, groundwater utilization in the City was estimated to be about 4 mgd, mostly used by the City's Recreation and Park Department in Golden Gate Park, at the Zoo and by the Presidio, now managed by the National Park Service.

Lake Merced continues to be a source of emergency supply for San Francisco, although it has not been used for potable water supply in San Francisco since the 1930's. The potential for converting existing wells to potable water supply wells and for developing new municipal supply wells is addressed in this Plan, as are the ongoing efforts to develop monitoring wells, including a coastal monitoring well system, to evaluate whether new municipal wells are viable as regular supply and emergency water sources. If the implementation of this Plan results in a viable new potable emergency water supply for San Francisco, the likelihood of emergency potable use of Lake Merced water will become extremely remote. Supplemental water sources such as recycled water and storm water that are under consideration for maintaining Lake Merced water levels will be less likely to conflict with past SFPUC policy of preserving the possibility of potable use of water from Lake Merced during emergencies.

The principal use of groundwater in the Westside Groundwater Basin as a whole has been for municipal and irrigation water supply, primarily in northern San Mateo County. Groundwater has been a primary source of water supply to Daly City, South San Francisco (through its water service utility, California Water Service Company), and San Bruno for at least the last 50 years. Groundwater has also been the historical water supply for golf courses around Lake Merced and into San Mateo County, as it has also been for irrigation supply at the cemeteries in Colma. Issues and opportunities associated with groundwater pumping for municipal and irrigation

supply within the South Westside Groundwater Basin are discussed in this Groundwater Management Plan, to the extent relevant to the North Westside Groundwater Basin.

North Westside Groundwater Basin

The groundwater basin beneath the western part of San Francisco from the vicinity of Golden Gate Park, and extending southeasterly into San Mateo County beneath Daly City, Colma, South San Francisco, and San Bruno, is identified in California Department of Water Resources (DWR) Bulletin 118 as both the Merced Valley Basin and the Westside Basin (DWR, 2003). Since it is more commonly known as the Westside Basin, that designation is used in this Plan. The aquifer system that comprises the basin, and its associated relationship to surface water features, most notably Lake Merced, are described in detail in this Plan. Although it is recognized that the overall Westside Groundwater Basin extends beyond the County line, and that the aquifer system also extends beyond the coast line, the portion of the overall groundwater basin that is the focus of this Plan is within the City and County limits of San Francisco, and is called the North Westside Basin for purposes of this Plan. The extent of the Westside Groundwater Basin mapped in Bulletin 118 is illustrated on Figure 1-1. The political division at the San Francisco-San Mateo county line is also shown on Figure 1-1 to locate the southern boundary of the North Westside Basin. The North Westside Basin is about 14 square miles in area and the South Westside Basin is about 31 square miles in area.

The North Westside Groundwater Basin Plan includes an element comprised of relationships with other municipal and private pumpers that also overlie the Westside Groundwater Basin south of Lake Merced. The purpose of this element is to formalize the working relationship to cooperatively investigate issues such as seawater intrusion and lake-aquifer interconnection, and to cooperatively implement projects for conjunctive use of the Westside Groundwater Basin and lake level management at Lake Merced. These efforts will be the subject of a future program devised by the participating pumpers and the SFPUC. However, the elements of this Plan, although applicable to the North Westside Basin, are generally consistent with overall basin management objectives, including development of a future basin-wide conjunctive use program. The locations of the various entities that have historically developed groundwater from the overall basin are shown in Figure 1-2.

Overview of Water Requirements and Supplies

The SFPUC water supply system supplies all of the San Francisco municipal demand and about two-thirds of the total water demands of its wholesale customers. Current total water demand

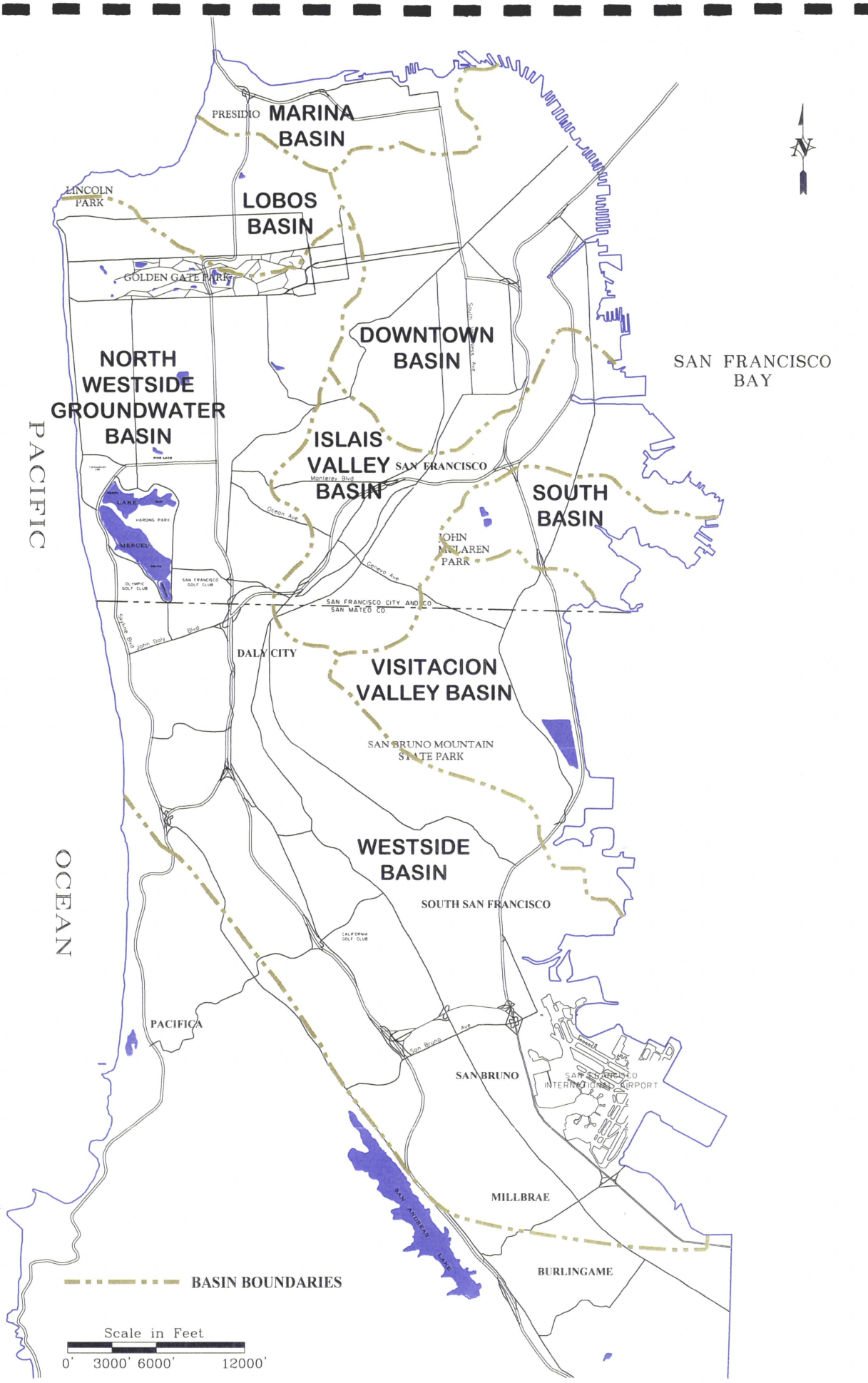

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Figure 1-1
Ground-Water Basins in San Francisco and Northern Peninsula
North Westside Ground-Water Basin Management Plan

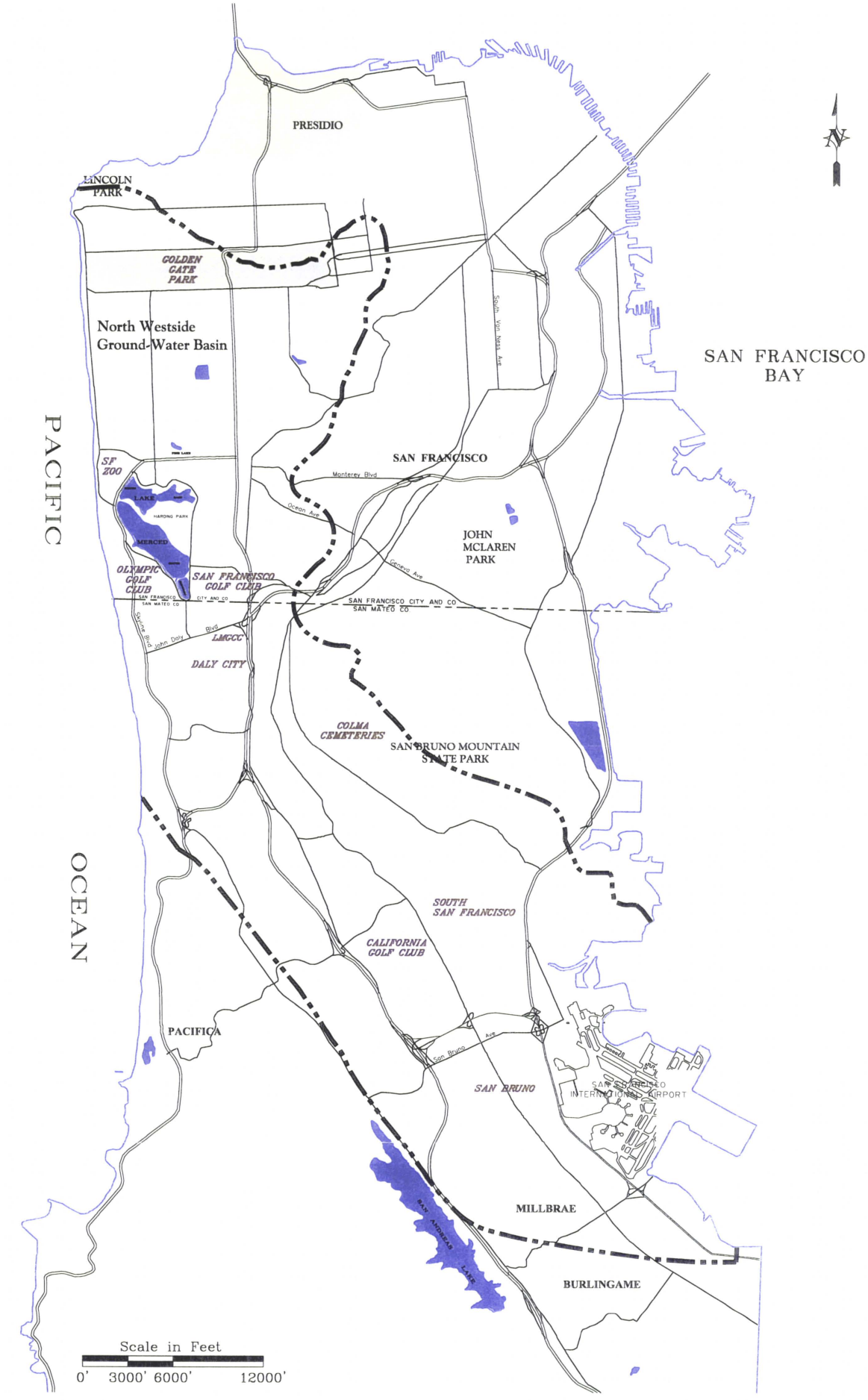

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Figure 1-2
Historical Pumpers in the Westside Ground-Water Basin
North Westside Ground-Water Basin Management Plan

(FY01-02) of retail customers in San Francisco is nearly 94 million gallons per day (mgd), or about 105,000 acre-feet per year (afy), which represents significant decreases in water demands from recent drought periods. The total water requirements of the Bay Area wholesale customers are about 255 mgd, or about 286,000 afy. Those total water demands are met by a combination of about 170 mgd from the San Francisco system (about 192,000 afy) and the balance from local surface water and groundwater, and from other supplies such as the State Water Project.

Water demands in San Francisco over the next 30 years (to 2030) are projected to range from about 103,000 to 104,700 afy (URS, 2004). Over the same time period, water demands of the wholesale customers are projected to increase more substantially, to about 363,000 afy. The projected water demands of San Francisco and its wholesale customers are planned to be met by a continued combination of predominately SFPUC system water (Hetch Hetchy and local Bay Area surface water) and other existing supplies (local surface water supplies of wholesale customers, local groundwater, imported supplies from the State Water Project, and recycled water).

Historical and projected water requirements and supplies of both San Francisco and SFPUC wholesale customers are discussed in more detail in Section IV of this Plan.

Legislation Related to Groundwater Management Plans

The Legislature enacted legislation in 1992 (AB 3030) and 2002 (SB 1938), now incorporated in the Water Code Section 10753, *et seq.* to encourage local public agencies to adopt plans to manage groundwater resources within their jurisdictions. San Francisco will implement this North Westside Groundwater Basin Management Plan through the adoption of ordinances by its Board of Supervisors, and via rules and regulations adopted by the SFPUC, rather than as an "AB 3030 Plan". The Plan will first be subject to environmental review by the SFPUC.

SB 1938 provided that adoption of a groundwater management plan, whether in the form of an "AB 3030 Plan" or not, will be a prerequisite to obtaining funding assistance for groundwater projects or groundwater quality projects from funds administered by DWR. To comply with SB 1938, a groundwater management plan must include groundwater management components that address monitoring and management of water levels, groundwater quality degradation, inelastic land subsidence, and changes in surface flows and quality that either affect groundwater or are affected by groundwater pumping. There must be provisions to cooperatively work with other public (and presumably private) entities whose service area or boundary overlies the groundwater basin. Provisions must also be made to allow participation by interested parties in

development of the plan. The plan must include mapping of the groundwater basin, as defined in DWR's Bulletin 118, and the boundaries of the local agencies that overlie the basin. In this case, the Plan focuses on that portion of the Westside Basin (the North Westside Basin) which underlies the City and County of San Francisco and, as a result, San Francisco is the only "agency". Finally, to comply with SB 1938, monitoring protocols must be designed to detect changes in groundwater levels, groundwater quality, inelastic land subsidence (for basins where subsidence has been identified as a potential problem), and flow and quality of surface water that either directly affect groundwater, or are directly affected by groundwater pumping.

The potential components of groundwater management plans are listed in Water Code Section 10753:

- the control of saline water intrusion.
- identification and management of wellhead protection areas and recharge areas.
- regulation of the migration of contaminated groundwater.
- the administration of a well abandonment and well destruction program.
- mitigation of conditions of overdraft.
- replacement of groundwater extracted by water producers.
- monitoring of groundwater levels and storage.
- facilitating conjunctive use operations.
- identification of well construction policies.
- the construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- the development of relationships with state and federal regulatory agencies.
- the review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

Prior and Current Groundwater Management

Prior to the mid 1990s, there was no coordinated monitoring, management, or investigation of the overall Westside Basin. Concerns about declining lake levels in Lake Merced in the early 1990s resulted in the initiation of cooperative studies by the SFPUC, and the cities of Daly City, South San Francisco (through its water service utility, California Water Service Company) and San Bruno. A Groundwater Management Plan was prepared for the overall Westside Basin in 1999 (Bookman Edmonston, 1999). That plan was an outgrowth of early cooperative efforts to manage groundwater in the South Westside Basin. The Bookman-Edmonston plan followed guidelines set forth in California Water Code Section 10750 et seq. ("AB 3030"). The goals of the plan were to protect water quality and to enhance water supply reliability in the Westside

Basin. Five plan elements were developed for meeting management goals related to: groundwater storage and quality monitoring; saline water intrusion; conjunctive use; recycled water; and source water and wellhead protection.

The City-wide Groundwater Master Plan (1997 Master Plan) looked at all seven groundwater basins in San Francisco (Figure 1-1) and was finalized in 1997 (SFPUC, 1997), and the associated Environmental Impact Report was certified in 1997 (City and County of San Francisco, Department of City Planning, 1996). However, the 1997 Master Plan was not adopted by the SFPUC. City efforts on groundwater management since then have focused on the overall Westside Basin, largely due to public concern related to Lake Merced water levels. Indeed, the research investigation associated with Lake Merced, largely in response to a petition filed in January 2001, at the State Water Resources Control Board by California Trout, has resulted in useful data that will shape the overall groundwater program, both as proposed in this Plan and in conjunction with the municipal pumpers in the South Westside Basin.

This Plan represents a scaling back of the 1997 Master Plan in order to focus SFPUC resources on the North Westside Basin, which has the greatest potential benefit to San Francisco water supply needs. This Plan also includes the projects described in the 1997 Master Plan, the installation of production wells in the Sunset District, coupled with a monitoring program to ensure that the installation and operation of those wells will not cause seawater intrusion, further declines in water levels at Lake Merced and Pine Lake, or other significant environmental effects.

Of the potential groundwater management activities listed in Water Code Section 10753, those already being cooperatively investigated and implemented as part of less formal groundwater management by the various pumpers in the basin include:

- implementation of a conjunctive use pilot program.
- design and construction of recycled water facilities to provide water to replace groundwater pumping for non-potable, irrigation uses at the golf courses around Lake Merced.
- monitoring of groundwater levels and quality, including detailed monitoring of aquifer conditions around Lake Merced.
- analysis of basin yield for avoidance of overdraft while maintaining municipal water supply and potentially increasing emergency and dry year water supply
- analysis and reporting on basin conditions.

- continuing technical investigation to assess potential seawater intrusion and potential pumping impacts on surface water resources.
- installation of a network of dedicated coastal monitoring wells between Thornton Beach and Golden Gate Park.
- construction of test wells in the Sunset District to assess the potential yield of that portion of the North Westside Basin and to provide a design basis for new Sunset production wells described in the 1997 Master Plan.
- development of a conceptual model of the surface water and groundwater system.
- continued development of lake augmentation programs.
- development of a numerical groundwater flow model of the Westside Basin.

The primary focus of recent groundwater management activities in the Westside Basin has been on the issue of Lake Merced water levels, and the interconnection between the Lake and the underlying aquifer system from which both irrigation and municipal water supply pumping takes place. A parallel focus has been on potential seawater intrusion in light of significantly depressed groundwater levels in the South Westside Basin.

Corresponding to the assessment of depressed groundwater levels has been a recognition of a significant amount of vacated aquifer storage space, which represents an opportunity for purposeful conjunctive use to increase overall system (surface and groundwater) yield. As part of the ongoing management activities by the various pumpers, coordinated semi-annual measurements of groundwater conditions are integrated with a large amount of more frequent groundwater monitoring, and the results have been incorporated with all other available data into a computerized database for access in describing and assessing basin conditions, and for utilization in the current development of a numerical groundwater flow model of the basin, which will include the North Westside Basin.

The Groundwater Management Plan described herein discusses these ongoing management efforts, with a focus on the North Westside Basin and groundwater management issues particularly applicable to that area, because the SFPUC only has jurisdiction over this part of the Basin under the City's Charter. This Plan establishes a set of management objectives, or goals, that are potentially applicable to the Westside Basin as a whole, and which the SFPUC believes should be adopted for the North Westside Basin. Application of these objectives to areas outside San Francisco is subject to future negotiation and agreement with the affected municipal and other pumpers through the ongoing development of a regional conjunctive use program. The SFPUC believes, after extensive consultation with the entities having jurisdiction over these

resources, that the goals and objectives set forth in this Plan will be fully consistent with those adopted for the basin as a whole.

This Plan first discusses management objectives (goals) for the North Westside Basin. It then describes existing groundwater basin conditions, including areas of concern and identified problems, as well as historical and projected water demands in the basin. Finally, this Plan presents a set of groundwater management actions which, in aggregate, are the central elements of this Groundwater Management Plan.

Public Outreach and Involvement

Public outreach and involvement efforts that occurred during development of the North Westside Basin Groundwater Management Plan included staff presentations, public workshops, email noticing, newspaper advertisements, web posting, and noticing in SFPUC newsletters. A summary of these activities is listed below: Appendix 4 includes a list of North Westside Basin stakeholder organizations that were contacted during development of this Groundwater Management Plan. In addition to these organizations, the SFPUC contacted numerous individual residents during development of this Plan.

Initial Staff Outreach

1993 – SFPUC Groundwater Workshop – Overview of recent geologic investigations in the Westside Groundwater Basin; Conceptualization of Lake Merced and Groundwater Basin; and Outline of the proposed Groundwater Management Plan.

April 24, 2004 – Lake Merced Newsletter (Fact Sheet) distributed via email and at CalTrout Day at Lake Merced provided updates on the status of Lake Merced work effort and development of the Groundwater Master Plan.

April 26, 2004 – Public notice of May 12, 2004 SFPUC Public Meeting posted on SFPUC's website, sent via email to interested parties and local community leaders. Notice was also mailed to stakeholders, local libraries and recreation centers.

May 12, 2004 – SFPUC Public Meeting – Topics covered included Storm Water Diversion, Lake Level Management and Groundwater Management.

March 24, 2004 – Web Posting of the Groundwater Project portion of the Capital Improvement Program Project Overview.

Public Involvement During Review of Draft Plan

May 2004 – Mailing of reports to 30 key stakeholders; reports included Draft North Westside Basin Management Plan.

June 1, 2004 – Web Posting – Notice of availability of the Draft North Westside Basin Groundwater Management Plan and upcoming public workshop on June 24, 2004 on Draft North Westside Basin Groundwater Management Plan.

June 3, 2004 – Public Notice sent via email to interested parties announcing upcoming June 24, 2005 Public Meeting on the Draft North Westside Basin Groundwater Management Plan.

June 9, 2004 – SFPUC staff presentation at Lake Merced Task Force Meeting including distribution of Lake Merced Newsletter, display of copies of recent Lake Merced technical memos and Draft North Westside Basin Management Plan.

June 10, 2004 – Reminder email notice to stakeholders, announcement of June 24, 2004 public meeting on Draft North Westside Basin Groundwater Management Plan.

June 17, 2004 – Reminder email notice to stakeholders, announcement of June 24, 2004 public meeting on Draft North Westside Basin Groundwater Management Plan.

June 24, 2004 – SFPUC Public Workshop on Draft North Westside Basin Groundwater Management Plan. Workshop included staff summary presentation and questions and answers.

July 20, 2004 – Public Notice sent via email to all stakeholders and posted on SFPUC Web Site. Extension of public comment period on Draft North Westside Basin Groundwater Management Plan. Comment period extended 30-days, through August 15, 2004, to allow for additional public comments.

August 15, 2005 – End of Public Comment Period.

September 15, 2004 – Public Notice sent via email and posted on SFPUC Web Site to stakeholders announcing October 13, 2004 SPUC Public Meeting on the Draft North Westside

Groundwater Basin.

October 6, 2004 – A written response to comments was prepared, mailed to the individuals that commented on the Draft Plan, and posted on the SFPUC's Web Site. An email was sent to all interested parties notifying the stakeholders of the availability of this document.

October 13, 2004 – Public Meeting on the Draft North Westside Groundwater Basin Management Plan.

II. North Westside Basin Management Objectives

Prior to the 1930's when the Hetch Hetchy reservoir and aqueduct system was completed, local groundwater was a part of the water supply for the City. Since that time, however, imported and local Bay Area surface water has been the predominant water supply, and groundwater is only developed to a very small degree for non-domestic use in the City. Other pumpers within and immediately adjacent to the City, however, have developed groundwater from the Westside Basin for ongoing municipal and irrigation supply. In recent years, the effects of lower groundwater levels on the most notable surface water body in the area, Lake Merced, and the depressed level of Lake Merced, have prompted a number of cooperative management efforts by SFPUC, municipal pumpers in San Mateo County (Daly City, California Water Service Company (South San Francisco), and San Bruno), and overlying pumpers for golf course irrigation supply near Lake Merced (Olympic Club, San Francisco Golf Club, Lake Merced Golf and Country Club).

Those management efforts have focused on five areas: initiation of surface and groundwater monitoring, including collection and organization of available historical data; development of a conceptual description of the geology and hydrogeology of the lake aquifer system throughout the basin; investigation of conjunctive use potential via a pilot program of surface water substitution for municipal pumping, and associated in-lieu recharge; initiation of a pilot program of incremental addition of supplemental water to Lake Merced; and implementation of a plan to add tertiary treatment at the North San Mateo County (Daly City) wastewater treatment plant, which has resulted in the delivery of recycled water to the three golf clubs adjacent to Lake Merced in order to substantially reduce groundwater pumping for irrigation supply in that area.

The above management actions constitute initial components of a groundwater management plan. They have also provided insights into opportunities for groundwater management actions that can potentially increase the overall yield of an integrated groundwater and surface water supply system, while protecting both the local groundwater resource and interrelated local surface water resources.

The overall basin management objectives, or goals, for the North Westside Basin can be expressed as follows:

Development of Local Groundwater as a Component of SFPUC Water Supplies. This objective includes the integrated use of surface water, groundwater, and recycled water in order

to augment existing water supplies and for emergency purposes. This objective encompasses the entire Westside Basin, since pumping from the North Westside Basin is from the same aquifer system that comprises the larger Westside Groundwater Basin that extends south of San Francisco. The SFPUC emphasizes that implementation of this objective outside San Francisco requires the consent and cooperation of the affected pumpers. Increased use of local water resources such as groundwater and recycled water in San Francisco and the entire Westside Basin will ultimately make the SFPUC water system more reliable since importation of surface water supplies is vulnerable to interruption from earthquakes and other disasters.

Avoidance of Overdraft and Associated Undesirable Effects. It is necessary to assess groundwater basin conditions to determine a range of operational yields of groundwater resources. Assessment of groundwater basin conditions will be based on a continuation of baseline monitoring, complemented by expanded monitoring to incorporate, for example, dedicated monitoring wells along the coast to measure both water levels and water quality relative to adjacent seawater. In terms of basin goals, the assessment of groundwater basin conditions and the resultant operational yields will have the primary objective of developing groundwater at a rate that remains within perennial or sustainable yield, i.e. avoids overdraft and the undesirable effects associated with overdraft. In this case, seawater intrusion and depletion of local surface water resources, e.g. Lake Merced, are examples of undesirable effects to be avoided.

Protection of Interrelated Surface Water Resources. Characterization of the hydrogeologic setting in the Westside Basin has shown that Lake Merced is a surface expression of the water table associated with a shallow aquifer beneath the Lake. That hydrogeologic characterization has also shown that a deeper aquifer, confined below about 200 feet beneath Lake Merced, is sufficiently confined that pumping from that aquifer does not immediately affect the Lake. From a practical standpoint, the presence of both a shallow and a deep aquifer system provides opportunities to separately manage Lake Merced and the deeper aquifer system such that the Lake is maintained at desired levels for a combination of aesthetic, environmental, and recreational reasons, while the deeper aquifer system is operated to provide regular and emergency water supply. At the same time, adding water to Lake Merced to increase lake levels and maintain more water in the lake also serves, over the long term, to recharge water to the Westside Basin. This objective for the basin reflects the need for management of both surface water features (such as Lake Merced) and groundwater systems to ultimately accomplish the two preceding goals for the basin: groundwater development for water supply, and avoidance of undesirable effects, such as depressed lake levels.

Preservation of Groundwater Quality. Historical development of groundwater for irrigation supply in the vicinity of Lake Merced and in the Colma area, and for municipal supply in Daly City, South San Francisco, and San Bruno, combined with urban development that has changed surface infiltration and runoff, have resulted in a significant depression of groundwater levels, more than 100 feet below sea level in several locations south of Lake Merced, outside the North Westside Basin. While such hydraulic conditions are logically of concern in such a coastal aquifer system, geologic and hydraulic conditions on both the Ocean and Bay sides of the basin have impeded groundwater quality degradation associated with seawater intrusion. Groundwater quality remains acceptable for beneficial uses, although there have been some water quality impacts resulting from historical land use practices, and possibly from the closed hydraulic nature of the basin, i.e. limited or no groundwater outflow. This objective for the basin reflects a desire to maintain the utility of the basin for municipal and other beneficial uses, and to avoid any significant loss of groundwater storage or availability due to degradation of groundwater quality. Included in this management goal will be the active characterization and solution of any groundwater contamination problems, through cooperation with responsible parties or through independent action if the other management objectives for the basin are impacted or constrained by contamination.

Quantitatively, the preceding objectives translate into general preservation of groundwater levels and quality in the basin, including fluctuations through seasonal demands and local hydrologic variations (wet and dry periods). As discussed in more detail in the next chapter, the hydrogeologic setting in the area has resulted in widely varying groundwater conditions in different parts of the basin: basically undeveloped conditions between the Zoo and Golden Gate Park; and significantly developed groundwater conditions to the south of Lake Merced, extending beneath Daly City, Colma, South San Francisco, and San Bruno. Groundwater pumping has historically been the source of irrigation water for Golden Gate Park. However, the SFPUC and the San Francisco Recreation and Park Department are in the process of evaluating replacement of most groundwater pumping with recycled water in the future. This is an example of how additional groundwater in the North Westside basin could be freed up for municipal supply.

In terms of intended management as described in this Plan, understanding these widely varying conditions is essential to achieving the above goals for the basin. The generally undeveloped groundwater north of the Zoo suggests that there is a reasonable potential to develop local groundwater in that area to augment the water supplies available to the SFPUC and to provide a significant emergency water source. The significant historical use of groundwater south of Lake Merced, and the significant decline in groundwater levels associated with it, on the other hand,

suggests that a conjunctive use program can be initiated to make valuable use of the available aquifer storage space and thus increase dry period, or emergency, water supply. Recent intensive investigations of the relationship and interaction between Lake Merced and the surrounding aquifer, and recent investigation of coastal groundwater conditions have shown that such potential management actions can be integrated with others to accomplish goals such as improvement and preservation of Lake Merced water levels, and avoidance of undesirable groundwater conditions such as seawater intrusion. A modification of historical basin conditions, through integration of a number of complementary management actions designed to make beneficial use of groundwater while also maintaining surface water resources like Lake Merced, can be expected to accomplish all four of the basin objectives discussed above.

III. Groundwater Basin Conditions

Geologic Setting

The four major geologic units in the North Westside Groundwater Basin are Mesozoic Franciscan Complex, Pleistocene Merced Formation, Pleistocene Colma Formation, and Pleistocene to recent Dune Sands. There are also minor, yet widespread, units of recent alluvium along stream channels. Groundwater development has primarily occurred in the Colma and Merced Formations. The Merced Formation is the primary water-producing aquifer in the basin; however, the Colma Formation is also of interest since Lake Merced is incised within this formation.

The Mesozoic Franciscan Complex consists of well-consolidated, highly deformed marine sandstone and shale with some volcanic greenstone and metamorphic rocks; it is considered to be non-water bearing bedrock. The Pleistocene Merced Formation is a weakly consolidated, marine to non-marine fine sandstone with secondary siltstone and claystone, and is strongly deformed to slightly deformed. The Pleistocene Colma Formation is composed of fine to medium sand with interbedded gravelly and clay beds, attributed to deposition in shallow marine and non-marine environments, and is largely undeformed. The Pleistocene - Holocene Dune Sands consist of well sorted fine to medium sands.

The Franciscan Complex is exposed in the low hills east and northeast of Lake Merced. The surface of the bedrock slopes southwestward and is covered by younger sedimentary deposits. Beneath Lake Merced and southward to Daly City, the bedrock slopes gently westward from bedrock exposures to depths of almost 600 feet near the center of Lake Merced, and to nearly 1,000 feet beneath the southern portion of Daly City. The bedrock surface then abruptly descends to a concentric low just south of Thornton Beach to depths of 3,000 feet (Phillips et al., 1993; LSCE, 2004).

The Merced Formation is considered to be largely of Pleistocene age and has a measured thickness of over 5,000 feet in exposure along the Pacific Ocean sea cliffs (Clifton and Hunter, 1987, 1999). The Merced Formation is subdivided into three units: lower, middle, and upper. The lower Merced Formation is approximately 4,000 feet thick and is composed of fine sandstone and siltstones. This unit has northeast dips ranging from 45 to 70 degrees. The middle Merced Formation is approximately 600 feet thick and is composed of fine sandstone, siltstone, and mudstone. These beds are moderately dipping to the northeast at 25 to 45 degrees

with some evidence of folding and steeper dips near the Serra fault near the Olympic Club. The upper Merced is approximately 500 feet thick, located between the Fort Funston area and the Great Highway. This unit consists of a sequence of thin-bedded beach, dune, estuary, and fluvial deposits of weakly consolidated fine sandstone with some gravel and mudstone beds. This unit is only moderately to slightly deformed with decreasing northeast dips from 20 to 5 degrees from Fort Funston to the Great Highway.

The Colma Formation is a surficial unit consisting of fine-grained sand with some clay, sand and gravel beds of fluvial, floodplain, alluvial fan and dune sand origin. The separation between the Colma and the underlying Merced Formation materials is not clearly definable from borehole information.

The Dune Sands are also a surficial map unit based on relic dune topography and cross-bedding exposures north of Lake Merced, and dune features west of Lake Merced. The unit consists of fine-grained sands with some clay soil horizons. The separation between this unit and the underlying Colma and Merced Formations is also difficult to define from borehole information.

The majority of the surficial geologic units in the North Westside Basin are composed of the Colma Formation and Dune Sands. As a result of the difficulty of differentiating the contacts between the Dune Sands, the Colma Formation, and the Merced Formation, the precise thickness of the Colma Formation and Dune Sands overlying the Merced Formation has not been determined. Groundwater in the vicinity of Lake Merced, and north to Stern Grove and Golden Gate Park, is encountered at relatively shallow depths (ranging from approximately 5 to 60 feet).

One aspect of the North Westside Basin, which has implications for any future development of groundwater resources, is offshore topography and geology. Offshore topography is a gently westward sloping plain with ocean water depths reaching only 60 feet at two miles offshore, 100 feet at eight miles offshore, and 300 feet at 25 miles offshore, which marks the edge of the continental shelf to steeper continental slope to abyssal depths. This continental shelf is underlain by a thick sequence of Quaternary sedimentary deposits dissected by the San Andreas fault and other offshore faults, including a possible extension of the Serra fault. It is highly likely that the Merced and Colma Formation extend offshore and a fresh groundwater system could extend for a considerable distance offshore, up to several miles.

The subsurface configuration of the various geologic units in the Westside Basin has been delineated in a series of geologic cross-sections based on a combination of lithologic logs on water well driller's reports and geophysical logs. Given the extent of historical exploration and

development of groundwater in the basin, most of which has been south of San Francisco, the availability of lithologic data is greatest from the vicinity of Lake Merced to the south. Hence, most of the cross-sectional illustrations and associated discussion are focused on that area. The locations of those cross-sections are illustrated in Figure 3-1; the cross-sections are included in Appendix 2.

Historical Groundwater Development

By the early 1900's, wells were drilled north, east, and south of Lake Merced for farming and drinking water supply. During that time, Spring Valley Water Company had two wells located near the Lake Merced outlet. Spring Valley pumpage was only about 100 afy (Bartell, 1913). The total of Lake Merced, Sunset District, and Golden Gate Park pumpage averaged 400 to 500 afy. In the early 1930s, the San Francisco Board of Public Works installed production wells in the Sunset District with a pumping capacity of about 6 mgd. Groundwater withdrawals for emergency purposes averaged about 5 mgd from October 1930 through October 1935 until the availability of Hetch Hetchy water in the mid 1930s (San Francisco Water Department, 1961).

In San Mateo County beginning in the early 1950's, post World War II development of Daly City began with pumpage from Daly City wells increasing from about 1,000 afy to nearly 5,000 afy between 1950 and 1970 (Kirker, Chapman & Associates, 1972). Since then, Daly City's groundwater pumpage has ranged between approximately 3,000 and 5,000 afy, where it has remained until October 2002, when an increase in SFPUC system water replaced the majority of Daly City's groundwater supply as part of a demonstration conjunctive use pilot program among San Francisco, Daly City, California Water Service Company in South San Francisco, and the City of San Bruno. This demonstration program continued through early 2005 for California Water Service Company and the City of San Bruno, while the Daly City program is ongoing.

Groundwater pumpage by California Water Service Company in South San Francisco has declined from 2,200 afy in 1947, to 1,600 afy in 1969, to 620 afy in 2002. In early 2003, groundwater pumpage was discontinued as part of the same demonstration conjunctive use program described above, with local surface water supplies replacing pumped groundwater. Pumpage in San Bruno was approximately 1,900 afy in 1969, and has increased to about 2,500 afy in recent years. San Bruno also decreased groundwater pumping for municipal water supply in early 2003, and utilized increased deliveries of surface water as part of the demonstration conjunctive use pilot program.

Groundwater for irrigation of golf courses has remained relatively constant for much of the last century in the vicinity of Lake Merced, about 1,200 afy. However, as discussed in this Plan, the majority of that pumpage began to be replaced by recycled water from the North San Mateo County (Daly City) wastewater treatment plant beginning in 2004.

Groundwater and Lake Level Monitoring Network and Program

Available historical data on groundwater levels dates to 1913 in the Lake Merced/Sunset District area, and to the 1940's and early 1950's in the Westside Basin south of Lake Merced. Monitoring of groundwater levels was sporadic in the North Westside Basin until the late 1980's and early 1990's, when various investigations and construction projects implemented site-specific monitoring programs. Those projects included the construction of the Oceanside Water Pollution Control Plant, the Westside Transport, and investigations of Lake Merced and vicinity by USGS and others.

In 2000, the semi-annual Westside Basin Partners Groundwater Monitoring Program was initiated to begin to collect basin-wide data in the spring and fall from production and monitoring wells. In 2001, San Francisco began collecting continuous water level measurements from monitoring wells in the vicinity of Lake Merced and in the individual lakes that comprise Lake Merced (LSCE, 2002a). Historically, San Francisco has collected daily lake level measurements from South Lake at the pump house located on the east side of the lake.

Monitoring of groundwater quality has been more sporadic and sparse than water level measurements. The current semi-annual monitoring program includes monitoring of water quality from selected production and monitoring wells throughout the Westside Basin.

Lake Merced

Lake Merced is incised in the shallow aquifer and is composed of four lakes: North Lake, East Lake, South Lake, and Impound Lake. A narrow channel connects North and East Lakes, thereby creating equal water elevations in both lakes. A conduit between North Lake and South Lake allows water to flow between the lakes when the elevation in either lake is approximately 3.35 feet, San Francisco City datum (20.85 ft. Lake Merced Gage Board datum). Below that elevation, these two lakes are separated and exhibit different lake level elevations. South Lake and Impound Lake are separated by the Ingleside combined sewer pipeline and the foundation of a pedestrian walkway below an elevation of approximately 4.26 feet, San Francisco City datum (21.76 ft. Lake Merced Gage Board datum). Soil has accumulated on the foundation to a

minimum elevation of approximately five feet, San Francisco City datum. Above that five-foot elevation, water can flow underneath the pedestrian walkway to connect both lakes.

Until the early 1900's, Lake Merced was one continuous body of water fed by local runoff and springs, with an outflow to the ocean in the form of a stream located at the northwestern end of North Lake. The stream flowed westward toward the ocean through the present day location of the San Francisco Zoo and Sloat Boulevard. The springs were primarily located on the eastern side and in the southern portion of Lake Merced, causing a primary flow direction through the lake from the south to the north (U.S. Coast Survey Map, 1852; Daily Alta Californian, 1872). In contrast, the current flow direction through the lakes is reversed, largely as a result of urban growth in the vicinity of Lake Merced which has resulted in reduced recharge from springs and increased pumpage in the deep aquifer south of Lake Merced. The urbanization of the watershed has also resulted in the diversion of an increasing amount of storm water away from Lake Merced and into the ocean or wastewater treatment plant. These diversions began with the construction of the Vista Grande Canal and Tunnel by the Spring Valley Water Works in 1897, and have continued with successive urban development in San Francisco, which has a combined storm water and sanitary wastewater system, and northern San Mateo County. The development of the watershed has also affected groundwater recharge from precipitation, which previously infiltrated and recharged the shallow aquifer. As a result, the amount of subsurface inflow into Lake Merced, which in the early 1900's was manifested as spring inflow, has been reduced. The reduction in subsurface recharge to Lake Merced results in short-term lake levels being more sensitive to fluctuations in precipitation, since direct precipitation, along with groundwater recharge, are the primary lake recharge mechanisms.

Since the lakes are incised in the shallow, unconfined aquifer and generally reflect the shallow groundwater level, the change in flow direction through the lake also indicates a change or reversal of the groundwater gradient from a historical northwesterly direction in the Lake Merced area to one with a southerly to southwesterly direction. This is further discussed in the section on groundwater conditions below.

Pine Lake

Pine Lake is located north of Lake Merced in the westernmost portion of the Stern Grove and Pine Lake Park. Pine Lake (also known as Laguna Puerca) is one of San Francisco's few natural lakes. It is a small, shallow lake approximately three acres in size. Similar in nature to Lake Merced, Pine Lake is a surface expression of the groundwater table. The lake has historically been overgrown with aquatic plants which have periodically been removed. The Recreation and

Park Department is currently implementing a park improvement program for the Stern Grove and Pine Lake Park area.

Groundwater Conditions

The aquifer system north of Lake Merced to Golden Gate Park is characterized by a thinning sedimentary section from south to north from about 600 to 400 feet in thickness. In addition, clay beds present in the San Francisco Zoo and Lake Merced area appear to thin and pinch out beneath the Sunset District. Underlying the sediments is Franciscan bedrock, which slopes to the southwest (with bedrock exposures to the east).

Prior to the early 1940's, water levels in the North Westside Basin and in the northern portions of San Mateo County were above sea level, with water levels suggesting a westerly to northwesterly gradient in both the shallow and deep aquifers. By the 1940's, however, a decline of groundwater levels of up to 160 feet began in the Westside Basin immediately south of San Francisco (Daly City to San Bruno). This continued through the 1970's, after which groundwater levels stabilized at elevations well below sea level. This also coincided with a reduction in water levels below sea level in the deep aquifer near the southern end of Lake Merced. To a lesser extent, groundwater flow directions in the shallow aquifer (present in the Lake Merced area) have also changed from a northwesterly to a southwesterly direction over the period from the late 1940's to the 1970's, after which time pumpage and groundwater levels essentially leveled off.

It appears that, following World War II, the decrease in groundwater levels in Daly City and South San Francisco resulted in a change in groundwater flow direction from northwesterly to southerly in the Lake Merced-northern San Mateo County area of the Westside Basin. This change is evidenced by the interrelationship of individual lake levels (flow to the south, away from the historical ocean outlet, a reversal from the historical northwesterly lake outlet) and by the fact that groundwater levels in Daly City declined to below sea level, while groundwater levels in the Lake Merced area north to Golden Gate Park largely remained above sea level. This process likely occurred over several decades; however, detailed data are not available to delineate exact changes versus time.

One important note with regard to the preceding discussion of historical changes in groundwater levels and flow directions is the fact that groundwater levels toward the northern and western parts of Lake Merced have remained above sea level, resulting in a combination of apparent

subsurface outflow toward the ocean and hydraulic resistance against seawater intrusion from the ocean.

Groundwater Quality

Groundwater quality is an important factor in assessing both the Colma and Merced Formations as a potential municipal water supply. However, there is no long-term record of water quality, i.e. water quality data in one or more wells that span several decades and continue to be monitored in the North Westside Basin. The only available water quality data for the North Westside Basin, which may reflect water quality in the Sunset District, is from wells located at the San Francisco Zoo, Golden Gate Park, West Sunset Playground, and Edgewood School. The historic data from these wells is sporadic and includes very infrequent sampling events at each location. However, beginning in May of 2000, the wells at Edgewood School, the Zoo, Elk Glen and West Sunset Playground have been sampled on a regular semi-annual basis as part of the ongoing Westside Basin Partner's groundwater monitoring program. Water quality data from those wells are summarized in Table 3-1. The Edgewood School production well has nitrate and some iron concentrations exceeding drinking water standards, and the West Sunset Playground monitoring well has iron concentrations exceeding drinking water standards. The Elk Glen 2 well in Golden Gate Park has nitrate concentrations that exceed drinking water standards. Historical land use, sampling methods, and well construction features may account for the high concentrations of iron and nitrate. However, elevated concentrations do not preclude the development of groundwater supplies in the North Westside Basin. Additional investigation will be conducted and mitigation measures employed as an element of developing groundwater supplies.

Subsidence Potential

One form of subsidence occurs when sustained groundwater withdrawals cause a permanent dewatering of laterally extensive clay beds. Once dewatered, the framework of the clay particles can collapse or become compacted, potentially resulting in land subsidence. As mentioned above, the Dune Sands, Colma Formation and the Merced Formation are primarily composed of sands with interfingered silt and clay beds. North of Lake Merced, where most of the proposed groundwater supply projects in this Plan are located, extensive clay beds, if present, are located hundreds of feet below ground surface and below sea level (see cross-section D-D', Appendix 2). In addition to the lack of extensive near-surface clay beds, the proposed groundwater projects are planned to be operated in a manner which will not result in a sustained or long-term lowering of groundwater levels, primarily to avoid potential seawater intrusion. The combination of geologic

and hydrologic conditions, e.g. the lack of extensive near-surface clay beds and the maintenance of generally high groundwater levels, is expected to minimize the potential for any land subsidence in the area.

Pumping-induced subsidence has been previously evaluated and is not expected to be of concern (CH2M-Hill, 1996). Historic and current groundwater pumping at the Zoo, Golden Gate Park, Sunset Well Field, and Harding Park has not resulted in any reported subsidence.

Areas of Concern

With any management of groundwater resources in the North Westside Basin, there are two primary concerns which have the potential to develop: seawater intrusion and impacts to surface water features, including Lake Merced and Pine Lake. The physical impediments to seawater intrusion that are evident west of Daly City (as a result of faulting and steeply dipping beds of the Merced Formation) are not as evident in the North Westside Basin where the beds do not exhibit pronounced dips and faults are further offshore. For example, during the construction of the Oceanside Water Pollution Control Plant, intensive dewatering of the shallow aquifer for a relatively short period of time caused some temporary seawater intrusion to occur. This likely occurred due to pumping of the shallow aquifer which is in direct contact with the ocean near the coastline. Once dewatering ceased, the induced landward gradient, which resulted in seawater migrating into the shallow aquifer, reversed and the natural outward flow of freshwater to the ocean resumed.

The deep aquifer (deeper than approximately 200 feet), which is where municipal production wells would be screened, extends miles offshore in that portion of the basin north of the San Francisco Zoo. Therefore, any short-duration pumping for dry year or emergency water supply would not be expected to permanently change the westward regional flow direction of groundwater in the North Westside Basin. This expectation derives from the lack of seawater intrusion when a network of 21 wells in the Sunset District produced about 5 million gallons per day (about 5,600 acre-feet per year) over a five year period from 1930 through 1935, after which time the wells were placed in emergency standby service coincident with the availability of Hetch Hetchy water (Boyd, 1977; SFWD, 1961; SFPUC, 1934, 1935).

Table 3-1
Groundwater Quality – North Westside Groundwater Basin
2000-2002

Sample Site	Title 22 Primary and Secondary Drinking Water Standards	Zoo 4	Zoo 5	Edgewood School	West Sunset Playground	Elk Glen 2
Alkalinity (mg/l)		157	140	100-108	44-68	108-140
Bromide (mg/l)		0.39	0.2	ND-0.2	ND-0.33	0.2-0.21
Chloride (mg/l)	250	43.4	48-53	28.4-31	20.2-23	38.4-41
Conductivity (uS/cm)	900	386	490-500	410-440	169-230	526-580
Fluoride (mg/l)	1.4	ND	0.1	ND-0.2	<0.1	0.1-0.21
Hardness (mg/l)		212	170	114-170	39.8-98	211-240
Ammonia-N (mg/l)		ND	< 0.05	ND	<0.05	<0.05
Nitrate (mg/l)	45	33.1	19-23	33.8-46	<0.2-4.1	49-55
pH		7.71	8.0-8.1	7.1-7.5	7.91-9.40	7.6-7.7
Sulfate (mg/l)	250	37.7	22-23	32.3-37	8.26-23.5	48.8-52
TDS (mg/l)	500	312	290-300	200-280	80-165	330-364
Boron (mg/l)		ND	<0.05-0.04	ND-0.40	ND-0.03	<0.05
Calcium (mg/l)		29.9	24	25-59	6.64-26.57	30.4-35
Potassium (mg/l)		2.33	2	1-5.4	0.35-1.90	<1-1
Magnesium (mg/l)		33.6	27	26-36	6.6-25.39	32.8-39
Manganese (mg/l)	0.05	ND		0.09	0.008-0.04	ND
Sodium (mg/l)		42	38-39	24.2-44	17.5-23.1	24.2-28
Iron (mg/l)	0.3	0.03		0.073-1.36	0.24-1.15	ND

The construction of coastal monitoring wells and the implementation of a water level and quality monitoring program included in this Plan as part of Element 1 will provide additional data, most notably as direct input to confirming that intrusion has not occurred or, if coastal conditions change, that some modification of pumping might be warranted. In addition, the planned expansion of the monitoring network will be linked to the existing monitoring network in the vicinity of Lake Merced to further investigate the geologic structure and aquifer units in this portion of the basin.

In addition to the two most notable concerns about the basin discussed above, several other topics that might be classified as concerns have historically been identified. They include:

- quantification of groundwater use by various pumpers, intended to be addressed via implementation of Plan Element 1;
- SFPUC water system supplies versus total demand on that system, and any implications of additional groundwater dependence, intended to be partly addressed via implementation of Plan Elements 3, 4, and 5;
- health-related and other impacts associated with potential use of recycled water, intended to be addressed via implementation of Plan Element 6;
- needs for additional groundwater and other data on which to assess the impacts of historical and future groundwater use, intended to be addressed via implementation of Plan Elements 1 and 2.
- feasibility of conjunctive use to increase water availability, particularly during dry periods, intended to be addressed via implementation of Plan Elements 3, 4 and 5.

IV. Current and Projected Water Requirements and Supplies

Current and projected water requirements and supplies for San Francisco are included in several documents. San Francisco's 2030 Purchase Estimates (URS, 2004) includes a summary of current and projected water demands of San Francisco and the SFPUC's wholesale customers. The Bay Area Water Users Association (BAWUA) Annual Survey for fiscal year (FY) 2001-2002 provides a complete summary of current and projected water requirements for wholesale customers (BAWUA, 2002).

Two management objectives for the North Westside Basin are development of local groundwater for augmentation of SFPUC water supplies within a sustainable yield of the Basin in order to avoid overdraft and associated undesirable effects, and implementation of conjunctive use programs. Plan elements in the next section include, among a wide range of details, the initiation of conjunctive use operations which are expected to apply to a large part of the overall Westside Basin. In that light, the following discussion of water requirements and supplies addresses the SFPUC and its wholesale customers.

Current Water Requirements

As discussed in the 2001 Final Urban Water Management Plan (UWMP, San Francisco, 2001), water use within San Francisco is currently less than the level of water use experienced in the 1940's. Many factors have contributed to this reduction in water use including significant changes to the mix of industrial and commercial businesses and associated water demand, and the general characteristics of water use by San Francisco water customers. In particular, the droughts of 1976-77 and 1987-92, and the conservation programs either voluntarily embraced by residents and businesses or mandated by San Francisco, have affected water demands.

Current total water demand (FY 2001-2002) by retail customers in San Francisco is nearly 94 mgd, or about 104,900 afy. This represents a decrease from total demands of about 110 to 120 mgd for the decade preceding the 1976-77 drought, and a decrease from total demands of about 100 mgd for the decade prior to the 1987-92 drought. Of the current total water demand, approximately 53 percent is delivered to San Francisco residential customers; non-residential water use accounts for approximately 38 percent of the total demand, and unaccounted water amounts to approximately 9 percent.

The BAWUA Annual Survey for FY 2001-2002 reports the total water requirements of all the SFPUC Bay Area wholesale customers to be about 272 mgd, or about 305,000 afy, including unaccounted water (URS, 2004). Of those totals, about two-thirds is supplied by the SFPUC system, while the remaining water demand is met by a combination of local (e.g. surface water and groundwater) and other imported supplies (e.g. State Water Project). A small amount of recycled water has also been developed to meet some of the total demand.

In summary, the total current (FY 2001-2002) water requirements of the SFPUC and its wholesale customers are about 366 mgd, or about 410,000 afy, including unaccounted water (system losses). Within the entire system, slightly more than ten percent of that total demand is met by local groundwater; however, the great majority of that pumping occurs outside the Westside Basin. Significant groundwater supplies within the Westside Basin, all in northern San Mateo County, are developed by Daly City (about 4,000 afy), California Water Service Company serving South San Francisco (about 1,000 afy), and San Bruno (about 2,500 afy).

Projected Water Requirements

As also discussed in San Francisco's 2001 UWMP and reflected in the 2030 Purchase Estimates, the SFPUC uses disaggregated water use forecast models to project its retail water demands. San Francisco's water demand is segregated into three distinct categories of water use: non-residential (representing industrial and commercial business water use), multi-family residential (representing water use within multiple family dwellings such as townhouses and apartments), and single-family residential (representing water use within single-family dwellings). The remainder of San Francisco's water demands, such as unaccounted for water and minor uses such as docks and shipping, are forecast by trend analysis.

Based on the results of several water use models applied to the preceding three categories of water use, San Francisco's water demand is projected to remain flat over the horizon of SFPUC planning, through 2030. Over that time period, demands are projected to change from 93.6 mgd to 93.4 mgd, or about 104,700 afy (URS, 2004). Over the same time period, the total water demands of the wholesale customers are projected to increase by about 19 percent, to slightly more than 324 mgd, or about 363,000 afy (including unaccounted water). Total existing and projected water requirements for San Francisco and its wholesale customers are summarized through the 2030 UWMP horizon in Table 4-1.

Table 4-1
Existing and Projected Water Requirements
San Francisco and SFPUC Wholesale Customers
(*acre-feet per year*)

	Current (FY 2001-2002)	2030*
San Francisco	104,900	104,700
Wholesale Customers		
SFPUC Supply	190,500	234,200
Other Supplies	114,300	128,900
Total	**409,700**	**467,800**

* Projected demand on SFPUC system as reported in SFPUC 2030 Purchase Estimates.

Existing and Projected Water Supplies

The water demands of SFPUC and its wholesale customers are met primarily (about 72 percent) by water from the SFPUC system, which is a combination of surface water imported from the Hetch Hetchy system and surface water from the Bay Area system, commonly called the local system. As summarized in Table 4-1, for example, 295,400 afy of the current total water demand of 409,700 afy is supplied by the combined Hetch Hetchy and local systems. The balance of the total demand of the SFPUC's wholesale customers is met from other supplies, which are comprised of local groundwater local surface water, and other supplies, notably from the State Water Project and other components of the Santa Clara Valley Water District System.

Over the planning horizon of the SFPUC, the projected 2030 total water demand of San Francisco and SFPUC wholesale customers is nearly 468,000 afy, of which nearly 339,000 are projected to be supplied by the SFPUC system.

Such as other water supplies, i.e. non-SFPUC system water, include local groundwater and, to a small extent, some recycled water, one of the basin management objectives of this Plan is to augment SFPUC water supplies by increasing groundwater development in the North Westside

Basin. Within the constraints of the other basin management objectives, for example to avoid overdraft and seawater intrusion, it is unlikely that groundwater supply in the North Westside Basin will be a very large amount. However, in combination with conjunctive use in adjacent parts of the basin, as described in Element 5 of this Plan, and also in combination with the initiation of recycled water use to make available some surface and groundwater supplies now delivered for non-potable uses, as described in Element 6 of this Plan, total groundwater supply from the North Westside Basin and its adjoining part of the total basin could potentially be on the order of 10,000 to 12,000 afy.

North Westside Basin Projects described in Appendix 3 would result in an estimated production of between 1,700 and 2,700 afy. Average annual recharge in the North Westside Basin has been calculated to be 4,846 afy (Phillips, et al., 1993). This figure was also incorporated into the 1997 Master Plan. The 1997 Master Plan indicated a potential of 800 to 900 afy from several wells in the Sunset District and 500 to 900 afy from a new Elk Glen (Golden Gate Park) well to be used for municipal purposes. Thus, earlier production estimates were in the 2,000 afy range. Potential conversion of Golden Gate Park groundwater supplies to potable use following delivery of recycled water for irrigation would add to this estimate. Replacing some Zoo groundwater use and other existing non-potable uses of groundwater with recycled water could further increase the potential for groundwater production for municipal purposes, or for other uses such as replenishing Lake Merced and Pine Lake water levels.

V. Elements of the Groundwater Management Plan

Introduction

The management objectives, or goals, for the North Westside Groundwater Basin include the following:

Goal 1: Development of Local Groundwater for San Francisco Water Supply
Goal 2: Avoidance of Overdraft and Saltwater Intrusion
Goal 3: Protection of Interrelated Surface Water Resources
Goal 4: Preservation of Groundwater Quality

To accomplish those goals, this Plan incorporates a number of components which are divided into a set of 13 elements. The elements restate or expand certain existing activities by San Francisco and others, and assess their ongoing effectiveness. They also recognize the probable need for additional activity (e.g. additional groundwater development, and conjunctive use of supplemental surface water with existing groundwater). They reflect the focus on local groundwater management in the North Westside Basin by the SFPUC and continuing cooperation with the cities and other pumpers in the South Westside Basin. In summary, this North Westside Basin Groundwater Management Plan will enable the City to manage its own groundwater resources, and provide the foundation for the City and its neighbors to cooperatively manage and potentially expand use of groundwater on a regional basis for municipal and emergency water supply purposes.

Plan Elements

Monitoring of Groundwater Levels, Quality, Production, and Subsidence
Monitoring and Management of Surface Water Resources
Determination of Basin Yield and Avoidance of Overdraft
Development of Municipal Water Supply including Emergency Water Supply
Initiation of Conjunctive Use Operations
Integration of Recycled Water and Storm Water into Basin-Wide Planning Efforts Development and Continuation of Local, State and Federal Agency Relationships
Continuation of Public Education and Water Conservation Programs
Identification and Management of Recharge Areas and Wellhead Protection Areas
Identification of Well Construction, Abandonment, and Destruction Policies

Identification and Mitigation of Soil and Groundwater Contamination
Groundwater Management Reports
Provisions to Update the Groundwater Management Plan

Plan Element 1 - Monitoring of Groundwater Levels, Quality, Production, and Subsidence

Despite the lack of existing groundwater production for municipal supply in San Francisco, there is a fairly substantial amount of historical groundwater level data, and limited groundwater quality data. All the available historical groundwater level and quality data have been organized into a computerized database that includes the North Westside Basin that is the focus of this Plan; the database also includes information from the South Westside Basin, in San Mateo County.

The network of wells from which groundwater data are collected is illustrated in Figure 5-1. The network is comprised of a combination of active production wells, inactive production wells, and dedicated monitoring wells, all as shown on Figure 5-1. Data collection has historically varied from random and infrequent to regularly scheduled but infrequent (e.g. semi-annual), to continuous. The latter continuous monitoring has significantly increased in the last few years. Numerous monitoring wells and selected production wells have been equipped with measurement and recording devices to investigate or monitor specific aspects of basin conditions such as pilot-scale in-lieu groundwater recharge and augmented recharge (water addition) to Lake Merced and Pine Lake.

Other than a cooperative semi-annual designated day when production wells are shut down and static water levels are measured, there is no formalized program of groundwater data collection in the overall Westside Basin. However, it is well recognized that monitoring of existing wells, and expansion of the network of production and monitoring wells used for groundwater data collection, are key to accomplishing management goals. Monitored groundwater levels, quality, and pumping will collectively be the bases for defining basin conditions and developing and managing groundwater resources within both the North Westside Basin and the Westside Basin in general.

An element of this Plan is to develop, implement, and expand as appropriate a groundwater monitoring program that is comprised of a network of wells, mostly as illustrated in Figure 5-1. Installation of coastal monitoring wells between the Zoo and Golden Gate Park was completed in 2004 to serve as a key expansion of monitoring in the North Westside Basin under this Plan

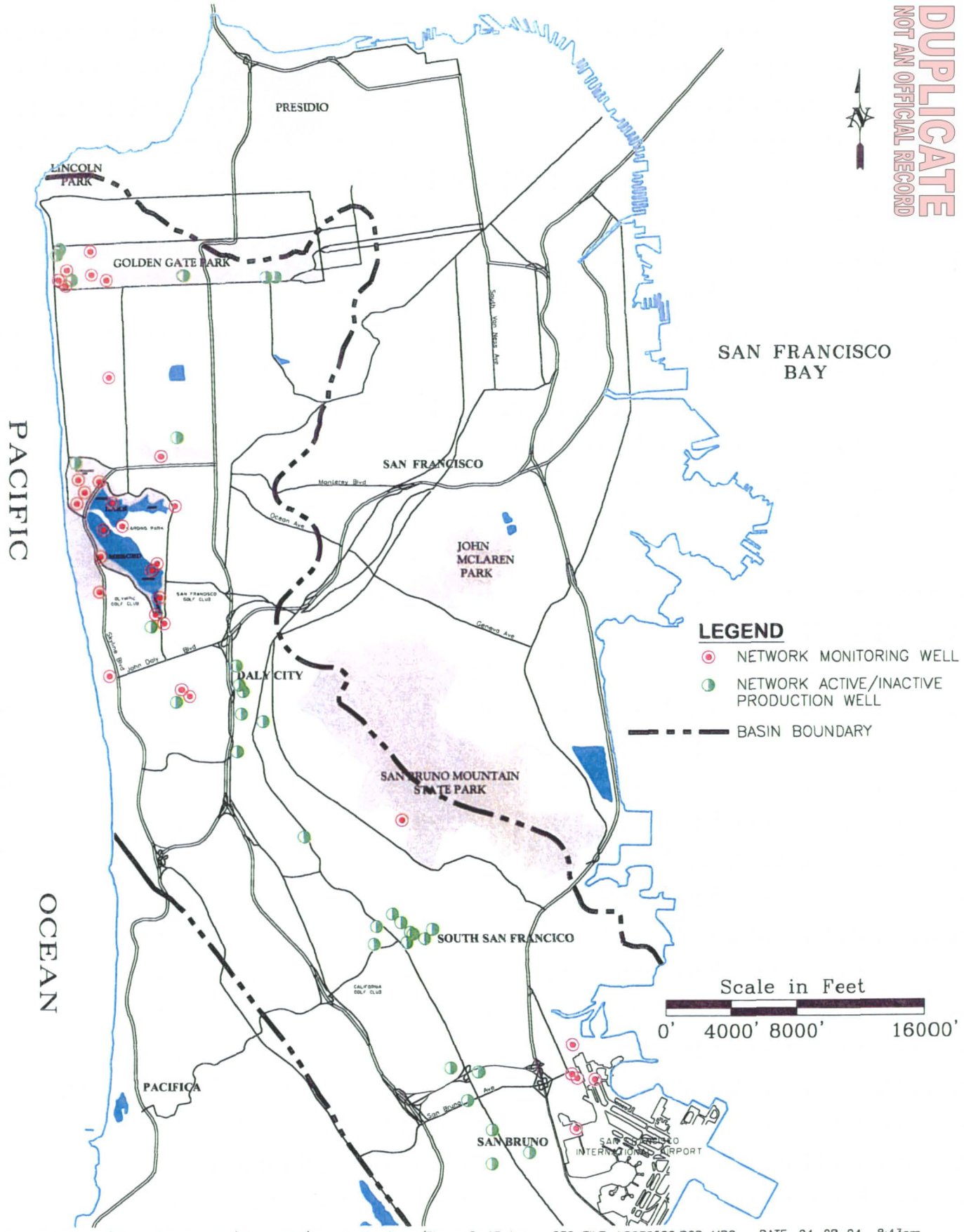

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Figure 5-1
Ground-Water Data Well Network
North Westside Ground-Water Basin Management Plan

Element. These wells will serve both the refinement of the conceptual model of the North Westside Basin, and ongoing monitoring and assessment of potential seawater intrusion as a result of pumping from production wells as contemplated in the 1997 Master Plan and as further described in Appendix 3 of this Plan. The frequencies and types of groundwater data collection will vary as a function of specific monitoring objectives in the North Westside Basin.

These monitoring wells will also serve to monitor the effects of pumping from all other wells that may be developed as this Plan is implemented. In addition to the establishment of a coastal monitoring network, test wells described for projects listed in Appendix 3 will assess existing groundwater conditions, aquifer characteristics, and potential seawater intrusion pathways. The test wells will be designed for initial testing and monitoring, with provisions for conversion to production wells.

As discussed in Section 3, land subsidence resulting from groundwater production in the North Westside Basin is not expected to be a concern due to the planned operation of the proposed groundwater supply projects to prevent seawater intrusion and through the implementation of this monitoring program. However, periodic monitoring and evaluation of land surface elevations will be conducted to assess potential land subsidence as a result of pumping from production wells described in Appendix 3.

Plan Element 2 - Monitoring and Management of Surface Water Resources

A notable area of concern in the Westside Basin has been the decline of Lake Merced's level over the last 50 years. Similar concern has been expressed about the much smaller Pine Lake in nearby Stern Grove. Investigation of the interrelationship between those lakes and groundwater has been a major focus over the last five to ten years. Among other things, that investigation has included the installation of dedicated monitoring facilities in the individual Lake Merced lakes, as well as the installation of numerous monitoring wells around and near Lake Merced and Pine Lake. The latter are part of the network illustrated in Figure 5-1.

Analysis of the lake aquifer system at Lake Merced to date indicates that the lake system can be separately managed to achieve a desired level, or range of levels, while also using a portion of the underlying aquifer system as part of a conjunctive use program to preserve, and potentially increase, water supply. The results have also shown that, while the underlying aquifer system can successfully be used in a conjunctive use operation, the lake system will function to a certain degree as a recharge source. It will continue to be essential to monitor the surface water system,

most notably Lake Merced, to continue to understand its interrelationship with the aquifer system, and to manage it to accomplish the third basin management objective, Preservation of Interrelated Surface Water Resources. The separate management and maintenance of surface water features, most notably Lake Merced, is critical to integrated water resource management. Information to date indicates that lake levels can be maintained while still allowing increased pumping within the North Westside Basin. Similarly, conjunctive use operations using imported SFPUC system water can increase the utility and yield of the aquifer system throughout the rest of the basin while Lake Merced levels are separately managed. Continuing surface water monitoring is essential to accomplishment of all four of the Basin Management Objectives.

Plan Element 3 - Determination of Basin Yield and Avoidance of Overdraft

In order to accomplish all the basin management objectives, it will be essential to determine what yield can be developed on both a regular and an intermittent (dry period or emergency) basis. Such a determination of basin yield will be made in order to accomplish two main objectives of ultimately operating within the yield of the basin: avoidance of overdraft and control of seawater intrusion.

Historically, in the vicinity of the County line and continuing into the municipal pumping areas of Daly City, South San Francisco and San Bruno, there has been a significant and substantial lowering of groundwater levels, to depths between 100 and 200 feet below sea level over the last 50 years or so. While such conditions are not normally desirable in a coastal aquifer system, particularly in this case because the aquifer system is bounded on two sides by saline water bodies, there has been no seawater intrusion into the overall Westside Basin.

It appears that the geologic makeup of the basin to the south, where groundwater levels have historically been most depressed, provides a physical barrier against intrusion from the Pacific Ocean on the west. However, immediately west of Lake Merced and continuing north along the coast of the North Westside Basin, while the geologic makeup does not appear to be as potentially retardant to potential intrusion, the lack of significant groundwater development results in groundwater levels that are not depressed, and there is thus hydraulic resistance to intrusion. Dedicated coastal monitoring is planned, as discussed in Plan Element 1, to measure coastal groundwater levels and quality. Those data will be used in concert with analyses of other water budget components to derive a range of operating yields for the basin, which are intended to vary from wet to dry conditions. The North Westside Basin will be pumped to meet some smaller ongoing, or regular, water supply needs, and will alternately be pumped at higher

capacities during dry or emergency conditions such that the net, long-term results are avoidance of overdraft (groundwater storage depletion) and avoidance of any associated undesirable results (seawater intrusion).

Coordinated evaluation and data gathering activities will ultimately serve the development of a numerical groundwater flow model of the Westside Basin. The technical questions of basin yield (i.e., the yield of the North Westside Basin) and seawater intrusion will be addressed through the application of a numerical model due to the complexity of the system. Such an effort requires the development and refinement of a conceptual model and ongoing acquisition of data through monitoring and testing that are a part of this Plan. Ultimately, the appropriate model may be of regional scale (e.g., encompassing the South and North Westside Basin) or local scale (e.g., the Sunset District). The appropriate scaling will be determined from the results of hydrogeologic conceptualization and will be based on what is optimal to be able to address a specific groundwater management question.

Determination of basin yield, complemented by ongoing investigation of the potential for seawater intrusion, will be essential to the accomplishment of Basin Management Objectives 2 and 4.

Plan Element 4 - Development of Groundwater to Augment SFPUC Municipal Water Supplies

It is notable that, in the North Westside Basin, apart from wells in Golden Gate Park and the Zoo used for irrigation and animal housing purposes, there is currently no significant groundwater pumping despite the existence of aquifer materials throughout the Basin. Pumping in the Sunset requires continued monitoring to maintain the requisite seaward gradient and to establish no direct adverse impact on Pine Lake or Lake Merced, along with a commitment to change the pumping operation if data indicate a problem. Wells in the Sunset intercept fresh water that is flowing to the ocean; continued monitoring will ensure that pumping would not induce seawater intrusion into the aquifer or affect the lakes.

San Francisco has an opportunity to develop additional water supply in the North Westside Basin via development of groundwater in the area between Golden Gate Park and the Zoo. This Plan element is included to address the planned development of groundwater supply in the North Westside Basin to meet the first Basin Management Objective.

Development of groundwater in the North Westside Basin includes ongoing efforts to monitor and test, which indicate groundwater production can increase in this area. Coastal and other groundwater monitoring contributes to the detailed conceptualization of the lake-aquifer system around Lake Merced and of the overall Westside Basin. Part of that work has included initial coastal monitoring for seawater intrusion to the west of Daly City and immediately west of Lake Merced (at the San Francisco Zoo). Geophysical data, and initial groundwater level and quality data as part of that work show that no intrusion has occurred, and that hydraulic conditions (water levels) are such that intrusion is not potentially occurring to the west and north of Lake Merced. That initial coastal monitoring has subsequently been expanded to now include coastal monitoring wells between the Zoo and Golden Gate Park which provide key geologic data for conceptualization of potential seawater-freshwater aquifer connections and which serve as permanent sentinel wells to monitor the effect of inland pumping activities and ensure protection of groundwater quality.

Inland monitoring well installations, test wells, and production wells are planned to ultimately implement objectives of this Plan Element. Notably, these actions are consistent with those described in the 1997 Master Plan. Test wells to be used for acquisition of geologic data and determination of groundwater conditions will be installed within the Sunset District. Previously identified production well sites will be evaluated to assess optimal number of wells, their spacing, and individual capacities. Associated construction of pipelines, groundwater disinfection facilities (and potentially some blending) will be required as previously identified. All of these activities will be conducted in a coordinated manner to maximize understanding of the groundwater system, to develop and refine appropriate operating parameters (e.g., optimal spacing and sizing of production wells), and to provide safeguards for the quality and quantity of groundwater resources in the North Westside Basin. Eight potential groundwater supply projects in the North Westside Basin are listed and described in Appendix 3.

To the extent groundwater is developed that can be called upon to provide drinking water in an emergency, that source of supply could replace Lake Merced as a source of emergency drinking water. This would make the emergency use of Lake Merced for potable purposes extremely remote, thereby eliminating part of the institutional complexity of considering recycled water and other non-potable water supplies as sources of water to maintain Lake Merced water levels. Implementation of this Plan Element will be essential to accomplishing all the management objectives, or goals, for the basin.

Plan Element 5 - Initiation of Conjunctive Use Operations

To a certain extent in the Westside Basin as a whole, there are elements of conjunctive use already in place. The municipal water requirements of Daly City, South San Francisco, and San Bruno are met by a combination of local groundwater and SFPUC system water. However, the only "conjunctive" aspect of those water supplies is simply that both are used; there is no planned goal in terms of objectives for groundwater storage, levels, quality, etc. In the North Westside Basin, there is currently no significant groundwater development and use for municipal water supply apart from a small amount of irrigation pumpage; consequently, there is no conjunctive use of surface and groundwater in the North Westside Basin in any sense.

In considering the overall state of groundwater conditions in the basin, as described in Section III above, in combination with a recognition of several issues and opportunities associated with both groundwater and surface waters, e.g. Lake Merced, there are at least two obvious conjunctive use scenarios which can be implemented in the basin: development of some groundwater in the North Westside Basin to add that yield to the existing water supply and to provide an emergency source of supply, and purposeful use of the available groundwater storage space that has been vacated in those portions of the basin south of San Francisco. The development of a conjunctive use scenario that makes use of the vacated groundwater storage space to the south of San Francisco has begun to be assessed on a demonstration basis, with delivery of a replacement water supply and substantial pumping reductions by Daly City, South San Francisco (California Water Service Company), and San Bruno beginning in late 2002.

Within San Francisco, an important part of this Plan is the development of groundwater, generally between Golden Gate Park and the Zoo, and the integration of that groundwater supply with SFPUC system supply, including emergency supply. A program to develop groundwater within the North Westside Basin can be successfully implemented via a combination of several of the elements of this Plan, notably Elements 2 and 3, to accomplish the goals of developing groundwater for water supply, including emergency supply, while also preserving surface water features, such as Lake Merced, at desired levels.

Planning for groundwater development in the North Westside Basin will incorporate the use of a numerical groundwater flow model, currently in development, and continuation of coastal groundwater monitoring that has now been extended northward throughout the coastal portion of the aquifer system (Figure 5-2). Monitoring will be utilized for determination of key groundwater parameters and conditions for input to well design and pumping; it will also be used

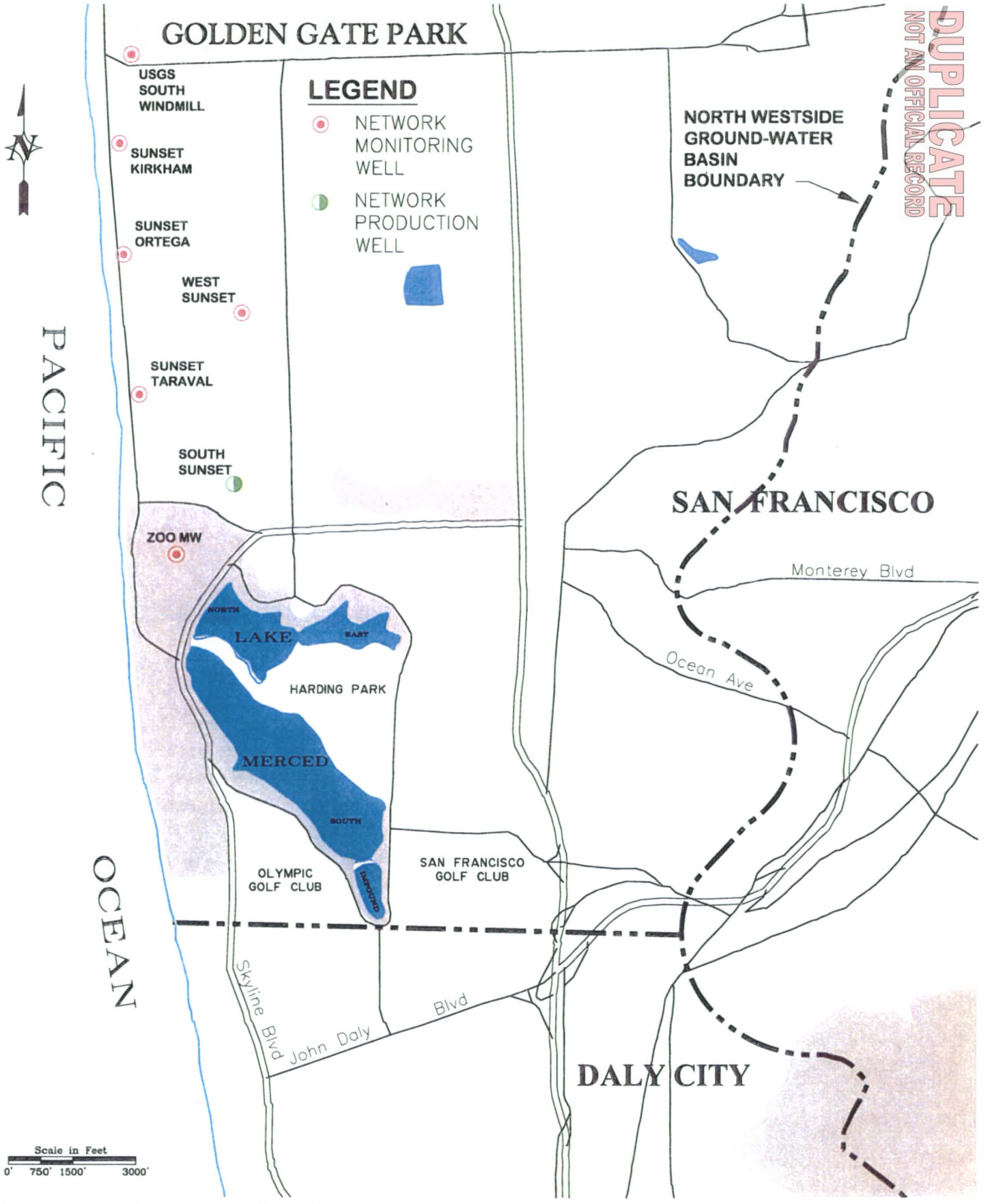

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Figure 5-2
Coastal Monitoring Network
North Westside Ground-Water Basin Management Plan

to determine actual basin response to pumping in order that operations be adjusted as necessary to remain within basin management objectives, i.e. avoid overdraft, intrusion and adverse effects on surface water bodies.

As part of conjunctively using surface water and groundwater in the overall Westside Basin, it is recognized that, particularly since a large fraction of surface water is imported from outside the basin, there will be variations in the amount of available surface water supply from year to year. Similarly, there are expected to be variations in local groundwater conditions as a function of local hydrologic conditions which affect, among other things, the natural recharge to the groundwater basin from year to year. In the case of this basin, local hydrology, which affects local groundwater conditions, may not necessarily be the same as the hydrology in a distant (Central Sierra Nevada) location that directly affects the availability of imported surface water in any given year. Thus, conjunctive use management within the Westside Basin poses additional challenges to ensure that the groundwater basin is maintained to meet a regular component of water supply and to be able to meet a larger component of water supply during "dry periods" that affect supplemental surface water availability. In light of all the preceding, implementation of this Plan Element is essential to accomplishing all the Basin Management Objectives.

Plan Element 6 - Integration of Recycled Water

A program has been initiated to reduce groundwater pumping for irrigation supply by substituting recycled water as the primary irrigation supply at three golf courses immediately adjacent to Lake Merced: the Olympic Club, Lake Merced Golf and Country Club, and San Francisco Golf Club. A fourth golf course, Harding Park in San Francisco, has undergone complete renovation which includes provisions for irrigation with recycled water.

The delivery of recycled water for irrigation water supply, which commenced in 2004, adds recycled water as a component of water supply in the basin and as a component of this Groundwater Management Plan. There are opportunities for recycled water use to substitute for irrigation beyond the golf courses, and other non-potable uses of groundwater in the North Westside Basin. Thus, this element of the Plan is included to address potential recycled water use in both the North Westside Basin and the entire basin.

The adoption of this Plan, in conjunction with ongoing efforts to revise the 1997 Recycled Water Master Plan, can create a new water supply in the form of groundwater formerly pumped at Golden Gate Park and the Zoo, and potable water offsets for water currently used by irrigators in

areas such as Harding Park. These groundwater and imported surface water supplies offset by the development of recycled water can be used to accomplish objectives of this Plan, including possibly providing a dedicated source of water for maintaining Lake Merced water levels or for pumping reductions by entities participating in the conjunctive use program in the South Westside Basin.

Plan Element 7 - Development and Continuation of Local, State and Federal Agency Relationships

Several of the currently ongoing basin management activities incorporated into this Plan are the result of local agency relationships that are intended to be continued through the implementation of this Plan. Most notable among those relationships are those with agencies who pump for municipal supply from the basin: Daly City, South San Francisco (primarily through its water purveyor, California Water Service Company), and San Bruno. Also notable is the relationship between the Westside Basin Partners and San Mateo County for semi-annual groundwater monitoring and reporting. The cooperative efforts have produced the groundwater monitoring and database (Plan Element 1) as well as the pilot conjunctive use/in-lieu recharge program (Plan Element 5) that are intended to expand into a larger scale utilization of vacated aquifer storage space. These efforts are all intended to aid in the development of both regular and dry year, and emergency water supply (Plan Element 4).

Historically, the SFPUC cooperated with the U.S. Geological Survey in an initial study of the Westside Basin (Yates, et al., 1990) and in subsequent cooperative efforts with Federal and State agencies. One important purpose of this Plan is to provide a comprehensive basis for coordinating with local, State and Federal agencies, as well as with environmental groups such as the Lake Merced Task Force.

Plan Element 8 - Continuation of Public Education and Water Conservation Programs

The SFPUC has an aggressive water conservation program and recently received the award for "Best Conservation Program-Large Utility" from the California Municipal Utilities Association (March 2000). The SFPUC's current conservation program is tailored around the Memorandum of Understanding Regarding Urban Water Conservation in California (1991) and includes water audits, large landscape conservation incentives, public and school education programs, and an ultra low flush toilet replacement program.

The SFPUC uses a variety of communication tools to provide for public information and involvement. These tools include newspaper ads, press announcements, public workshops, SFPUC web site posting, email distribution lists and regular mailing lists. The SFPUC regularly participates with the Lake Merced Task Force in conveying its investigations and findings relative to Lake Merced, most recently its conceptualization of the lake-aquifer system, its short-term water addition program, its investigation of a longer-term water addition program, and its in-lieu conjunctive use pilot program with Daly City and other municipal pumpers. This and other public participation efforts are intended to inform interested groups of technical and related details, to solicit input to lake management and conjunctive use planning, and to obtain community support for basin management actions.

Based on a recent review of its public education and water conservation programs, the SFPUC community information program will continue to focus on objectives of this Plan. The formalization of groundwater management in the North Westside Basin in this Plan will continue to include public education and water conservation toward the achievement of all four Basin Management Objectives.

Plan Element 9 - Identification and Management of Recharge Areas and Wellhead Protection Areas

The 1986 Amendments to the federal Safe Drinking Water Act (SDWA) established a new Wellhead Protection Program (WPP) to protect groundwater that supplies drinking water wells for public water systems. Each state was required to prepare a WPP and submit it to the USEPA by June 19, 1989. However, California did not develop an active state-wide Wellhead Protection Program at that time. Subsequently, in 1996, reauthorization of the SDWA established a related program called the Source Water Assessment Program. In 1999, the California Department of Health Services (DHS) Division of Drinking Water and Environmental Management developed its Drinking Water Source Assessment Program (DWSAP), and EPA approved it. The overall objective of the DWSAP is to ensure that the quality of drinking water sources is protected.

The wellhead protection aspect of the groundwater management plan component "identification and management of wellhead protection areas and recharge areas" is now essentially required as a result of the 1996 SDWA reauthorization.

In California, the DWSAP satisfies the mandates of both the 1986 and 1996 SDWA amendments. The California DWSAP includes delineation of the areas (i.e., protection areas or

Groundwater Protection Zones) surrounding an existing or proposed drinking water source where contaminants have the potential to migrate and reach that source. The program includes preparation of an inventory of activities that may lead to the release of contaminants within these zones. The activities, referred to in the DWSAP as Potentially Contaminating Activities, include such land uses as gas stations and dry cleaners, as well as many other land uses. The activities also include known contaminant plumes regulated by local, state, and federal agencies. The zones, which are calculated based on local hydrogeological conditions and also well operation and construction parameters, represent the approximate area from which groundwater may be withdrawn during 2, 5, and 10 year time periods. These zones also represent the area in which contaminants released to groundwater could migrate and potentially affect the groundwater extracted by wells located within the designated zones. The DWSAP assessment also includes a risk or vulnerability ranking based on a combined numerical score that results from points assigned to various evaluations conducted as part of the DWSAP process. This ranking provides a relative indication of the potential susceptibility of drinking water sources to contamination.

Although DHS is responsible for conducting drinking water source assessments for systems existing prior to the adoption of the California program, DHS has encouraged purveyors to perform their own assessments. Assessments for existing systems were due at the end of 2002; however, DHS has an extension allowing its assessment work to be completed by May 2003.

Permitting of a new water supply well requires that a DWSAP be completed as part of the permit process, and this is responsibility of the applicant. Since there has been no groundwater utilization for domestic supply by San Francisco, where limited groundwater development is mostly used by the City's Recreation and Park Department and the Presidio, only one DWSAP has been prepared thus far in San Francisco for the Lobos Creek Basin. That DWSAP is for the Presidio. In San Mateo County, where groundwater has been a principal source of water supply for many decades, several DWSAP assessments have been completed for the three municipal purveyors.

The results of the DWSAPs can be used as a planning tool to guide land use development in the vicinity of water sources. The DWSAPs prepared for water sources in the basin should, in some fashion, be reviewed every five years and updated more frequently as appropriate. The collective DWSAP information can also be integrated with other management activities including the siting of new wells, City ordinances regarding land use in the North Westside Basin, and well permitting ordinances administered by the City's Department of Public Health.

This Plan Element is included to incorporate the DWSAP efforts into the local groundwater management plan. Compliance with state DHS requirements is a key part of accomplishing the first and fourth Basin Management Objectives.

Plan Element 10 - Identification of Well Construction, Abandonment, and Destruction Policies

Well construction permitting in San Francisco is administered by the San Francisco Health Department which effectively implements the State Well Standards for water wells, monitoring wells, and cathodic protection wells. San Francisco is currently updating its Well Ordinance to address all aspects of well construction, pump installation, and well/pump operations. The goal of protecting and preserving groundwater quality requires that all wells be properly constructed and maintained during their operational lives, and properly destroyed after their useful lives. This ensures that wells do not adversely affect groundwater quality by, for example, serving as conduits for movement of contaminants from the ground surface and/or as conduits for inter-aquifer movement of poor quality groundwater. This element is included in the overall Plan to support well construction and destruction policies, and to participate in their implementation in the North Westside Basin, particularly with regard to surface and inter-aquifer well sealing and proper well destruction, which are particularly critical in coastal areas to maintain aquifer integrity.

Plan Element 11 - Identification and Mitigation of Soil and Groundwater Contamination

In general, groundwater is of high quality and meets drinking water standards in the North Westside Basin. However, nitrate levels have been detected at levels that exceed drinking water standards in two irrigation wells in the North Westside Basin. Locally elevated nitrate concentrations also occur in the Daly City area just south of the area included in this Plan; these elevated nitrate conditions are thought to be the result of historical farming practices in the area. In the more publicized arena of toxic or other hazardous chemical contamination, there have been localized instances of impacts on groundwater quality; however, these do not constrain potential municipal supplies. It is part of this Plan to actively monitor groundwater quality (Plan Element 1) and to actively participate with local health and other agencies as appropriate to identify spills, leaks or other threats to groundwater quality, and to participate in their control and cleanup such that groundwater quality is not impacted and does not limit water supply. Mitigation measures will be employed (well construction, placement, treatment, etc.) as an

element of developing groundwater supplies in order to reduce nitrate concentrations and other constituent concentrations, if they exceed drinking water standards, as necessary.

Plan Element 12 - Groundwater Management Reports

Given the very limited groundwater utilization in the North Westside Basin, in particular for municipal water supply, there has been no regular historical analysis and reporting on groundwater conditions in the basin. Over about the last decade, initial consideration of conjunctive use potential and significant concern about the level of Lake Merced have prompted a number of investigations, analyses, and reports, as well as extensive public comment, on groundwater in the Westside Basin and its interrelationship with Lake Merced.

Some of the more important reports on groundwater in the North Westside Basin in the last decade include the **Lake Merced Water Resource Planning Study** by Geo/Resource Consultants, 1993; two USGS Water Resources Investigations Reports, one by Yates and others in 1990 (WRI 90-4080) and the other by Phillips and others in 1993 (WRI 93-4019); and **Conceptualization of the Lake-Aquifer System, Westside Groundwater Basin, San Francisco and San Mateo Counties** by Luhdorff and Scalmanini, Consulting Engineers, 2002. Collectively, complemented by a large number of technical memoranda on a range of specific subjects, these reports provide the basic framework for understanding the geologic makeup of the system, the occurrence of groundwater in the basin, the interconnection between Lake Merced and the aquifer system, and between the aquifer system and the adjacent saline water bodies (the Pacific Ocean and San Francisco Bay), the history of groundwater use and the resultant groundwater conditions in the basin, and the current planning for future management of groundwater and related surface water features as described in this Plan.

As part of implementing this Plan, in particular as part of continuing agency relationships (Plan Element 7) and continuing public education (Plan Element 8), it is intended that future reporting will be in the form of a combination of ad-hoc technical reports and regular summaries of overall basin conditions. The various elements of this Plan will logically result in a number of technical reports on such topics as: maintenance of Lake Merced levels and quality; exploration, testing and development of groundwater north of Lake Merced; installation of extended coastal monitoring north of Lake Merced; conjunctive use program design in the basin, both north and south of Lake Merced; expanded utilization of recycled water to make additional groundwater available for potable use; and use of North Westside Basin wells as an emergency potable water source in lieu of Lake Merced. Work and reporting on those topics is expected to proceed over

the next several years. It is envisioned that regular reporting on surface water and groundwater conditions in the basin will be prepared on an annual or biennial frequency. The combination of annual or biennial reports and other technical reports will serve as regular and complete reporting on all aspects of this Groundwater Management Plan.

Plan Element 13 - Provisions to Update the Groundwater Management Plan

The elements of this Plan reflect the current understanding of the occurrence of groundwater in the North Westside Groundwater Basin, and specific problems or areas of concern about that resource. The Plan elements are designed to achieve specified objectives to develop local groundwater for regular and emergency water supply while both protecting and preserving groundwater quantity and quality and protecting and preserving valuable surface water resources that are directly related or connected to groundwater. While the Groundwater Management Plan provides a framework for present and future actions, new data will be developed as a result of implementing the Plan. That new data could define conditions which will require modifications to currently definable management actions. As a result, this Plan is intended to be a flexible document which can be updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future groundwater and surface water conditions. Although not intended to be a rigid schedule, review and updating of this Plan will initially be conducted in five years, with subsequent future updates scheduled as appropriate.

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APPENDIX 1

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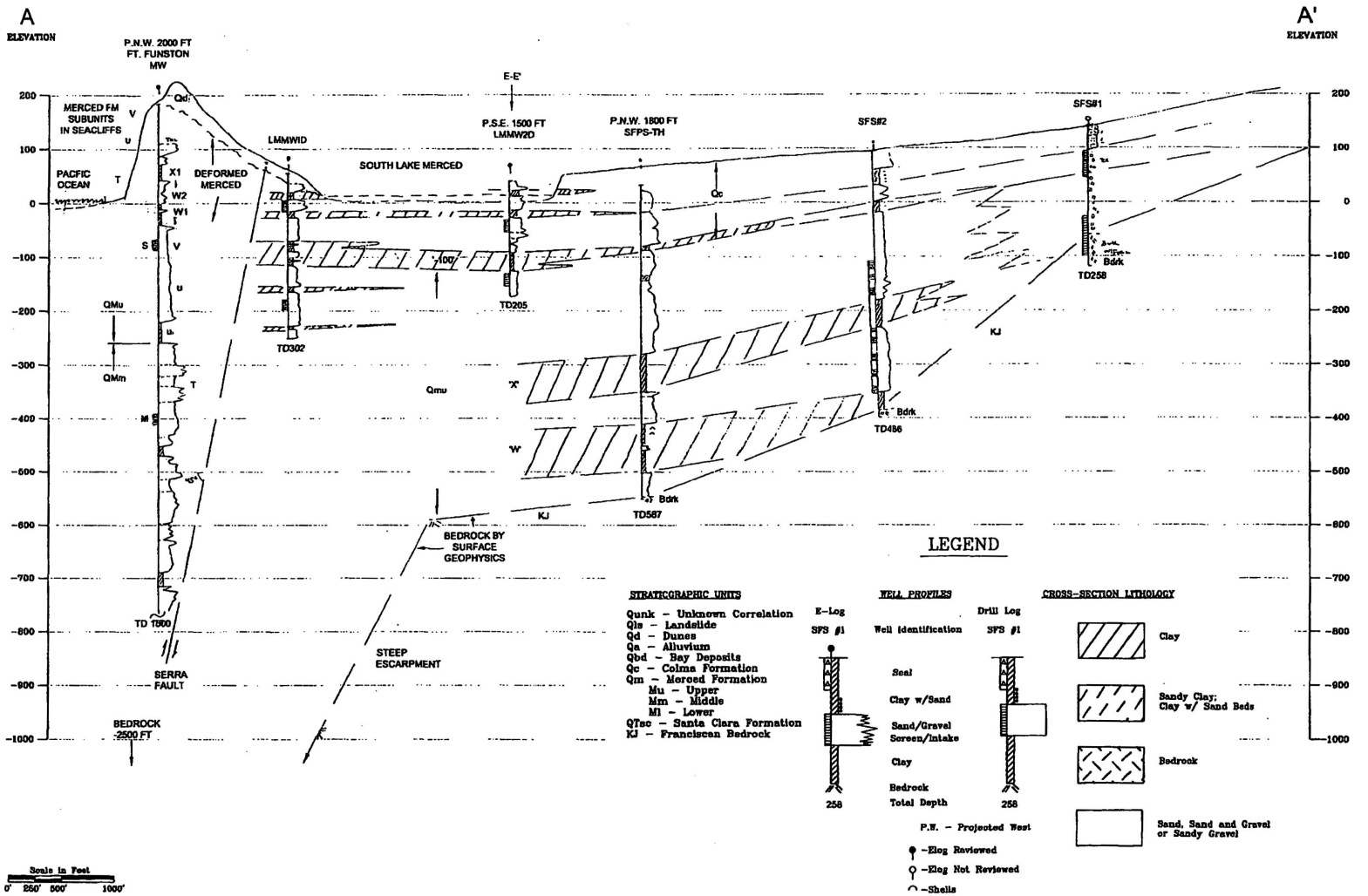
APPENDIX 2

Geologic Cross-Sections



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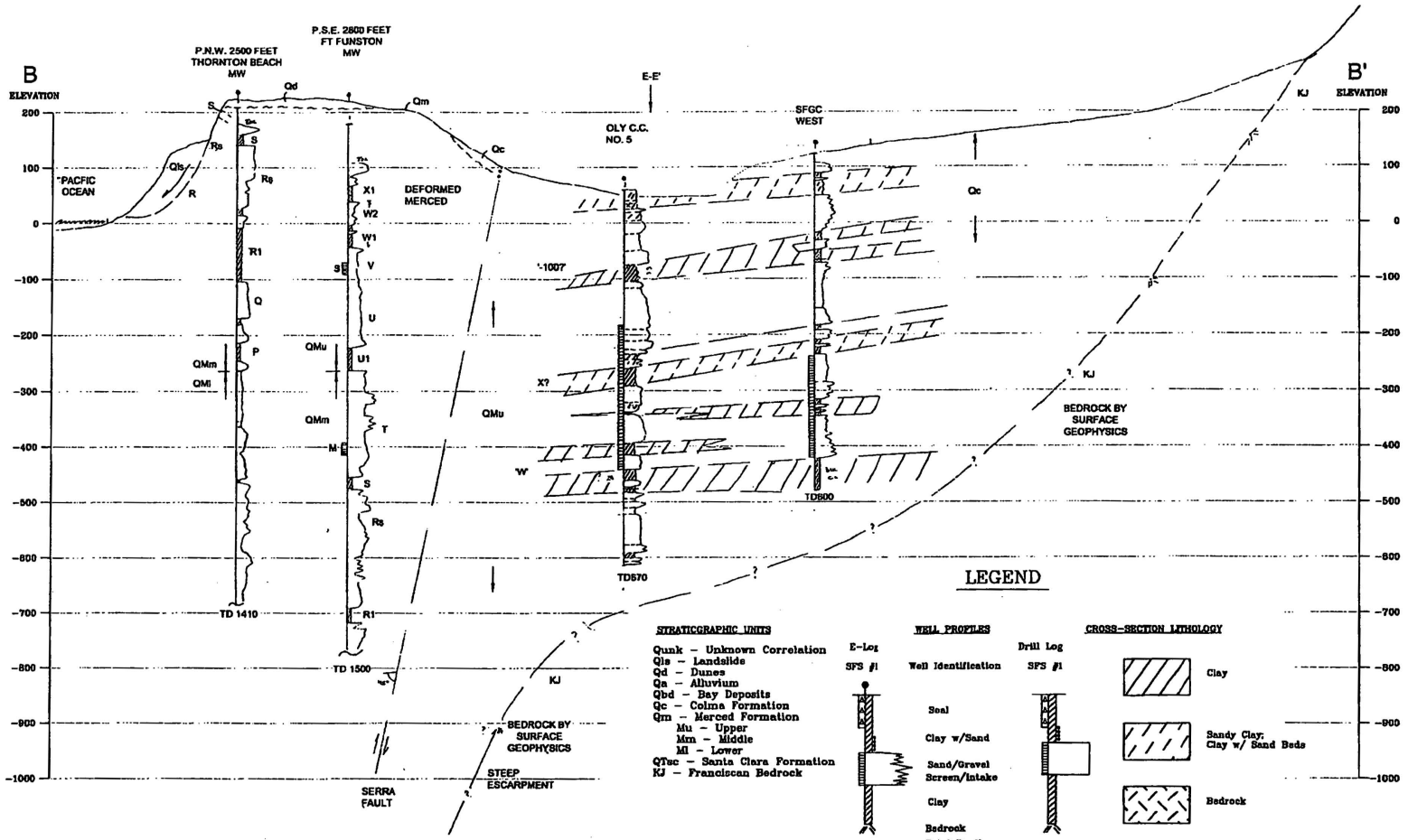
Geologic Cross Section A-A'
Westside Basin



LEGEND

STRATIGRAPHIC UNITS

Qunk – Unknown Correlation
Qls – Landslide
Qd – Dunes
Qa – Alluvium
Qbd – Bay Deposits
Qc – Colma Formation
Qm – Merced Formation
  Mu – Upper
  Mm – Middle
  Ml – Lower
QTsc – Santa Clara Formation
KJ – Franciscan Bedrock

WELL PROFILES

P.W. – Projected West
●–Elog Reviewed
○–Elog Not Reviewed
◠–Shells

CROSS-SECTION LITHOLOGY

Clay
Sandy Clay;
Clay w/ Sand Beds
Bedrock
Sand, Sand and Gravel
or Sandy Gravel

Scale in Feet
0' 250' 500' 1000'
Vertical Exag. 5X

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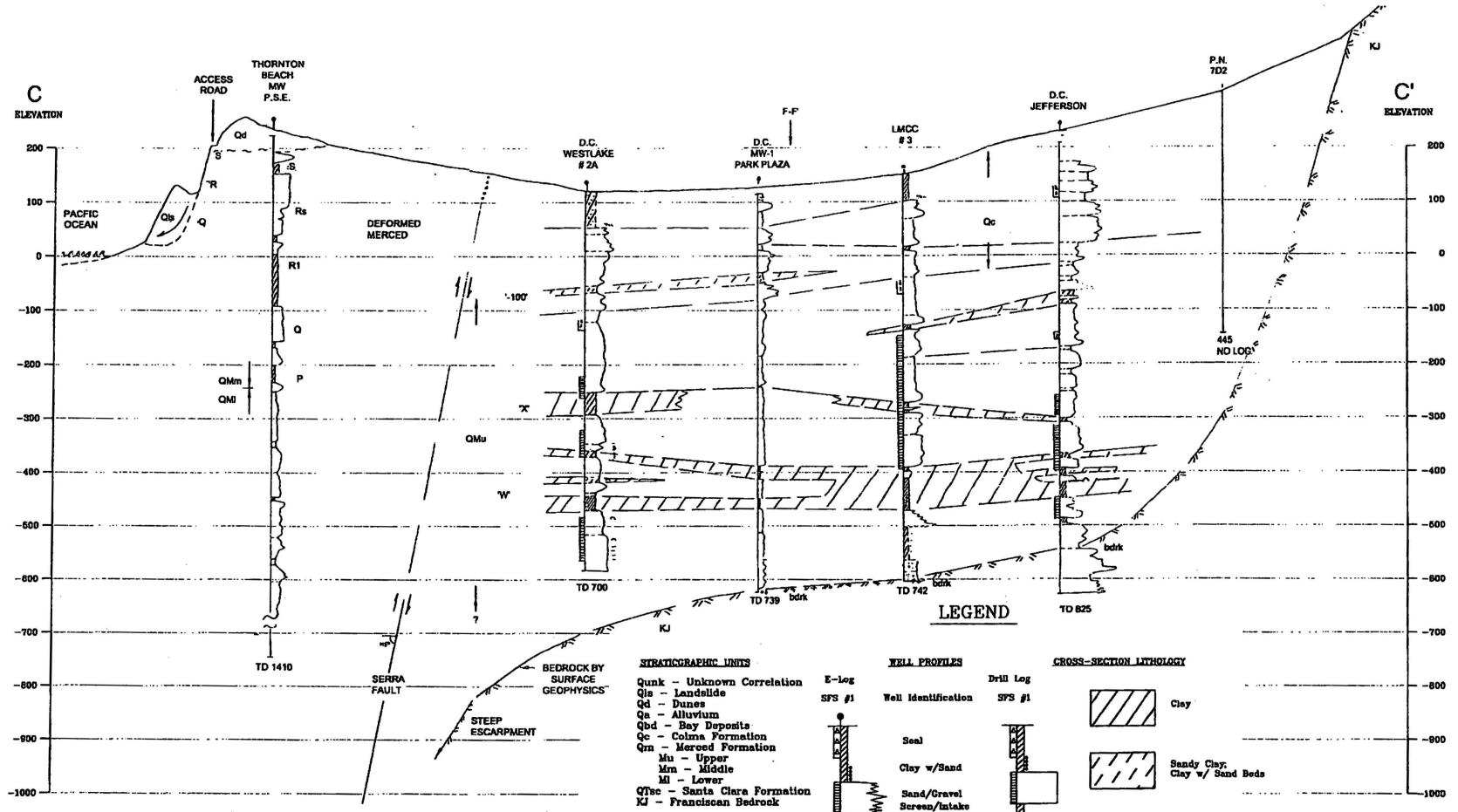
Geologic Cross Section B-B'
Westside Basin



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LUHDORFF & SCALMANINI
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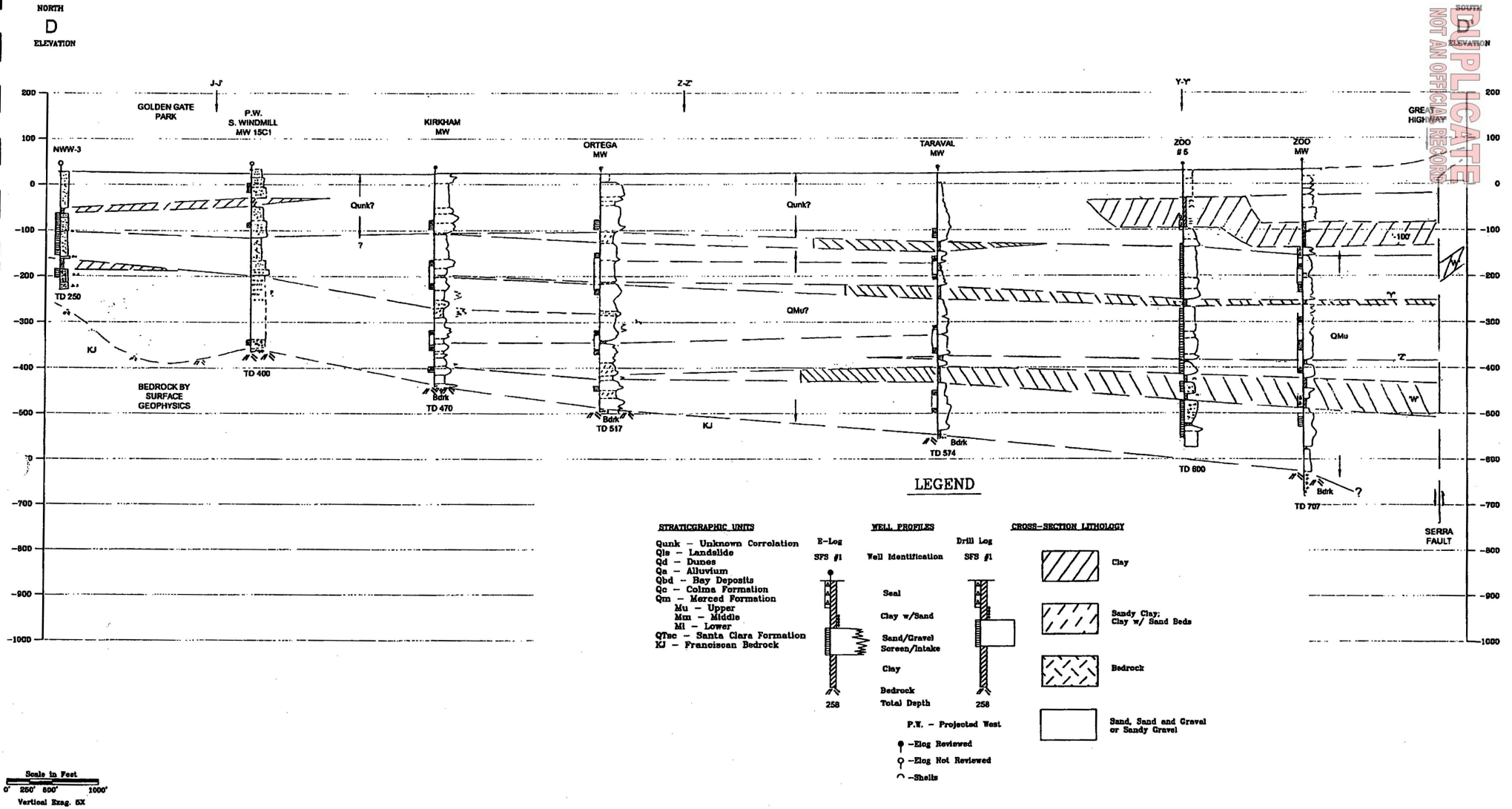
Geologic Cross Section C-C'
Westside Basin



LEGEND

STRATIGRAPHIC UNITS

- Qunk – Unknown Correlation
- Qls – Landslide
- Qd – Dunes
- Qa – Alluvium
- Qbd – Bay Deposits
- Qc – Colma Formation
- Qm – Merced Formation
  - Mu – Upper
  - Mm – Middle
  - Ml – Lower
- QTsc – Santa Clara Formation
- KJ – Franciscan Bedrock

WELL PROFILES

P.W. – Projected West

- –Elog Reviewed
- –Elog Not Reviewed
- –Shells

CROSS-SECTION LITHOLOGY

Scale in Feet
0' 250' 500' 1000'
Vertical Exag. 5X

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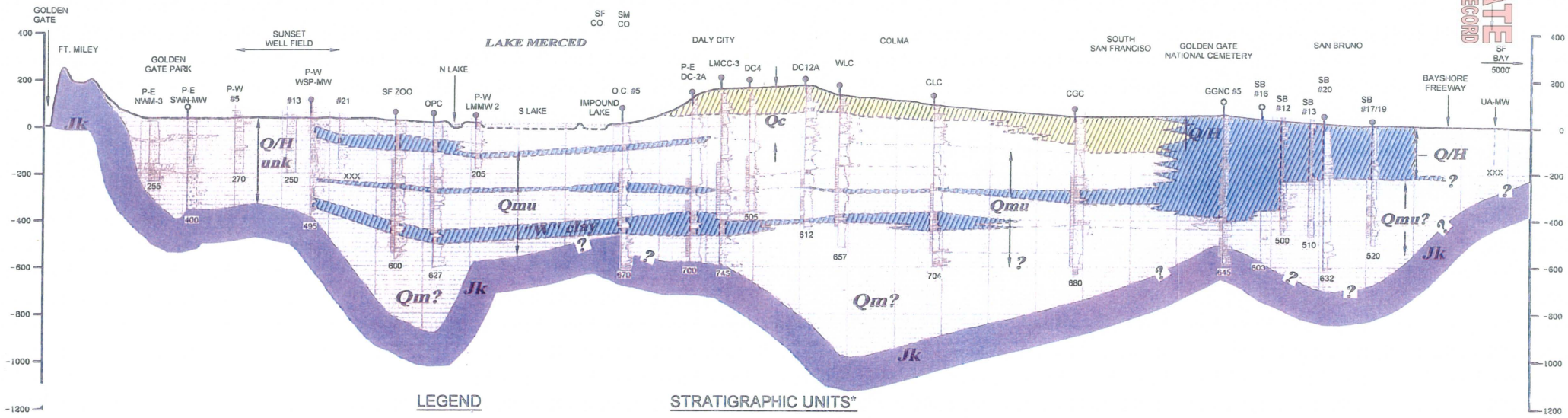
Geologic Cross Section D-D'
Westside Basin

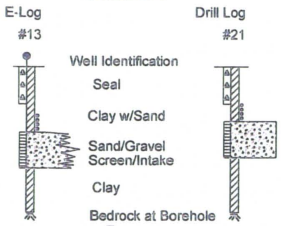
NORTH

SOUTH



LEGEND

WELL PROFILES



P-W - Projected West
P-E - Projected East
-Elog Reviewed
-Elog Not Reviewed

Scale in Feet
0' 1250' 2500' 5000'
Vertical Exag 12.5X

STRATIGRAPHIC UNITS*

Q/H	Bay Clays
Q/H unk	Unknown Correlation
Qc	Colma Formation
Qmu	Upper Merced Formation
Qm?	Older Merced Formation - Middle, Lower
Jk	Franciscan Bedrock

* SURFICIAL UNITS NOT SHOWN

APPENDIX 3

Potential Groundwater Supply Projects
North Westside Groundwater Basin

Potential Groundwater Supply Projects
North Westside Groundwater Basin

Most of the activities in this Plan would involve conducting studies and investigations for data collection purposes, or coordinating and executing a planning effort such as groundwater monitoring, groundwater modeling, and reporting. Implementing these study and planning efforts themselves would not have physical environmental impacts; however, specific facility projects and water management actions may result (and are intended to result) from these efforts and these may have physical environmental effects.

This Appendix describes eight specific groundwater production projects to be phased in within two to five years of plan adoption. The locations of the eight projects are illustrated in Figure A3-1. Project Nos. 2, 3 and 5 were previously reviewed in the Environmental Impact Report for the Recycled Water Master Plan and Groundwater Master Plan, certified by the CCSF Department of City Planning on August 7, 1997. Projects 1, 4, 6, 7 and 8 will require a supplemental review by the CCSF Department of City Planning. Prior to implementation, all of the projects listed below will involve public meetings, coordination and approval of property owners (e.g., Recreation and Parks Commission, San Francisco Zoo, San Francisco Unified School District), a Drinking Water Source Assessment as discussed under "Plan Element 9" (above), and permitting by the California Department of Health Services.

Project 1: Lake Merced Pump Station and Harding Park Emergency and Supplemental Well Facilities

This project would involve construction of up to four new wells, located at or near the Lake Merced Pump Station, to be used primarily as an emergency drinking water supply. Groundwater would be pumped into the distribution system in the event of an emergency. One or more of these wells may be designed to inject SFPUC system water into the underground Westside Basin aquifer for recharge. In addition, the piping system will be constructed to allow groundwater to be pumped into Lake Merced on a limited short-term basis. Such pumping to Lake Merced may occur on a limited basis to help maintain lake levels and during well testing.

The Lake Merced Pump Station is an existing facility located off of Lake Merced Boulevard and adjacent to South Lake. The facility currently has capability to draw water from Lake Merced at a rate of 1.7 mgd as an emergency water supply for the City distribution system. Lake Merced does not meet drinking water standards and there is no treatment facility at the Lake Merced

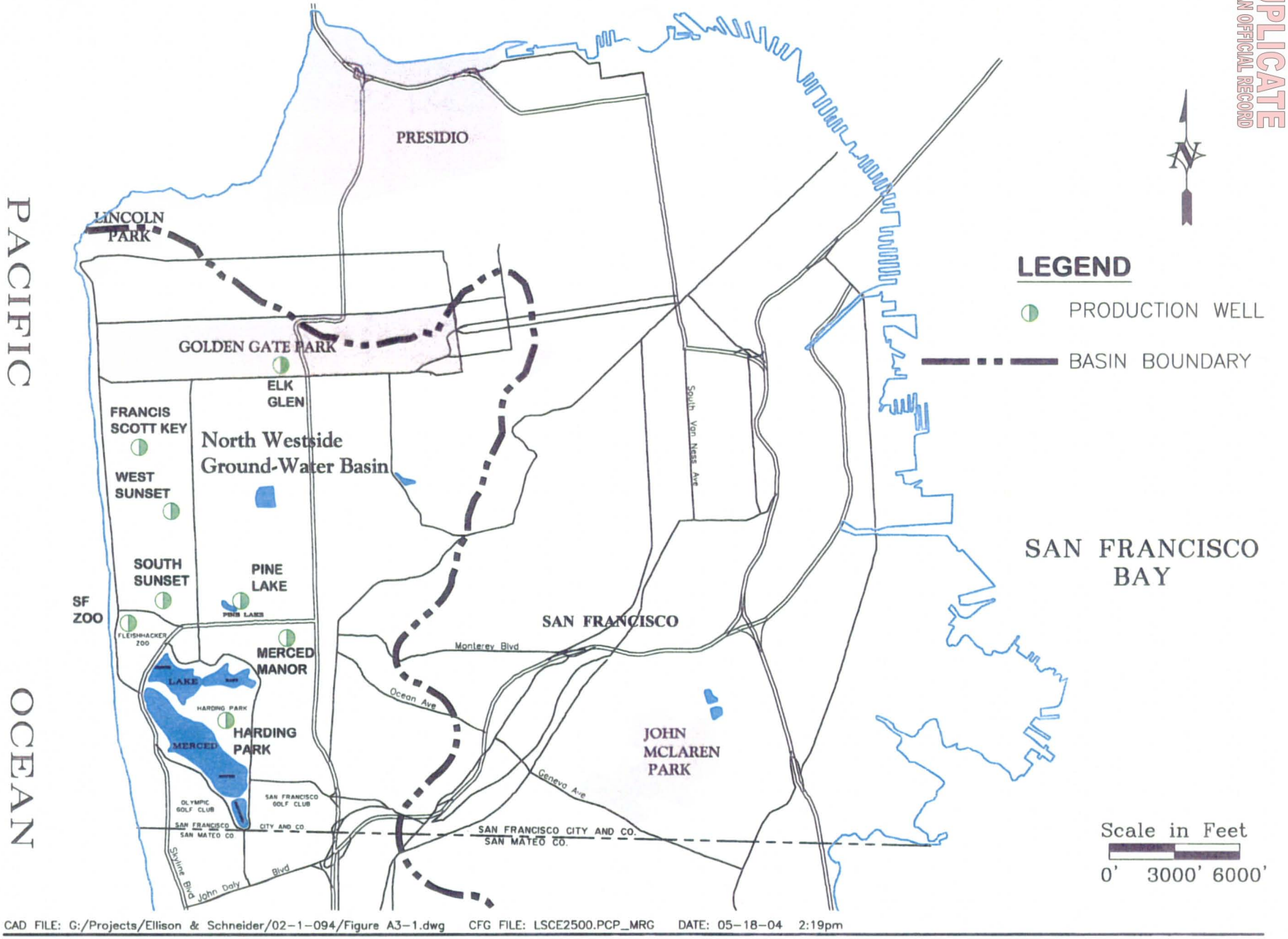


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Figure A3-1
Potential Ground-Water Supply Projects
North Westside Ground-Water Basin Management Plan

Pump Station. Therefore, SFPUC policy is that a "boil water order" would be issued in the event that lake water is ever needed during an emergency and pumped into the distribution system. Fortunately, this emergency capability has never been needed. Having the ability to pump local groundwater into the distribution system would increase system reliability in the event that the main water supply line to the Lake Merced Pump Station is interrupted due to an earthquake or other disaster.

Groundwater from deeper aquifers in the vicinity of Lake Merced is of high quality, generally meets drinking water standards, and nearby wells can yield over 500 gallons per minute. Installation of emergency wells at or near the Lake Merced Pump Station and nearby Harding Park appears feasible based on data from nearby wells and a site-specific 500 ft deep exploratory boring drilled in December 2003. Additional groundwater modeling and field investigations will be conducted prior to final design. The goal of Project 1 is to provide a short-term emergency capacity of up to 300 af for up to 30 days. Project 1 would involve a phased approach to installing emergency and supplemental well facilities and assumes that two wells could be located at or near the adjacent Harding Park Golf Course and be piped to the Lake Merced Pump Station.

Project 2: West Sunset Playground Groundwater Production Facility

This project would involve construction of one or two new municipal wells and a disinfection station at the West Sunset Playground to provide supplemental water to the SFPUC system and increase water supply reliability in the event of a drought or emergency. The decision regarding the final location and pumping rate of the wells would be based on aquifer testing and water quality testing at test wells at each of the proposed sites and on groundwater modeling which will help to evaluate any potential for future saltwater intrusion. See Plan Element 3 of this Plan for a description of the approach to avoid saltwater intrusion.

West Sunset Playground is located at 41st Avenue and Quintara Street. The proposed well and disinfection station would be located in the northeast corner of the existing parking area, which is approximately 335 feet by 70 feet. The site is accessible from Quintara Street. A 10-inch pipeline would be installed below grade from the disinfection station east up Quintara Street, south along 39th Avenue, and east up Rivera Street connecting to the existing water main on 30th Avenue. A test well was installed at this location by the SFPUC during development of the 1997 Master Plan.

This project would allow for the capture of groundwater that is currently lost to the Pacific Ocean. The design capacity of each well would be approximately 1,000 afy. However, actual pumping rates would be determined by current groundwater modeling efforts, and would on average be lower than design capacity in order to prevent saltwater intrusion. Previous groundwater modeling results indicate that the maximum pumping rate for each well would be up to 300 to 400 afy of potable water for a total of up to about 600 afy. Groundwater extracted from these wells would be added to the City's existing main water distribution system and also used for playground irrigation. New facilities would consist of a combination pumping and disinfection station (see Figure A3-2 for a typical disinfection station).

Project 3: Francis Scott Key School Site, Groundwater Production Facility

This project would involve construction of one new municipal well and disinfection station at the Francis Scott Key School site to provide supplemental water to the SFPUC system and increase water supply reliability in the event of a drought or emergency. The decision regarding the final location and pumping rate of the well will be based on aquifer testing and water quality testing at a test well at the proposed site and on groundwater modeling which will help to evaluate any potential for future saltwater intrusion.

Francis Scott Key School is bounded by 42nd and 43rd avenues and Kirkham and Lawton streets. The proposed well and disinfection station would be located in the northeast corner of the playground. The playground is approximately 800 feet by 200 feet and completely fenced. The playground is accessible from 42nd and 43rd avenues and Kirkham Street. A 10-inch pipeline would be installed below grade from the disinfection station east down Kirkham Street, connecting to the existing water main on 28th Avenue.

This project would allow for the capture of groundwater that is currently lost to the Pacific Ocean. The design capacity of the well would be approximately 1,000 afy. However, actual pumping rate would be determined by groundwater modeling efforts, and would on average be lower than design capacity in order to prevent saltwater intrusion. Previous groundwater modeling results indicate that the maximum pumping rate for the well would be up to 300 to 400 afy of potable water. Groundwater extracted from this well would be pumped into the City's existing main water distribution system and also potentially used for playground irrigation at Francis Scott Key School. New facilities would consist of a combination pumping well and disinfection station (see Figure A3-2 for a typical disinfection station).

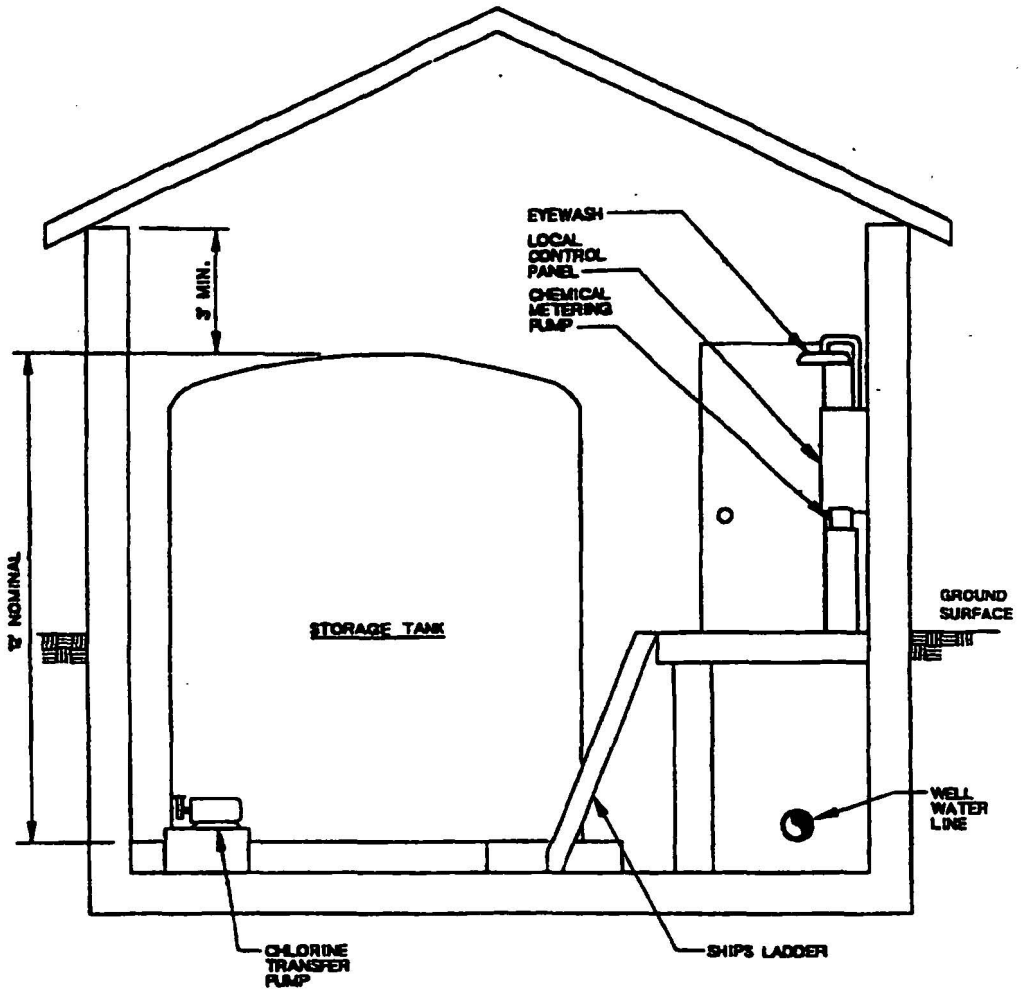

Figure A3-2
Example of a Disinfection Station
North Westside Ground-Water Basin Management Plan

Project 4: South Sunset Playground, Groundwater Production Facility

This project would involve construction of one new municipal well and disinfection station at the South Sunset Playground to provide supplemental water to the SFPUC system and increase water supply reliability in the event of a drought or emergency. The decision regarding the final location and pumping rate of the well will be based on aquifer testing and water quality testing at a test well at the proposed site and on groundwater modeling which will help to evaluate any potential for future saltwater intrusion. A test well was installed at this location by the SFPUC in 2003 during development of this Plan.

South Sunset Playground is bounded by 40th and 41st avenues and Vincente and Wawona streets. The location of the proposed well and disinfection station has not been selected.

The design capacity of the well will be based on results from the test well. Preliminary estimates indicate that the maximum pumping rate for the well would be up to 300 to 400 afy of potable water. Groundwater extracted from this well would be pumped into the City's existing main water distribution system and potentially for playground irrigation at South Sunset Playground. New facilities would consist of a combination pumping well and disinfection station (see Figure A3-2 for a typical well disinfection station).

Project 5: Golden Gate Park Elk Glen Well, Groundwater Production Facility

The Elk Glen Well is an existing well located on the northeast side of Elk Glen Lake in Golden Gate Park, near the intersection of Middle Drive West and Transverse Drive. The well is approximately 380 feet deep with a groundwater surface of about 60-70 feet below grade, and is currently used for irrigation at Golden Gate Park. The well pumps groundwater from 170 to 350 feet below grade, and currently has an estimated continuous pumping capacity of 1,300 afy. It is currently pumping about 500 afy.

The SFPUC, in coordination with the Department of Recreation and Parks, plan to supply recycled water to Golden Gate Park to replace a significant portion of the groundwater used for irrigation. Once recycled water is available, groundwater from the Elk Glen well, or a replacement well, could be pumped into the City's existing main water distribution system.

The Elk Glen Well would first be evaluated to determine whether or not the well meets construction standards for a municipal water supply well. Groundwater from the Elk Glen Well appears to meet all drinking water standards with the exception of nitrate. Nitrate levels in the

well have been measured between 49 and 55 mg/L which exceeds the drinking water standard of 45 mg/L. However, blending water from the Elk Glen well with SFPUC water would significantly reduce the nitrate levels to meet drinking water standards. Alternately, a new well could be constructed that selectively draws water from a deeper zone than the Elk Glen well.

If the well does not meet the standards, the San Francisco Water Department would coordinate with the Recreation and Park Department to determine whether the replacement well could be installed in the immediate vicinity of the existing well (this would prevent having to conduct water quality and aquifer testing in a new area) or whether another suitable location is available. The Elk Glen Well would be designed with a continuous pumping capacity of approximately 1,000 to 1,600 afy. However, actual pumping rates would be determined by groundwater modeling efforts, and would be lower than design capacity in order to prevent saltwater intrusion. Previous modeling results indicate that the maximum pumping rate would be about 850 afy.

Project 6: San Francisco Zoo Well Groundwater Production Facility

The San Francisco Zoo installed a new well, named "Zoo No. 5," in 1999. The Zoo No. 5 well is 480 feet deep and is screened between 150 and 460 feet below the ground surface. The well currently supplies water for zoo exhibits, irrigation, and facility wash down. The SFPUC, in coordination with the Department of Recreation and Parks and the Zoological Society, plan to supply recycled water to the Zoo to replace a significant portion of the groundwater currently pumped. Once recycled water is available, a significant portion of the groundwater from the Zoo No. 5 well could be used for municipal water supply by treating and adding the water into the SFPUC distribution system.

The volume of water to be utilized for municipal water supply has not been determined but will be based largely on the amount of recycled water that can replace groundwater and future aquifer tests and groundwater modeling.

Project 7: Pine Lake Water Supply Augmentation

This project would involve the construction of one new well or the use of an existing well and possibly a disinfection station, in or near Stern Grove for a combination of potential objectives: maintenance of Pine Lake and emergency or regular groundwater supply. The San Francisco Recreation and Park Department has been investigating alternatives to restore and maintain Pine Lake, and a logical candidate for supplemental water supply for the Lake is local groundwater.

Depending on the yield and capacity of a well constructed at that location, it is probable that there will be surplus capacity to the specific needs of the Lake. Such surplus capacity could be utilized for municipal supply by disinfecting and discharging it into the SFPUC distribution system. Supplemental water requirements for maintenance of Pine Lake have been preliminarily estimated to be nearly one acre-foot per day; however, a planned pilot test to raise and maintain lake levels to verify the initial estimates has not been conducted. Based on extensive empirical and analytical work at nearby and much larger Lake Merced, it is unlikely that the combined evaporation and infiltration losses of Pine Lake will be as high as initially estimated, and thus it can be expected that the supplemental water requirements at Pine Lake will be notably less than the probable capacity of a water supply well in that area. Thus, the surplus capacity from the well could be dedicated to municipal supply after appropriate disinfection, treatment if necessary, and physical separation between discharge to the Lake and discharge into the municipal distribution system.

Project 8: Central Pump Station/Merced Manor Reservoir, Groundwater Production Facility

This project would involve construction of a new municipal well(s) and disinfection station at Central Pump Station to provide supplemental water to the SFPUC system and increase water supply reliability in the event of a drought or emergency. This is the only listed project with an onsite water storage reservoir. However, the property is located in the eastern portion of the basin where pumping rates may be below average due to reduced aquifer thickness. The decision regarding the final location and pumping rate of the well will be based on aquifer testing and water quality testing at test wells at the proposed site and on current computer modeling which will help to evaluate any potential for future saltwater intrusion or impacts on Lake Merced and Pine Lake.

Central Pump Station and the Merced Manor Reservoir is bounded by 22nd and 23rd avenues and Sloat Boulevard and Ocean Avenue. Capital Improvement Project construction upgrades at Central Pump Station and the Merced Manor Reservoir began in April 2004. Groundwater extracted from this well would be pumped into the City's existing main water distribution system and/or into Merced Manor Reservoir. New facilities would consist of a combination pumping well and disinfection station (see Figure A3-2 for a typical well disinfection station)

Table A-1. Potential Groundwater Supply Projects, North Westside Groundwater Basin Regular and Emergency Well Facilities

Project No.	Location	Activity	Assumption	Benefit	Estimated Amount Acre feet/year[6]	Potential Constraints
1	Lake Merced Pump Station and Harding Park	Install two or more new wells, add into main pipeline as emergency supply	Well and disinfection site(s) exist at Harding Park	Primarily to be used as an emergency water supply. Potential use as a partial supplemental supply for Lake Merced	300-400[3] Potential short term emergency capacity of up to about to 3 MGD for up to 30 days	Located near Lake Merced
2	West Sunset Playground	Install one or two new wells, add into main pipeline	Well and disinfection site exists	Supply additional potable water to SFPUC system and use for playground irrigation	300-600[2]	
3	Francis Scott Key School Site	Install one new well, add into main pipeline	Well and disinfection site exists	Supply additional potable water to SFPUC system	300-400[2]	
4	South Sunset Playground	Install one new well, add into main pipeline	Well and disinfection site exists	Supply additional potable water to SFPUC system and use for playground irrigation	300-400[3]	Located near Pine Lake
5	Golden Gate Park	Operate Elk Glen well for maximum safe extraction amount, add into main pipeline	Existing well is okay for production of potable water. Recycled water would eventually replace most irrigation water demand	Supply additional potable water to SFPUC system	500-900 [0-500 Rec and Park use in Elk Glen][1]	
6	San Francisco Zoo	Operate Zoo No. 5 well for maximum safe extraction amount, add to main pipeline	Disinfection site exists	Supply additional potable water to SFPUC system	To be determined	
7	Pine Lake	Install one new well for lake augmentation and add to main pipeline	Well site and disinfection site exists	Supplemental water supply for Pine Lake and additional potable water to SFPUC system	300-400	

Table A-1. Potential Groundwater Supply Projects, North Westside Groundwater Basin Regular and Emergency Well Facilities, *continued*

8	Central Pump Station	Install one or more wells, add into main pipeline or Merced Manor Reservoir	Well and disinfection site exists	Supply additional potable water to SFPUC system. Only site with adjacent reservoir.	Well yield(s) to be determined based on test well. Higher, short term emergency capacity in coordination with wells in Project 1.	Located near Lake Merced and Pine Lake
	Total New Wells[4]	11 to 12		Total Potential Production[4,5]	1700-2700 ac-ft/yr	

Notes:
[1]San Francisco Groundwater Master Plan, 1997.
[2]San Francisco Recycled Water Master Plan and Groundwater Master Plan Final Environmental Impact Report, 1997.
[3]Preliminary estimate based on nearby wells at SF Zoo and Olympic Club.
[4] Does not include one or more wells at the Central Pump Station
[5] The US Geological Survey estimated that the average annual recharge in the North Westside Basin is 4,846 ac-ft/yr (Phillips, et al., 1993).
[6]One acre foot = The volume of water required to cover one acre of land to a depth of one foot, or 325,851 gallons.

APPENDIX 4

North Westside Basin Stakeholder Organizations

North Westside Basin Stakeholder Organizations

Following is a list of North Westside Basin stakeholder organizations that were contacted during development of this Groundwater Management Plan. In addition to these organizations, the SFPUC contacted numerous individual members during development of this Plan.

Non Profit Organizations:
Lake Merced Task Force
California Trout
San Francisco Zoological Society
Friends of Lake Merced
Committee to Save Lake Merced
Sierra Club

Private Businesses:
California Water Services (South San Francisco)
San Francisco Golf Club
Olympic Club Golf Course
Lake Merced Golf and Country Club
Edgewood School

San Francisco Departments and Agencies:
San Francisco Department of Recreation and Parks
San Francisco Department of Public Health
San Francisco Unified School District

Other Local, Regional and State Agencies:
Bay Area Water Supply and Conservation Agency
City of Daly City
City of San Bruno
San Mateo County Health Department, Environmental Health Division
California Department of Health Services
San Francisco Bay Regional Water Quality Control Board
California Department of Water Resources

APPENDIX.5

North Westside Basin
Dispute Resolution

North Westside Basin Dispute Resolution

A dispute resolution process for groundwater management issues is outlined below. Such a process is not expected to be called upon often because 1) the North Westside Basin is a relatively small sub area, located entirely within the City and County of San Francisco, 2) Existing pumping, other than by San Francisco Departments, is limited to two private golf courses and one private school and 3) in 2004, the golf courses began receiving recycled water for irrigation and reducing their groundwater pumping.

Opportunities for addressing disputes will, if necessary, follow 4 steps:

Step 1 – Dispute is brought to the attention of the SFPUC's Integrated Water Resources Manager. Dispute is resolved or elevated.

Step 2 – Dispute is brought to the attention of the SFPUC's General Manager. Dispute is resolved or elevated.

Step 3 – Dispute is brought to the attention of the SFPUC at a regular Commission Meeting. Dispute is resolved or elevated.

Step 4 – Dispute is brought to the attention of the San Francisco Board of Supervisors for final resolution.

This dispute resolution process will be periodically reviewed and revised if needed.