Policy 11.3: Encourage development that efficiently coordinates land use with transit service, requiring that developers address transit concerns as well as mitigate traffic problems.

Objective 12: Develop and implement programs in the public and private sectors, which will support congestion management and air quality objectives, maintain mobility and enhance business vitality at minimum cost.

Policy 12.2: Build on successful efforts implemented at numerous private sector worksites, such as the downtown Transportation Brokerage Program and voluntary programs, and adapt such programs for application in new areas as appropriate.

Policy 12.3: Implement private and public sector TDM programs, which support each other, and explore opportunities for private-public responsibility in program implementation.

Policy 12.8: Encourage the creation of Transportation Management Associations where specific needs are identified and coordination with other similar associations and agencies is pursued.

Objective 14: Develop and implement a plan for operational changes and land use policies that will maintain mobility and safety despite a rise in travel demand that could otherwise result in system capacity deficiencies.

Policy 14.6: Reduce peak period congestion through the promotion of flexible work schedules at worksites throughout the City.

Policy 14.7: Encourage the use of transit and other alternative modes of travel to the private automobile through the positioning of building entrances that prioritize access from these modes.

Objective 16: Develop and implement programs that will efficiently manage the supply of parking at employment centers throughout the City so as to discourage single-occupant ridership and encourage ridesharing, transit and other alternatives to the single-occupant automobile.

Policy 16.1: Reduce parking demand through the provision of comprehensive information that encourages the use of alternative modes of transportation.

Policy 16.3: Reduce parking demand through the provision of incentives for the use of carpools and vanpools at new and existing parking facilities throughout the City.

Policy 16.4: Manage parking demand through appropriate pricing policies including the use of premium rates near employment centers well-served by transit, walking and bicycling, and progressive rate structures to encourage turnover and the efficient use of parking.

Policy 16.5: Reduce parking demand through limiting the absolute amount of spaces and prioritizing the spaces for short-term and ride-share uses.

Objective 18: Establish a street hierarchy system in which the function and design of each street are consistent with the character and use of adjacent land.

Policy 18.1: Wherever feasible, divert through automobile and commercial traffic from residential neighborhoods onto major and secondary arterials, and limit major arterials to nonresidential streets wherever possible.

Policy 18.2: Design streets for a level of traffic that serves, but will not cause a detrimental impact on adjacent land uses.

Policy 18.3: The existing single-occupant vehicular capacity of the bridges, highways and freeways entering the city should not be increased and should be reduced if needed to increase the capacity for high-occupancy vehicles, transit and other alternative means of commuting, and for the safe and efficient movement of freight trucks.

Policy 18.4: Discourage high-speed through traffic on local streets in residential areas through traffic "calming" measures that are designed not to disrupt transit service or bicycle movement.

Policy 18.5: Mitigate and reduce the impacts of automobile traffic in and around parks and along shoreline recreation areas.

Objective 20: Give first priority to improving transit service throughout the City, providing a convenient and efficient system as a preferable alternative to automobile use.

Policy 20.2: Reduce, relocate or prohibit automobile facility features on transit preferential streets, such as driveways and loading docks, to avoid traffic conflicts and automobile congestion.

Policy 20.5: Place and maintain all sidewalk elements, including passenger shelters, benches, trees, newsracks, kiosks, toilets, and utilities at appropriate transit stops according to established guidelines.

Objective 21: Develop transit as the primary mode of travel to and from downtown and all major activity centers within the region.

Policy 21.1: Provide transit service from residential areas to major employment centers outside the downtown area.

Objective 22: Develop and improve demand-responsive transit systems as a supplement to regular transit services.

Policy 22.2: Consider possibilities for supplementary, privately operated transit services.

Objective 23: Improve the city's pedestrian circulation system to provide for efficient, pleasant, and safe movement.

Policy 23.2: Widen sidewalks where intensive commercial, recreational, or institutional activity is present and where residential densities are high.

Policy 23.5: Minimize obstruction to through pedestrian movement on sidewalks by maintaining an unobstructed width that allows for passage of people, strollers and wheelchairs.

Objective 24: Improve the ambience of the pedestrian environment.

Policy 24.2: Maintain and expand the planting of street trees.

Policy 24.3: Install pedestrian-serving street furniture where appropriate.

Policy 24.4: Preserve pedestrian-oriented building frontages.

Objective 27: Ensure that bicycles can be used safely and conveniently as a primary means of transportation, as well as for recreational purposes.

Policy 27.1: Expand and improve access for bicycles on city streets and develop a well-marked, comprehensive system of bike routes in San Francisco.

Policy 27.9: Identify and expand recreational bicycling opportunities.

Objective 28: Provide secure and convenient parking facilities for bicycles.

Policy 28.1: Provide secure bicycle parking in new governmental, commercial, and residential developments.

Objective 30: Ensure that the provision of new or enlarged parking facilities does not adversely affect the livability and desirability of the city and its various neighborhoods.

Policy 30.2: Discourage the proliferation of surface parking as an interim land use, particularly where sound residential, commercial or industrial buildings would be demolished pending other development.

Policy 30.5: In any large development, allocate a portion of the provided off-street parking spaces for compact automobiles, vanpools, bicycles and motorcycles commensurate with standard that are, at a minimum, representative of their proportion of the city's vehicle population.

Policy 30.6: Make existing and new accessory parking available to nearby residents and the general public for use as short-term or evening parking when not being utilized by the business of institution to which it is accessory.

Objective 31: Establish parking rates and off-street parking fare structures to reflect the full costs, monetary and environmental, of parking in the city.

Policy 31.1: Set rates to encourage short-term over long-term automobile parking.

Policy 31.2: Where off-street parking near institutions and in commercial areas outside downtown is in short supply, set parking rates to encourage higher turnover and more efficient use of the parking supply.

Objective 40: Enforce a parking and loading strategy for freight distribution to reduce congestion affecting other vehicular traffic and adverse impacts on pedestrian circulation.

Policy 40.1: Provide off-street facilities for freight loading and service vehicles on the site of new buildings sufficient to met the demands generated by the intended uses. Seek opportunities to create new off-street loading facilities for existing buildings.

Policy 40.2: Discourage access to off-street freight loading and service vehicle facilities from transit preferential streets, or pedestrian-oriented streets and alleys by providing alternative access routes to facilities.

Policy 40.4: Driveways and curb cuts should be designed to avoid maneuvering on sidewalks or in street traffic, but when crossing sidewalks they should be only as wide as necessary to accomplish this function.

Policy 40.5: Loading docks and freight elevators should be located conveniently and sized sufficiently to maximize the efficiency of loading and unloading activity.

Policy 40.8: Provide limited curbside loading spaces to meet the need for short-term courier deliveries/pickup.

Policy 40.9: Where possible, mitigate the undesirable effects of noise, vibration and emission by limiting late evening and early hour loading and unloading in retail, institutional, and industrial facilities abutting residential neighborhoods.

ANALYSIS APPROACH

This section describes the steps followed to develop future year (2015) background socioeconomic growth conditions for the Mission Bay project transportation analysis. This information on future conditions was used to update the regional travel demand model developed by the Metropolitan Transportation Commission (MTC) that analyzes the regional freeway and highway network in San Francisco and the rest of the region. The update was determined necessary to account for potential employment and population growth in San Francisco, primarily in various redevelopment survey areas, that was not included in the Association of Bay Area Governments' (ABAG) 1996 regional growth forecasts currently used in the MTC model.

The update of the MTC regional travel demand estimates was conducted in three steps: 1) developing updated San Francisco year 2015 land use/socioeconomic information for the proposed redevelopment areas and the rest of San Francisco (see Table D.2 for a comparison of this 2015 information with forecasts for 2015 prepared by ABAG); 2) updating MTC's regional travel demand model to incorporate the revised population and employment growth forecasts, using an iterative technique/2/ to obtain revised year 2015 travel demand estimates to and from San Francisco, reflecting the revised population and employment growth projections, in order to obtain revised year 2015 travel demand estimates to and from San Francisco; and 3) determining the numbers and travel paths of vehicles that would use the regional and local San Francisco street network during the p.m. peak hour. The year 2015 was chosen as the time frame for the future cumulative impact analyses based on the longest time frame provided in the ABAG *Projections '96* regional growth forecasts and the MTC regional model.

The San Francisco Redevelopment Agency and the Planning Department worked together with a consultant to prepare updated cumulative employment and population growth forecasts for San Francisco for 2015. A more detailed description of the steps taken to prepare the year 2015 cumulative growth forecasts update effort is presented in a series of technical memoranda prepared for the Redevelopment Agency and the Planning Department by economic and transportation planning consultants in April, May, and August 1997 and in March 1998./3/ Because the transportation analysis for this SEIR and for other EIRs in preparation on Redevelopment Agency proposals (such as EIRs for Bayview Hunters Point, Hunters Point Shipyard Reuse Plan, and the Treasure Island Naval Station Reuse Plan) required considerable amounts of time, work to revise the MTC regional transporation model to incorporate the new cumulative growth forecast information was carried out during summer, 1997, using preliminary forecast results from the April and May technical memoranda. The draft citywide 2015 cumulative growth scenario results, reported in an August 27, 1997 memorandum from Keyser Marston Associates to Stanley Muraoka of the Redevelopment Agency, are not substantially different from those used to revise the transportation model—about 100 more employees (less than 0.02%) and about 500 more residents (about 0.06%) were used in the revised transportation model than are shown in the August 27 memorandum. The March 1998 final memorandum added text explanation and did not substantially alter scenario results. It should be noted that no changes were made to the land use and socio-economic database in ABAG's *Projections '96* for the other eight counties included in the San Francisco Bay Area. Thus, the differences in population and employment shown in Table D.2 for San Francisco County (about 24,100 residents and 26,700 jobs, respectively) also represent the added growth for the entire nine-county San Francisco Bay Area. Based on the projected build-out horizon of the Mission Bay project, the new citywide growth forecast assumes about 70% of the total Research and Development/Office component of the Mission Bay South Redevelopment Plan would be built and occupied by 2015. However, in this SEIR, for conservative project-related analysis purposes, the full development of all of the Project Area was assumed and added to the MTC model, based on interim assumptions of full development provided by Hausrath Economics Group in July 1997.

TABLE D.2
ABAG VS. SAN FRANCISCO REVISED COMPARISON OF YEAR 2015 POPULATION AND EMPLOYMENT

	ABAG Projections '96		San Francisco Revised Projections		Difference	
	Population	Employment	Population	Employment	Population	Employment
Mission Bay Project	5,473	17,260	11,124	25,358	+5,671	+8,098
Rest of San Francisco	790,325	621,424	808,818	640,042	+18,493	+18,618
Total San Francisco	795,798	638,684	819,942	665,400	+24,144	+26,716

Source: ABAG *Projections '96*; and Keyser Marston Associates, Technical Memorandum: TAZ Projections for San Francisco, Cumulative Growth Analyses, to Stan Muraoka, SFRA, April 16, 1997.

The second step in preparing a cumulative transportation analysis was to update MTC's regional travel demand model to include the new San Francisco growth forecasts and full build-out in Mission Bay. Intensive computer requirements precluded rerunning the first three steps of the travel forecasting process to generate new trip tables./4/ Instead, MTC staff indicated that the current MTC trip tables (developed in 1996) for year 2015 could be adjusted using an iterative modeling technique to reflect the effects of the revised population and employment growth projections on the origin/destination trip tables./5/ The results from the updated MTC regional model, including full development in the Project Area, were reported for regional cumulative transportation effects at the regional traffic screenlines (the Golden Gate Bridge, the Bay Bridge, and U.S.101/I-280 at the San Francisco/San Mateo County line) and on the regional transit services. The Mission Bay component of the data used to update the MTC model was from an interim estimate of project population and employment growth, again due to timing of the MTC model update; therefore, the cumulative regional impacts reported in the SEIR are slightly overestimated (less than 0.1%) compared to the results that would have been obtained had the employment and population totals discussed in "Project Area and Cumulative Citywide Growth" in Section V.C, Business Activity, Employment, Housing, and Population: Impacts, been available.

A future cumulative No Project scenario was created for the MTC model 2015 scenario by removing travel related to Mission Bay development but retaining all other added San Francisco growth.

The final step in the travel forecasting process was to conduct peak hour vehicular trip assignments using the updated year 2015 origin-destination trip tables as input to MTC's travel demand assignment model. The results of this process were year 2015 p.m. peak hour traffic estimates on the local street and regional highway networks in San Francisco and the rest of the Bay Area./6/ The results, which reflected the changes in population and employment described earlier, were then used to evaluate project impacts to local intersections within the study area. Project trip generation factors, described under "Methodology," below, and used to analyze project-specific impacts on local intersections, were based on land uses rather than on employment and population forecasts for the Project Area. By the time this step was carried out, final analyses were available for the project-specific land uses; therefore the numbers used for trip generation calculations for the project are the same as those used in the rest of the SEIR analyses.

The evaluation of project impacts on MUNI service has been conducted using a screenline analysis approach. MUNI screenlines are hypothetical lines representing aggregates of individual MUNI lines by corridor (as listed in Table V.E.3, with screenlines shown in Figure V.E.6), developed to measure conditions on combined MUNI transit lines from the greater downtown (including the Project Area) to other parts of San Francisco. This screenline analysis approach has been traditionally used for evaluation of projects in the greater downtown area and is based on the Downtown Plan and 1990 Mission Bay FEIR, which established the screenline definitions.

As a result of consultation with MUNI and Planning Department staff, the screenline locations and the transit routes included in each screenline have been modified for this Mission Bay project transit analysis, to better evaluate project impacts. The most important changes have been the elimination of "policy lines"/7/ from the screenline analysis and further disaggregation of each screenline into subcategories or transit corridors. It should be noted that the points of measurement for the screenlines do not actually follow the alignments shown schematically in Figure V.E.6, but instead are measured at the actual maximum load point for each MUNI line crossing a screenline.

METHODOLOGY

This section describes in detail the analysis methodology used in quantifying the transportation effects of the Mission Bay project. It presents the specific trip generation rates for each land use type and their p.m. peak hour proportions. It also describes trip distribution characteristics, travel mode splits, and typical vehicle occupancy rates.

Trip Generation Assumptions

Trip generation involves the determination of person trips that would be generated by Mission Bay development. Each land use type has a corresponding rate that indicates the number of daily person trips generated by a unit area (usually, square feet or dwelling unit) of a particular type of development, including both trips into and away from each land use./8/ Each type of space also has its own characteristic proportion of trips generated during the p.m. peak hour analysis time period. The time period chosen for analysis of predicted transportation needs was the peak hour of the 4:00 p.m. to 6:00 p.m. afternoon commute period. This time of day traditionally comprises a large portion of the total daily trips generated by any establishment, and consequently was chosen to reflect the worst case scenario within a typical weekday. The afternoon peak hour was chosen rather than the morning peak because the commute from greater downtown San Francisco to other parts of the City and to residential areas in the North Bay, East Bay, and South Bay is more concentrated during the afternoon peak. San Francisco workers largely contribute to the greater number of individuals traveling through San Francisco from jobs and other activities, such as shopping, to non-San Francisco destinations.

The daily trip rates and p.m. peak hour trip rates shown in Table D.3 are those for a typical weekday. The trip rates for the p.m. peak hour are given as percentages of the total weekday daily trips. As noted, the trip rates are based upon data gathered by the San Francisco Planning Department. Restaurant space generates substantially more person trips during the analysis period than retail establishments. The combination of the higher generation rate and the greater portion of the generated trips occurring during the p.m. peak hour yields many more trips than a comparable area of retail space. Some uses that could be established in the neighborhood-serving retail areas may have intermittent use, such as churches or small educational facilities (e.g., private sports schools or computer training facilities). In many cases the majority of travel to or from these uses occurs before or after the afternoon peak period and the p.m. peak hour trip rate would be relatively low; however, standard trip rates have been used for all but restaurant space in order to provide a most conservative (worst case) transportation impacts analysis.

The trip generation rate established for the proposed 25-screen movie theater was based upon attendance data gathered from the AMC Kabuki Theatres in San Francisco./9/ Knowledge of the theaters' movie schedules and attendance for shows at various times of the day allows the determination of trip generation rates for the p.m. peak study period. A rate of 0.22 person trip per seat/10/ was chosen for individuals leaving the theaters during the p.m. peak, and a rate of 0.35 person trip per seat was selected for individuals arriving at the theaters during the same time.

TABLE D.3
PERSON TRIP GENERATION RATES

Land Use Type	Generation Rate Units (Person Trips Per)	Weekday Daily Trip Rate	Weekday PM Peak Hour Trips (% of Total Weekday Daily Trips)
Residential	Dwelling Unit	10	17.3%
Retail (neighborhood-serving)	1,000 square feet	150	4.0%
Restaurant	1,000 square feet	200	13.5%
Movie Theater	seat	1.83	15.6%
Hotel	Room	6.92	9.5%
School	Student	3	5.0%
Office	1,000 square feet	18	11.1%
Research and Development	1,000 square feet	7.8	16.0%
Large Retail	1,000 square feet	110	9.0%

Sources:
San Francisco Planning Department, *Guidelines for Environmental Review: Transportation Impacts,* Appendix 1, July 1991.

Movie Theater: AMC Kabuki 8 Theaters attendance data, January 1994.

Retail and Residential: San Francisco Planning Department, *Guidelines for Environmental Review: Transportation Impacts*, July 1991.

Hotel: San Francisco Planning Department, *Citywide Travel Behavior Survey, Visitor Travel Behavior,* August 1993.

Office: San Francisco Planning Department, *Citywide Travel Behavior Survey, Visitor Travel Behavior*, August 1993.

The generation rate for residential spaces is 1.73 afternoon peak-hour person trips per dwelling unit. The hotel rates indicate a person-trip generation of approximately 0.66 afternoon peak hour trip per room.

Trip generation rates for research and development space were not available from the City and County of San Francisco Planning Department. Therefore, several other sources of information were investigated, including methodologies from the Institute of Transportation Engineers (ITE) *Trip Generation Manual*, Fifth Edition (January 1991), and from the *San Diego Traffic Generators Manual*

(May 1995). Data from the *UCSF Long Range Development Plan FEIR*/11/ and the EIR completed for the Chiron Medical Life Sciences Center in Emeryville/12/ were also used for reference.

The trip generation rates established for the large, or "big box" retail stores were based upon information gathered by Wilbur Smith Associates in prior studies for similar projects. These projects include the Price/Costco warehouse in San Francisco, and the proposed Home Depot at Pier 80. In addition, the Institute of Transportation Engineers and the San Diego Association of Governments were used as sources of information.

Although the same unit area of a "big box" (large) retail establishment generates fewer daily trips than the neighborhood-serving retail space, the percentage of trips taking place during the p.m. peak hour is substantially higher. Thus, 1,000 gross square feet of large retail space generates nearly ten p.m. peak hour person trips, whereas the same area of neighborhood-serving retail space generates only six p.m. peak hour trips. A similar situation occurs when comparing trip generation rates for office uses with those for research and development space. While a given area of office space generates more daily person trips than the same area of research and development space, the trips are less concentrated during the p.m. peak hour. Thus, 1,000 gross square feet of office space generates approximately two p.m. peak hour person trips; the same amount of research and development space generates approximately 1.25 p.m. peak hour person trips.

Trip generation rate estimation for the UCSF Subarea considers the UCSF site, including the proposed city public school site. The trip generation rate for the University of California, San Francisco site is that described in the *UCSF Long Range Development Plan Final EIR.*/13/ The new UCSF site is estimated to generate 18,377 external person trips per average weekday. It is estimated to produce 1,620 vehicle trips per weekday p.m. peak hour, comprising approximately 15% of the total p.m. peak hour vehicle trips from Mission Bay South.

The trip generation information for the proposed approximately 500-student city school site was compiled from research done by Wilbur Smith Associates./14/ The ITE trip generation rates, Caltrans' Trip Ends Generation Research Counts (December 1983), and the *San Diego Traffic Generators Manual* (May 1995) have provided some of the necessary information. A generation rate of three trips per student has been used.

<u>Multi-Use Development Capture Rates</u>

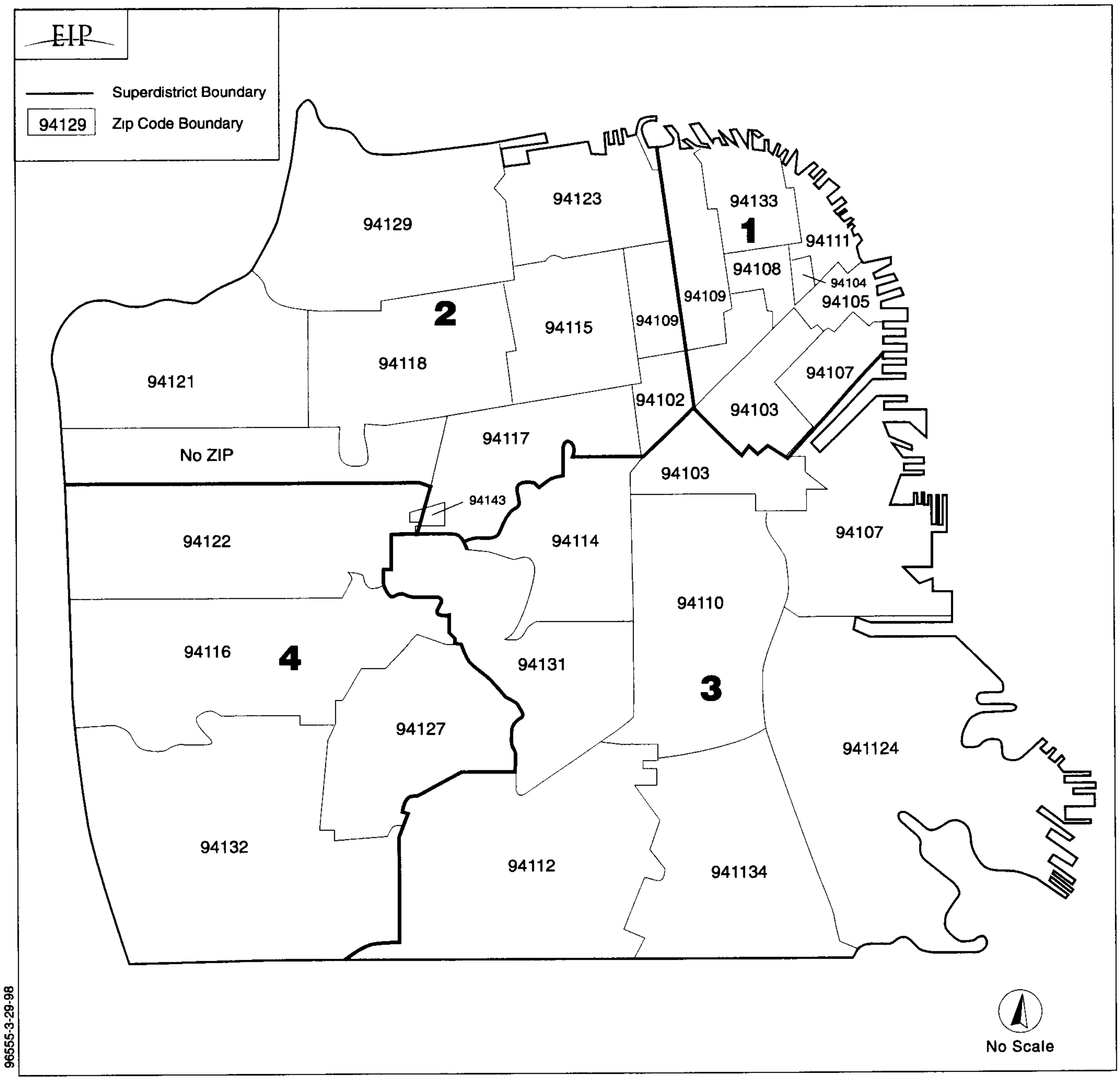
The trip generation rates presented in the previous sections are based on the trip-making characteristics of similar stand-alone existing uses. In order to estimate the number of trips generated by the Mission Bay project, the trip generation rates presented earlier could be applied to each individual land use in the project, and then trip estimates from all land uses could be added together. However, this method does not take into consideration the fact that some of the trips being estimated would be made within the Project Area; that is, they would begin and end within the Mission Bay area/15/ and are, therefore, being "double counted."

There is currently very little data available to quantify the number of trips that are internal to a multi-use development such as Mission Bay. Some information is available, however, from the Institute of Transportation Engineers/16/, which indicates that the average capture rate (the percentage of total project generated trips that begin and end within a multi-use development) during the p.m. peak period ranges from 15% to 45%, with an average rate of 29%.

After consultation with San Francisco Planning Department staff/17/, it was established that the stand-alone trip rate estimates for all travel modes, for those trips that begin or end in San Francisco's northeast or southeast quadrants (where the proposed Mission Bay project would be located) would be reduced by 20%, to account for trips internal to the project. The net effect of this trip rate reduction was a 10% decrease in the total number of trips being generated by the project.

Trip Distribution Assumptions

The previously generated trips were distributed as originating from or being destined for the East Bay, South Bay, North Bay, outside the Bay Area, or to the four quadrants that divide the City and County of San Francisco. The four quadrants of the City are delineated to capture the different travel characteristics that are associated with the various street networks, transit opportunities, and geographical constraints of different areas of San Francisco. The northeast quadrant of San Francisco (Superdistrict 1), is bounded by Van Ness Avenue to the west, Townsend Street to the south, and the San Francisco Bay. The northwest quadrant of the City (Superdistrict 2), is bounded by Van Ness Avenue to the east, the southern boundary of Golden Gate Park to the south, and the Pacific Ocean. The southeast quadrant (Superdistrict 3) is bounded by the San Mateo County line to the south, and the San Francisco Bay to the east, and reaches westward to incorporate the Twin Peaks area. The southwest quadrant of the City (Superdistrict 4) is bounded to the south by the San Mateo County line, to the west by the Pacific Ocean, to the north by the southern boundary of Golden Gate Park, and extends eastward to the Twin Peaks area./18/ Figure D.8 shows the boundaries that define the Superdistricts. The East Bay includes Alameda, Contra Costa, Napa, and Solano Counties. The North Bay includes Marin and Sonoma Counties. The South Bay is defined by San Mateo and Santa Clara Counties. "Other" includes locations outside the Bay Area. Table D.4 shows the total trip distribution for the entire Mission Bay area./19/



SOURCE: EIP Associates

MISSION BAY SUBSEQUENT EIR

FIGURE D.8 MAP OF SAN FRANCISCO SHOWING SUPERDISTRICT BOUNDARIES

TABLE D.4
PEAK HOUR PERSON TRIP DISTRIBUTION

	Mission Bay North	Mission Bay South			
		Central Subarea	East Subarea	West Subarea	UCSF Subarea
Superdistrict 1/a/	9.94%	6.11%	1.63%	1.53%	5.09%/b/
Superdistrict 2	2.77%	1.29%	2.43%	2.29%	
Superdistrict 3	4.31%	5.46%	6.74%	6.70%	
Superdistrict 4	1.04%	0.36%	1.57%	1.47%	
North Bay	1.58%	0.27%	1.10%	1.00%	
East Bay	3.72%	1.49%	2.59%	2.35%	0.93%
South Bay	3.10%	1.59%	4.54%	4.19%	2.44%
Other	6.54%	0.52%	0.68%	0.64%	0.00%
TOTAL	33.00%	17.09%	21.28%	20.17%	8.46%

Notes:
a. See Figure D.8 for a map showing locations of Superdistricts.

b. Trips generated by UCSF were distributed to three general Bay Area locations: the East Bay, the South Bay, and San Francisco/North Bay. This value represents the total distribution to all of San Francisco and the North Bay.

Sources:
Retail, Restaurant, and Hotel Visitors: *Citywide Travel Behavior Survey,* City and County of San Francisco Planning Department, August 1993.

Residential: Metropolitan Transportation Commission (MTC) Travel Demand Forecasting Model (Year 2015).

Movie Theater, Research and Development, Office, Hotel Workers: Supplemental Tables to the *Citywide Travel Behavior Survey,* City and County of San Francisco Planning Department, May 1993.

UCSF Site: University of California San Francisco, *UCSF Long Range Development Plan, Final Environmental Impact Report*, State Clearinghouse No. 95123032, January 1997, pp. 344-345.

The distribution values shown in Table D.4 represent the combination of the p.m. peak hour trips generated by each land use type in the entire Project Area. Tables D.5 through D.8 detail the trip distribution for each particular land use within each subarea. Table D.4 indicates the large number of trips that are made between Mission Bay North and other locations within the northeast quadrant.

The highest distribution of trips generated by the Central Subarea of Mission Bay South originates from or is destined for the northeast (Superdistrict 1) and southeast (Superdistrict 3) quadrants

TABLE D.5
MISSION BAY NORTH TRIP DISTRIBUTION - RESIDENTIAL, RESTAURANT, RETAIL

		Restaurant		Retail/b/	
Geographic Region	**Residential/a/**	**Workers/b/**	**Visitors /c/**	**Workers**	**Visitors**
San Francisco					
SuperDistrict 1	58.0%	12.8%	9.4%	12.8%	19.0%
SuperDistrict 2	5.0%	17.0%	7.8%	14.4%	8.0%
SuperDistrict 3	22.0%	13.6%	6.2%	17.0%	7.0%
SuperDistrict 4	1.0%	11.2%	1.9%	11.2%	4.0%
East Bay	7.0%	22.4%	14.3%	22.4%	10.0%
North Bay	1.0%	6.1%	7.2%	6.1%	7.0%
South Bay	6.0%	14.3%	12.3%	14.3%	10.0%
Outside the Region	0.0%	1.8%	41.8%	1.8%	35.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

Note:
Trip generation between Superdistricts 1 and 3 has been reduced by 20% in order to account for internal trips (trips that begin and end within the Mission Bay area). Superdistricts are shown in Figure D.8.

Sources:
a. Metropolitan Transportation Commission (MTC)/Association of Bay Area Governments (ABAG) Travel Demand Forecasting Model (Year 2015).
b. Supplemental Tables (Superdistrict 1) to the *Citywide Travel Behavior Survey*, City and County of San Francisco, Planning Department, August 1993.
c. *Citywide Travel Behavior Survey, Visitor Travel Behavior*, City and County of San Francisco, Planning Department, August 1993 (Superdistrict 1).
d. Metropolitan Transportation Commission (MTC)/Association of Bay Area Governments (ABAG) Travel Demand Forecasting Model (Year 2015).

locations. The East and West Subareas generate the largest proportion of trips to or from the southeast quadrant (Superdistrict 3). These values indicate the large portion of trips that begin and end within a particular geographic region, or Superdistrict, of the City.

Mode Split

"Mode split" is the designation of trips to the various means that people use to travel, such as automobile, transit, or walking, bicycling, taxi, or some other mode of transportation. The determination of the mode of transportation used in trips to and from Mission Bay depends on many

TABLE D.6
MISSION BAY NORTH TRIP DISTRIBUTION - MOVIE THEATER

Geographic Region	Distribution	
San Francisco		58.0%
Superdistrict 1	23.0%	
Superdistrict 2	16.0%	
Superdistrict 3	13.0%	
Superdistrict 4	6.0%	
East Bay		11.0%
North Bay		6.0%
South Bay		7.0%
Outside the Region		18.0%
TOTAL		100.0%

Note:
Trip generation between to Superdistricts 1 and 3 has been reduced by 20% in order to account for internal trips (trips that begin and end within the Mission Bay area). Superdistricts are shown in Figure D.8.

Source: Supplemental Tables to the *Citywide Travel Behavior Survey,* City and County of San Francisco, Planning Department, August 1993.

characteristics of the trip, for example: the type of trip (work or leisure), the origin/destination of the trip to/from Mission Bay, and the specific area of interest within the Project Area.

Mission Bay North

The travel behavior of patrons differs from that of employees. Therefore, the percentages of restaurant and retail trips by auto, transit, and any other mode of transportation (e.g., walking, bicycling) were further divided into worker trips and visitor trips./20/ Although a greater number of persons use an automobile as a mode choice for all land types, restaurant trips have a substantially higher proportion of person trips using an automobile as the primary mode compared to other land use types. Auto person trips account for approximately 57.5% of the total person trips generated by Mission Bay North.

TABLE D.7
MISSION BAY SOUTH TRIP DISTRIBUTION - RESIDENTIAL, HOTEL, RETAIL, R&D/OFFICE

		Hotel		Retail/b/		R & D /Office/d/	
Geographic Region	**Residential Distribution /a/**	**Workers/b/**	**Visitors/c/**	**Workers**	**Visitors**	**Workers**	**Visitors**
San Francisco							
Superdistrict 1	46.0%	8.3%	4.6%	8.3%	7.0%	8.3%	17.0%
Superdistrict 2	6.0%	10.6%	2.0%	10.6%	9.0%	10.6%	14.0%
Superdistrict 3	31.0%	23.9%	4.5%	23.9%	61.0%	23.9%	14.0%
Superdistrict 4	1.0%	7.8%	0.9%	7.8%	5.0%	7.8%	7.0%
East Bay	8.0%	14.3%	5.8%	14.3%	3.0%	14.3%	22.0%
North Bay	1.0%	5.6%	3.0%	5.6%	2.0%	5.6%	9.0%
South Bay	7.0%	26.9%	2.1%	26.9%	10.0%	26.9%	13.0%
Outside the Region	0.0%	2.6%	77.1%	2.6%	3.0%	2.6%	4.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note:
Trip generation between Superdistricts 1 and 3 has been reduced by 20% in order to account for internal trips (trips that begin and end within the Mission Bay area). Superdistricts are shown in Figure D.8.

Sources:
a. Metropolitan Transportation Commission (MTC)/Association of Bay Area Governments (ABAG) Travel Demand Forecasting Model (Year 2015).
b. Supplemental Tables (SD3) to the *Citywide Travel Behavior Survey,* City and County of San Francisco Planning Department, August 1993.
c. *Citywide Travel Behavior Survey,* City and Couty of San Francisco Planning Department, August 1993 (Superdistrict 1).
d. Supplemental Tables (Superdistrict 3, C-3) to the *Citywide Travel Behavior Survey,* Office Land Use City and County of San Francisco Planning Department, August 1993.

Mission Bay South

Because Mission Bay South is in the southeast quadrant (as opposed to Mission Bay North in the northeast quadrant) the mode split proportions are slightly different. However, the different types of land uses in Mission Bay North and Mission Bay South play a greater role in the mode split values than these locations in two different quadrants of the City. This can be seen by comparing the Central Subarea with the East and West Subareas in Mission Bay South (see Figure V.E.11 for a map showing subareas). The automobile is the favored mode choice in both areas, but the automobile is favored to a greater degree in the East and West subareas. This is largely attributable to the large, or "big box," retail establishments in those subareas. The automobile is chosen for approximately 86% of the person trips generated by these retail establishments.

TABLE D.8
UCSF SUBAREA TRIP DISTRIBUTION - UCSF SITE

Geographic Region	Distribution
San Francisco/North Bay	61%
East Bay	10%
South Bay	29%
TOTAL	100%

Source: University of California San Francisco, *UCSF Long Range Development Plan Final Environmental Impact Report*, State Clearinghouse No. 95123032, January 1997.

Auto Occupancy

Automobile occupancy (the number of persons per vehicle) is also very sensitive to the trip purpose, and the origin/destination characteristics. Tables D.9 and D.10 detail the average auto occupancy rates of each land use type in Mission Bay North and South, respectively. The different geographic locations of the Mission Bay North and Mission Bay South areas yield different auto occupancy rates.

Tables D.11 through D.18 are referenced in Section V.E, Transportation, and they provide additional information on levels of service and other transportation details.

TABLE D.9
AVERAGE AUTO OCCUPANCY RATES - MISSION BAY NORTH

Geographic Region	Residential /a/	Restaurant Workers /b/	Restaurant Visitors /c/	Retail/b/ Workers	Retail/b/ Visitors	Movie Theater/b/
San Francisco						
Superdistrict 1	1.20	1.28	2.62	1.28	1.64	1.64
Superdistrict 2	1.14	1.23	2.17	1.23	1.78	1.71
Superdistrict 3	1.14	1.29	3.09	1.29	1.86	1.86
Superdistrict 4	1.15	1.53	2.00	1.53	1.89	1.89
East Bay	1.17	3.33	2.61	3.33	2.26	2.26
North Bay	1.16	1.70	1.75	1.70	2.08	2.08
South Bay	1.15	1.23	2.56	1.23	2.55	2.55
Outside the Region	1.17	1.50	3.76	1.50	3.18	3.18

Note:
See Figure D.5 for a map showing superdistricts.

Sources:
a. MTC Travel Demand Forecasting Model - Year 2015, Revised Land Use, Transportation Analysis Zone 658.
b. Supplemental Tables (Superdistrict 1) to the *Citywide Travel Behavior Survey*, City and County of San Francisco, Planning Department.
c. *Citywide Travel Behavior Survey, Visitor Travel Behavior*, City and County of San Francisco, Planning Department (Superdistrict 1).

TABLE D.10
AVERAGE AUTO OCCUPANCY RATES - MISSION BAY SOUTH

Geographic Region	Residential /a/	Hotel		R&D/Office/d/		Retail/e/	
		Workers /b/	Visitors /c/	Workers	Visitors	Workers	Visitors
San Francisco							
Superdistrict 1	1.20	1.30	2.00	1.30	2.00	1.30	2.05
Superdistrict 2	1.14	1.26	3.00	1.26	1.07	1.26	1.78
Superdistrict 3	1.14	1.25	2.00	1.25	1.75	1.25	2.08
Superdistrict 4	1.15	1.48	2.80	1.48	1.22	1.48	2.19
East Bay	1.17	1.61	2.33	1.61	1.67	1.61	2.45
North Bay	1.16	1.44	2.00	1.44	1.63	1.44	1.78
South Bay	1.15	1.13	2.50	1.13	2.59	1.13	2.14
Outside the Region	1.17	1.56	2.88	1.56	1.93	1.56	1.91

Note: See Figure D.5 for a map showing Superdistricts.

Sources:
a. MTC Travel Demand Forecasting Model - Year 2015, Revised Land Use, TAZ 657.
b. Supplemental Tables (Superdistrict 3) to the *Citywide Travel Behavior Survey,* City and County of San Francisco, Planning Department.
c. *Citywide Travel Behavior Survey*, *Visitor Travel Behavior*, City and County of San Francisco, Planning Department (Superdistrict 1).
d. The Research and Development Office land use category in this table does not include the Unversity of California San Francisco (UCSF) site. The UCSF site was analyzed as a separate use, using transportation information contained in the UCSF Long Range Development Plan FEIR. The average auto occupancy rate for the overall UCSF site is 1.16 persons per vehicle.
e. Supplemental Tables (SD 3, C-3) to the *Citywide Travel Behavior Survey,* City and County of San Francisco, Planning Department (Superdistrict 1).

TABLE D.11
LEVEL OF SERVICE CRITERIA FOR A FREEWAY SECTION/a/

LOS	Maximum Density (pcpmpl)	Minimum Speed (miles per hour)	Max. Service Flow Rate (pcphpl)	Maximum Volume-to-Capacity Ratio
A	10.0	60	600	0.25
B	16.0	60	960	0.42
C	24.0	55	1,440	0.63
D	32.0	41	1,824	0.79
E	46.0	30	2,300	1.00
F	Varies	Varies	Varies	Varies

Notes:
LOS = Level of Service.
pcpmpl = Passenger cars per mile, per lane
pcphpl = Passenger cars per hour, per lane
a. Six to eight-lane freeways with a 60 mph free flow speed.

Source: Transportation Research Board, *Highway Capacity Manual*, Special Report No. 209, Washington, D.C., 1994. Modified to fit criteria established in annual monitoring reports published by the San Francisco County Transportation Authority.

TABLE D.12
LEVEL OF SERVICE DEFINITIONS, SIGNALIZED INTERSECTIONS BASED ON VEHICLE DELAY

Level of Service	Vehicle Delay (sec./veh.)	Typical Traffic Condition
A	≤ 5.0	**Insignificant Delays:** No approach phase is fully utilized by traffic and no vehicle waits longer than one red indication.
B	5.1 - 15.0	**Stable Operation/Minimal Delays:** An occasional approach phase is fully utilized. Many drivers begin to feel somewhat restricted within platoons of vehicles.
C	15.1 - 25.0	**Stable Operation/Acceptable Delays:** Major approach phases are fully utilized. Most drivers feel somewhat restricted.
D	25.1 - 40.0	**Approaching Unstable/Tolerable Delays:** Drivers may have to wait through more than one red signal indication. Queues may develop but dissipate rapidly, without excessive delays.
E	40.1 - 60.0	**Unstable Operations/Significant Delays:** Volumes at or near capacity. Vehicles may wait through several signal cycles. Long queues form upstream from intersection.
F	≥ 60.0	**Forced Flow/Excessive Delays:** Represents jammed conditions. Intersection operates below capacity with low volumes. Queues may block upstream intersections.

Source: Transportation Research Board, *Highway Capacity Manual*, Special Report No. 209, Third Edition, Washington, D.C., 1985 (updated 1994).

TABLE D.13
LEVEL OF SERVICE DEFINITIONS, UNSIGNALIZED INTERSECTIONS BASED ON VEHICLE DELAY

Level of Service	Vehicle Delay (sec./veh.)	Typical Traffic Condition
A	≥ 5.0	Little or no delay
B	5.1 - 10.0	Short traffic delays
C	10.1 - 20.0	Average traffic delays
D	20.1 - 30.0	Long traffic delays
E	30.1 - 45.0	Very long traffic delays
F	≥ 45.0	/a/

Notes:
a. Level of Service F exists when there are insufficient gaps of suitable size to allow a side street (minor street) demand to cross safely through a major street traffic stream. This level of service is generally evident from extremely long total delays experienced by side street traffic and by queuing on the minor approaches.

Source: Transportation Research Board, *Highway Capacity Manual*, Special Report No. 209, Third Edition, Washington, D.C., 1985 (updated 1994).

TABLE D.14
RAILROAD CROSSING DATA
16TH STREET/SEVENTH STREET CROSSING

Time Gate Down	Time Gate Up	Total Time of Restricted Vehicular Flow	Direction	Number of Vehicles Waiting	
Lights On	Lights Off	(min.:sec)	(SF/SJ)	Eastbound	Westbound
3:53 p.m.	3:54 p.m.	01:25	SJ	8	14
4:28 p.m.	4:29 p.m.	01:18	SJ	6	11
4:33 p.m.	4:35 p.m.	01:17	SJ	5	8
4:37 p.m.	4:38 p.m.	01:17	SF	9	12
4:57 p.m.	4:58 p.m.	01:23	SJ	13	8
5:02 p.m.	5:03 p.m.	01:23	SJ	5	10
5:06 p.m.	5:07 p.m.	01:36	SF	9	14
5:28 p.m.	5:29 p.m.	01:19	SJ	9	10
5:33 p.m.	5:35 p.m.	01:24	SJ	10	12
5:37 p.m.	5:39 p.m.	01:45	SF	4	12
5:39 p.m.	5:40 p.m.	01:25	SJ	10	20
5:44 p.m.	5:45 p.m.	01:19	SJ	7	12
6:06 p.m.	6:07 p.m.	01:31	SF	4	13
6:08 p.m.	6:10 p.m.	02:08	SJ	7	18

Source: Wilbur Smith Associates. Data collected on Tuesday, July 1, 1997.

TABLE D.15
SAMTRANS SERVICE AND RIDERSHIP DESCRIPTION

Route	AM Peak Headway	Midday Headway	PM Peak Headway	Average Daily Ridership
1F	10 minutes	---	10 minutes	613
7F	30 minutes	30 minutes	25 minutes	3,102
16F	4 trips	---	4 trips	271
17F	3 trips	---	2 trips	183
18F	15 minutes	---	15 minutes	281
19F	20 minutes	---	20 minutes	306
41F	2 trips	---	3 trips	149
47F	3 trips	---	4 trips	240
48F	1 trip	---	2 trips	79
49F	1 trip	---	3 trips	168
5M	20 minutes	30 minutes	20 minutes	9,697
7B	20 minutes	30 minutes	25 minutes	5,633

Sources: San Mateo County Transit District, *SamTrans Short Range Transit Plan*, FY 1995/1996 to FY 2004/2005, September 1995; SamTrans Bus System Route Map, March 1996; Bay Area Transit Information Webpage: www.transitinfo.org.

TABLE D.16
SAN FRANCISCO MUNICIPAL RAILWAY SERVICE AND RIDERSHIP DESCRIPTION

Route	AM Peak Headway	Midday Headway	PM Peak Headway	Average Daily Ridership
15	10	10	6	26,342
22	4	6	4	21,153
30	6	9	8	25,261
32	15	15	12	1,088
42	10	12	10	16,090
45	6	8	7	15,057
48	12	20	12	7,721
80X	10	--	10	1,472
81X	10	--	10	1,084
82X	20	--	20	463

Sources: *San Francisco Municipal Railway Short Range Transit Plan*, July 1996 - June 2005, November 12, 1996; San Francisco Municipal Railway Street and Transit Map, 1996

TABLE D.17
LEVEL OF SERVICE CRITERIA FOR PEDESTRIANS

Quality of Flow	Conflicts	Square Feet per Person	Flow Rate/a/	Service Levels/b/
Open	None	Over 530	Under 0.5	A
Unimpeded	Minor	530 - 130	0.5 - 2	A
Impeded	Some	130 - 40	2 - 6	A
Constrained	50% Probability	40 - 24	6 - 10	B
Crowded	High Probability	24 - 16	10 - 14	C
Congested	Unavoidable	16 - 11	14 - 18	/c/
Jammed	Unavoidable	2 - 11	0 - 25	/c/

Notes:
a. Flow Rate, persons per minute per foot of walkway width.
b. Fruin, *Designing for Pedestrians.*
c. Exceeds design capacity for pedestrian areas.

Source:
Pushkarev and Zupan, *Urban Space for Pedestrians,* Tables 3-6 & 3-7, MIT Press, 1975. Wilbur Smith Associates.

TABLE D.18
GUIDELINES FOR BICYCLE PARKING FOR NEW CONSTRUCTION

Land Use	Suggested Bicycle Parking Requirement/a/
Multi-Family Residential	
• General	1 Class I per unit, plus 1 Class II per 5 units
• Primarily for students and low-income families	1 Class I per unit, plus 1 Class II per 5 units
• Primarily for residents 62 or older	1 Class I per 10 units, plus 1 Class II per 10 units
Schools	
• Elementary, middle school, high school	1 Class I per 10 employees/b/, plus 1 spot per 4 students (50% Class I, 50% Class II)
Colleges	
• Student residences	1 Class I per 1.5 beds, plus 1 Class I per 10 employees/b/
• Academic buildings and other facilities	1 Class I per 10 employees/b/, plus 1 spot per 3 student seats (25% Class I, 75% Class II)
Parking Garages and Park-and-Ride Lots	20% of auto parking (75% Class I, 25% Class II)
Transit Centers	15% of daily boardings (75% Class I, 25% Class II)
Park-and-Ride Lots and Transit Centers	35% of required automobile spaces
Cultural and Recreational (includes libraries, theaters, museums, and religious institutions)	1 Class I per 10 employees/b/, plus 1 Class II per 500 s.f. or 20 seats (whichever is greater)
Park and Recreational Fields	1 Class I per 10 employees/b/, plus 1 Class II per 3 users during daylight times at peak season
Retail Sales, Shopping Centers, Financial Institutions, Supermarkets	1 Class I per 10 employees/b/, plus 1 Class II per 2,000 s.f.
Offices and Office Buildings	1 per 2,000 s.f. (75% Class I, 25 % Class II)
Hotels, Motels, and Bed and Breakfasts	1 Class I per 10 rooms, plus 1 Class I per 10 employees
Hospitals	1 Class I per 10 employees/b/, plus 1 Class II per 15 beds
Restaurants	1 Class I per 10 employees/b/, plus 1 Class II per 1,000 s.f.
Industrial	1 Class I per 10 employees/b/ or 5,000 s.f. (whichever is greater), plus 1 Class II per 5,000 s.f.
Day Care Facilities	1 Class I per 10 employees/b/, plus 1 Class II per 25 students
Auto-Oriented Services	1 Class I per 10 employees/b/
Other Uses	Same as most similar use listed.

Note:

a. Class I bicycle parking spaces protect the entire bicycle and its components against theft, vandalism and weather. Class II bicycle parking spaces are racks that permit locking the bicycle frame and one wheel with a U-lock and support the bicycle without damage.

b. Employees means the maximum number of employees on duty at any one time. When the suggestion is based on number of employees, the minimum number of spaces called for is 4, unless the above standards would call for 1 or fewer, in which case the minimum is 2.

Source: San Francisco Bicycle Plan, adopted March 4, 1997, Board of Supervisers Resolution No. 225-97.

NOTES: Appendix D, Transportation

1. The *Mid-Embarcadero Roadway Terminal Separator Structure Project Final EIS/EIR* (State Clearinghouse No. 92083065, case file 92.202E and 94.060E, certified September 1996) assumes Harrison Street to be one-way westbound between The Embarcadero and Third Street by the year 2015. However, at this time the Department of Parking and Traffic does not intend to implement the conversion of Harrison Street from two-way to one-way between The Embarcadero and Third Street.

2. The specific iterative technique used in the MTC origin/destination trip tables adjustment is known as a *Fratar* process. It adjusts the number of trips in each geographic area within the model individually by applying specified "production" or "origin" and "attraction" or "destination" growth factors to each trip table. Since the application of the origin factors affects the total number of trips destined to a geographic area and vice versa, the factoring process is repeated several times, in order to converge on a reasonable solution which, to the extent possible, preserves the already estimated totals for both origins and destinations for each geographic area.

3. Keyser Marston Associates, Inc., *TAZ Projections for San Francisco Cumulative Growth Analysis, Technical Memorandum*, April 16, 1997. Wilbur Smith Associates and Korve Engineering, *Year 2015 San Francisco Cumulative Growth Forecasts, Technical Memorandum*, May 22, 1997. Keyser Marston Associates, Inc., *San Francisco Cumulative Growth Scenario, Draft Technical Memorandum*, August 27, 1997; *Final Technical Memorandum*, March 30, 1998. A copy of these technical memoranda are available for public review in the project case file at the San Francisco Planning Department, 1660 Mission Street, San Francisco.

4. Initially, the intent was to incorporate the updated employment and housing growth projections into the MTC model, and have MTC staff run the first three steps of the travel demand forecasting process (trip generation, trip distribution and mode choice) to generate updated trip tables detailing the number of trips generated by Mission Bay, the origin/destination of these trips, and the percentage of these trips made by auto, transit or another mode. However, MTC staff indicated that due to time constraints, MTC would be unable to incorporate these revisions into their model.

5. Chuck Purvis, Senior Transportation Planner, Metropolitan Transportation Commission, telephone conversation with Wilbur Smith Associates, April 15, 1997.

6. The p.m. peak hour is chosen to reflect the most congested traffic conditions on the roadway network at any time during the period between 4 p.m. and 6 p.m. The observed hour of the highest level of congestion occurs at different times for different parts of the network, and varies from day to day as well. For instance, the hour of highest traffic congestion at one intersection may occur between 4:15 p.m. and 5:15 p.m., while another intersection or freeway ramp may experience the peak hour of congestion from 4:30 p.m. to 5:30 p.m. Determination of the p.m. peak hour of congestion for any particular intersection for any particular weekday is difficult, and analysis of network traffic conditions under such a detailed approach is less accurate. The typically chosen approach is more conservative in that the most congested hour of each part of the roadway network is selected, and compiled to form a common p.m. peak hour, within the 4 p.m to 6 p.m. period. Although the p.m. peak hour of relative parts of the roadway network may not coincide, the assumption that each part's worst case scenario occurs simultaneously provides a more conservative approach that absorbs any traffic fluctuations.

7. Policy lines are generally defined as lines operating at greater than 10- to 12-minute headways during the peak periods. Their service is maintained independent of ridership and any capacity available on these lines cannot be redistributed to the rest of the transit system.

8. These trip generation rates are based either on local surveys such as the S.F. Planning Department's Citywide Travel Behavior Survey, August 1993, or surveys compiled by the Institute of Transportation Engineers and published in *Trip Generation,* Fifth Edition, 1991.

9. Wilbur Smith Associates, *Technical Methodology Memorandum*, June 4, 1997. A copy of this memorandum is on file for public review at the Office of Environmental Review, Planning Department, 1660 Mission Street, San Francisco.

10. One-way person trips per seat is reflective of the average attendance (in percent of total seats) for shows ending (outbound) and beginning (inbound) during or near the p.m. peak period.

11. University of California San Francisco, *UCSF Long Range Development Plan Final Environmental Impact Report*, State Clearinghouse No. 95123032, certified January 1997.

12. City of Emeryville, *Chiron Development Plan Environmental Impact Report*, State Clearinghouse No. 9406300), certified June 1995.

13. University of California San Francisco, *UCSF Long Range Development Plan*, *Final Environmental Impact Report*, State Clearinghouse No. 95123032, certified January 1997.

14. Wilbur Smith Associates, technical memorandum to Bill Wycko, San Francisco Planning Department, July 25, 1997. A copy of this memorandum is on file for public review at the Office of Environmental Review, Planning Department, 1660 Mission Street, San Francisco.

15. The most common example would be a trip from home to work, for a person who lives and works in the Mission Bay Project Area. Another example would be trips made from the work place to shops, services, restaurants, or movie theaters.

16. Institute of Transportation Engineers, *Trip Generation,* Fifth Edition, January 1991, Chapter VIII, pp. I-14 to I-53.

17. Bill Wycko, Senior Planner, San Francisco Planning Department, memorandum summarizing several telephone conversations with Wilbur Smith Associates, July 28, 1997.

18. City and County of San Francisco, Planning Department, *Citywide Travel Behavior Survey, Visitor Travel Behavior,* August 1993.

19. The Citywide Travel Behavior Survey defines "other" as zip codes outside the Bay Area reaching from Washington and Oregon to Sacramento and south to Los Angeles and San Diego. Visitors arriving in San Francisco from the airport are considered to have traveled from the Peninsula.

20. Worker/Visitor split based upon the City and County of San Francisco Planning Department *Citywide Travel Behavior Survey, Visitor Travel Behavior*, August 1993 (Restaurant, Superdistrict 1), and Supplemental Tables to the City and County of San Francisco Planning Department *Citywide Travel Behavior Survey,* August 1993 (Restaurant and Retail, Superdistrict 1).

E. AIR QUALITY

This appendix includes additional details on the analysis methods for certain criteria air pollutants, namely, carbon monoxide and fine particulates as well as supporting data in Tables E.1-E.3. Regarding toxic air contaminants, this appendix describes the fundamentals of risk assessment and how the expected types of toxic air contaminant emissions from the project were identified. Finally, this appendix presents tables containing information on ambient air pollutant concentrations and population projections.

CRITERIA AIR POLLUTANTS—ANALYSIS METHODS

Carbon Monoxide

Caltrans' CALINE4 program was used to model local carbon monoxide (CO) impacts. The CALINE4 model was implemented according to the guidelines contained in *Transportation Project-Level Carbon Monoxide Protocol ("CO Protocol")*./1/ Emission factors were derived from the BAAQMD CEQA Guidelines.

Vehicular travel speeds on major arterials were obtained from the travel time analysis conducted by the project transportation consultant. For other surface streets in the general traffic study area, but not included in the arterial analysis, speeds were derived from relationships between traffic volume/lane/hour and travel speeds given in Tables B.13 and B.14 of the *CO Protocol*. For the Interstate 80 freeway mainline and ramps, travel speeds were derived from mainline and intersection levels of service, respectively, based upon the Highway Research Board's *Highway Capacity Manual*.

For existing and future cumulative traffic in the project site vicinity, the percentages of vehicles operating in hot stabilized or cold start modes were derived, based on times of day and roadway types, as recommended in Caltrans' Technical Advisory T950428.02.

Meteorological inputs to the CALINE4 model include wind speed, wind direction, wind variability, temperature, atmospheric stability, and vertical mixing height. Values for wind speeds and variability were assumed to change with the time of day based upon the relationship presented in Table B.11 of *CO Protocol*. CALINE4 automatically selected the "worst-case wind angle." Temperatures were taken from National Oceanic and Atmospheric Association monitoring data for San Francisco's Mission Dolores weather station. Atmospheric stability estimates were also obtained from the *CO Protocol*'s Table B.11. A default mixing height of 1,000 meters (about 3,200 feet) was applied.

TABLE E.1
SUMMARY OF RECORDED AIR POLLUTANT LEVELS IN SAN FRANCISCO

	Ozone		Nitrogen Dioxide		Carbon Monoxide				PM_{10}	
Year	1-hr High (ppm)	Number of Exceedances	1-hr High (ppm)	Number of Exceedances	1-hr High (ppm)	Number of Exceedances	8-hr High (ppm)	Number of Exceedances	24-hr High ($\mu g/m^3$)	Number of Exceedances
1995	0.09	0	0.09	0	9.0	0	5.5	0	50	0
1994	0.06	0	0.09	0	7.5	0	5.3	0	n.a.	6
1993	0.08	0	0.08	0	10	0	6.9	0	69	5
1992	0.08	0	0.09	0	10	0	7.4	0	81	9
1991	0.05	0	0.10	0	14	0	8.4	0	109	15
1990	0.06	0	0.11	0	12	0	6.9	0	165	12

Notes:
The "high" is the highest concentration for the year. Exceedances for ozone, nitrogen dioxide, and carbon monoxide refer to federal and state standards, while those for PM_{10} refer only to state standards. The ozone, nitrogen dioxide, and inhalable particulate data were collected at the 10 Arkansas Street station in San Francisco. The carbon monoxide data were collected at the 939 Ellis Street station in San Francisco.

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
n.a. = not available

Source: California Air Resources Board, *California Air Quality Data Summaries 1995, 1993, 1992, 1991, 1990;* Bay Area Air Quality Management District, Air Currents, March 1996.

TABLE E.2
AMBIENT AIR TOXICS MONITORING DATA, 1996
10 Arkansas Street, San Francisco, California

Toxic Air Contaminant	Number of Observations	Maximum Concentration (ppb)	Minimum Concentration /a/ (ppb)	Mean Concentration (ppb)
meythyl ethyl ketone	27	0.5	0.05	/b/
methylene chloride	31	1.8	0.5	0.66
styrene	31	0.2	0.05	0.06
chloroform	31	0.10	0.01	0.032
meta/para-xylene	31	2.7	0.3	0.67
1,3-butadiene	31	0.55	0.02	0.138
methyl chloroform	31	0.25	0.06	0.109
ortho-dichlorobenzene	31	0.3	0.05	0.08
para-dichlorobenzene	31	0.4	0.1	0.12
carbon tetrachloride	31	0.12	0.07	0.078
trichloroethylene	31	0.07	0.01	0.028
benzene	31	1.4	0.25	0.43
ethyl benzene	31	0.8	0.3	0.33
perchloroethylene	31	0.42	0.01	0.084
toluene	31	6.6	0.3	1.62

Notes:
ppb = parts per billion
a. Observations that were less than the level of detection are displayed as one-half of the level of detection. Data for vinyl chloride, ethylene dibromide, and ethylene dichloride were all below the level of detection.
b. Data for annual means were provided only for years with data in all 12 months.

Source: California Environmental Protection Agency, Air Resources Board, http://arbis.arb.ca.gov/aqd/toxics.htm.

A persistence factor (i.e., the ratio between local worst-case eight-hour and one-hour concentrations) of 0.8 has been applied to the modeled hourly CO concentrations to obtain eight-hour average estimates because this has been consistent with the *CO Protocol*'s recommendations for "urban sites with a recognized tendency for persistent stagnant meteorological conditions and/or persistent traffic congestion."

TABLE E.3
COMPARISON OF ASSOCIATION OF BAY AREA GOVERNMENTS *PROJECTIONS '96* WITH SAN FRANCISCO CUMULATIVE GROWTH SCENARIO

	San Francisco Cumulative Growth Scenario /a/,/b/		ABAG *Projections '96* /c/	
	1995	**2015**	**1995**	**2015**
Employment	534,600	665,300	534,610	638,670
Households	311,430	343,622	311,430	338,390
Population	759,900	819,500	759,900	795,800
Employed Residents	376,800	428,030	376,800	415,400

Notes:

a. San Francisco totals without adjustment for build-out of the Mission Bay Project Area. See Table V.C.8 and Table V.C.9 for the total San Francisco numbers analyzed in this SEIR (Project Area build-out plus "Rest of City" subtotals from the *SFRA San Francisco Cumulative Growth Scenario* prepared by Keyser Marston Associates.)
b. Keyser Marston Associates, Inc., *San Francisco Cumulative Growth Scenario*, Final Technical Memorandum, prepared for the San Francisco Redevelopment Agency, March 30, 1998.
c. Association of Bay Area Governments, *Projections '96*, December 1995.

Source: EIP Associates and Hausrath Economics Group.

Fine Particulates (PM_{10})

U.S. Environmental Protection Agency (U.S. EPA) measurements of dust emissions during construction of a shopping center in Arizona indicate that about 1.2 tons of dust per month are emitted per acre of construction, about 64% of which is PM_{10}, a potential health threat to a sensitive population living near the construction activity. Thus uncontrolled construction-related PM_{10} emissions could generate up to 51 pounds (lb) per acre per day, exceeding the BAAQMD's 80 lb/day significance threshold, when the area to be worked is greater than 1.5 acres.

TOXIC AIR CONTAMINANTS

This appendix provides additional background material to facilitate understanding of the toxic air contaminants discussion presented in Section V.F, Air Quality. The following topics are expanded upon: fundamentals of risk assessment and methodology for identifying expected types of toxic air contaminant emissions from the proposed project.

Toxic Air Contaminants—Fundamentals of Risk Assessment

To provide a clear understanding of the potential impacts of toxic air contaminant emissions from the project on public health, it is necessary to discuss the elements of the risk assessment process and how risk is estimated. The following section describes this process.

Risk Assessment

A risk assessment is an estimate of both cancer and non-cancer health risks attributable to a particular emission source or a facility that emits toxic air contaminants from more than one source. Information regarding the toxic air contaminants emitted, their emission rates, their dispersion in the air, possible receptor locations, and chemical toxicity of toxic air contaminants is used to conduct a "screening-level" or a "formal" health risk assessment. A "screening-level" risk assessment uses worst-case assumptions and default values to roughly estimate the risks from toxic air contaminants, whereas a "formal" risk assessment uses more realistic assumptions and more complex, or sophisticated, computer modeling to more accurately quantify risk. A screening-level risk assessment is often used to determine whether a formal risk assessment is required.

Hazard Identification and Estimation of Emissions

The first step in the risk assessment process is to identify the compounds of concern, i.e., the compounds emitted that may be toxic. Next, the quantity of toxic air contaminant emissions must be estimated. Together, these steps may be referred to as an "emissions inventory." Emissions are quantified using emission factors, expressed as grams per second or pounds per year. Emission factors are obtained from published sources or actual source tests (air monitoring data) of emissions from various types of devices and processes. Typically, these emission factors are conservative and tend to overestimate emissions.

Exposure Assessment

Using the emission factors and hours of operation, emissions can be quantified. Using emissions information and dispersion analysis, the concentrations of toxic air contaminants can be estimated at off-site locations. This process is called exposure assessment.

Dispersion is the dilution of an air pollutant as it moves away from its source. A dispersion analysis estimates the concentration of a toxic air contaminant at a point where a receptor could be exposed. To assess the potential for chronic health effects, these concentrations can be estimated for long-term exposures (30 years based on U.S. EPA Risk Assessment Guidelines for Superfund Sites or 70 years based on CAPCOA Air Toxics "Hot Spots" Risk Assessment Guidelines). To assess the potential for acute health effects, concentrations can be estimated for short-term (worst-case one-hour) exposures. These exposure scenarios tend to be conservative.

Toxic air contaminant concentrations typically drop off rapidly as distance increases from the source. Factors such as the types and rates of emissions; wind speed, direction, and temperature; and surface wind effects caused by buildings and terrain are incorporated into the dispersion analysis. Once these factors are accounted for in the dispersion analysis, the toxic air contaminant concentrations to which a receptor could be exposed can be estimated.

The type of emissions source greatly affects the dispersion of toxic air contaminants. Toxic air contaminants may be emitted from a point, volume, area, or fugitive source. A point source is typically a stack (or a point where toxic air contaminants are released). For these types of sources, the release parameters are especially important. The higher the stack, the greater the dispersion is, typically. Similarly, the higher the rate of release, the greater the dispersion. Stacks that have a high rate of release behave as though they have a higher stack height. This is known as "effective stack height." Higher temperatures in the exhaust stack can increase the effective stack height as well.

A volume source is usually a building or structure where toxic air contaminants are allowed to mix before being emitted. For that reason, the volume of the structure is used to calculate the emission of toxic air contaminants. An area source is defined by the surface area of the emission point. Typically, pools of liquid are treated as area sources. Fugitive emissions, or areas where it is difficult to estimate losses or emissions of toxic air contaminants from various devices or processes (e.g., valves and flanges), may also be modeled as area sources.

The direction of the wind and its speed, in particular, will contribute to plume formation during the dispersion of a toxic air contaminant. A plume is a concentration gradient extending vertically and laterally from the emission source. As a pollutant is dispersed, the concentration is diluted away from the source. High winds tend to cause an increase in dispersion and dilution of contaminants. Stable conditions, where wind speed is low and an inversion (thermal boundary layer preventing upward escape of pollutants) is present, tend to trap toxic air contaminants near their source. Wind direction may abruptly change during the course of a year, and even over a 24-hour period. Information regarding wind patterns is used to predict the dispersion of contaminants at downwind receptor locations.

The topography of a location usually influences the dispersion characteristics of toxic air contaminants. Tall buildings tend to decrease wind speed, which can decrease dispersion. In addition, buildings can cause an effect known as "downwash," which can concentrate pollutants in turbulent eddies immediately downwind of the structures. This effect is most common when a taller structure is adjacent to a lower toxic air contaminant source.

"Receptor" is a term used to describe an individual who may be exposed to toxic air contaminants from an emissions source. A receptor can be real or hypothetical. Often, receptor locations where people actually live and work are included in a risk assessment. In addition, a risk assessment also considers a hypothetical individual who experiences a worst case exposure, or maximally exposed individual (MEI). The concept of the MEI is useful in estimating the point where toxic air contaminant emissions pose the greatest risk.

Whether or not the receptor is real or hypothetical, several assumptions are used to calculate exposure. These assumptions are conservative and designed to protect public health. Although these assumptions may appear to be unrealistic, they are designed to protect certain "sensitive" populations such as children, the sick, and the elderly. Typically, a risk assessment models two different types of receptor exposures. Concentrations are predicted for residential and off-site worker exposures using computer simulations.

Since most people spend a majority of their time at their place of residence, residential receptors are modeled for a full life-time exposure (30 years based on U.S. EPA Risk Assessment Guidelines for Superfund Sites or 70 years based on CAPCOA Air Toxics "Hot Spots" Risk Assessment Guidelines). A residential receptor is assumed to be exposed to toxic air contaminants at an estimated concentration for 24 hours a day, 365 days per year (30 years based on U.S. EPA Risk Assessment Guidelines for Superfund Sites or 70 years based on CAPCOA Air Toxics "Hot Spots" Risk Assessment Guidelines). The exposure scenario for off-site workers is usually 8 hours per day, 240 days per year, for 46 years./2/

In addition to the exposure duration for the different types of receptors, assumptions are made for the route of exposure to toxic air contaminants. Most toxic air contaminant exposures occur through the inhalation pathway, although some compounds are assimilated by the body through ingestion and dermal absorption as well. A risk assessment takes into account the average weight and amount of air breathed in per day by a "typical" individual, as well as ingestion rates and the amount of surface area of skin that can be subject to exposure. These exposure pathways can be used to predict the adverse health impacts of a particular toxic air contaminant.

Toxicological Assessment and Risk Characterization

Once the exposure concentration of a toxic air contaminant is estimated, actual risk is quantified using toxicity data. Some toxic air contaminants can be toxic in small quantities, while other toxic air contaminants are relatively harmless at higher exposure concentrations. In addition, health effects from short-term exposure to a particular toxic air contaminant may be inconsequential, but long-term exposure may be detrimental. Toxic properties of toxic air contaminants are usually expressed as a potency value. In comparing two compounds with equal exposure concentrations, the compound that exhibits greater toxic effects would be described as more potent than the other. For instance, chromium compounds are highly toxic in small quantities (a pound of chromium emitted annually may cause a significant health risk to nearby residents), but a similar quantity of isopropyl alcohol may not cause any measurable health risk.

As with the other steps in the risk assessment process, many assumptions are used in the toxicity analysis. Many toxicity data are derived from animal studies. Since it is difficult to know for certain if a specific animal model is appropriate for interpretation of health effects in humans, a sensitivity factor is often used to calculate the dose at which human exposure may cause adverse health effects. Dose is usually expressed in milligrams of a substance per kilogram of the receptor's body weight. The dose at which toxic effects are seen in rats is usually extrapolated to the human dose equivalent. To be on the safe side, this dose may be divided by a factor of ten to calculate the point at which humans may experience the same response, resulting in a more conservative estimate.

Several exposures of different types of toxic air contaminants may occur at each receptor location. To account for these types of multiple exposures, the toxic effects are simply added together. Possible synergistic effects or cancellation effects for combinations of toxic air contaminants are not considered. It is possible for two or more chemicals to combine and become more toxic than their individual additive effects or the combination of two or more toxic air contaminants may reduce their overall toxic effects. Since there are no data available on these types of effects for multiple toxic air contaminants exposure, risk assessments introduce another level of uncertainty by simply adding risks from each of the individual toxic air contaminants.

Assumptions regarding quantity and type of emissions, dispersion of pollutants, duration of exposure, receptor location, and toxicity of the pollutants are used in the risk assessment process. These assumptions are designed to err on the side of public health protection. The many assumptions used in the process limit the conclusions that can be drawn from the results. The results are not intended to predict actual adverse health impacts, but are used to characterize risk for comparison purposes. Typically, because conservative assumptions are used whenever specific data are unavailable, the more refined the data used in a risk assessment are, the lower the resultant risk is. However, comparison of risk assessment results from different sources or facilities is valid only if the assumptions used are consistent. Most risk assessments are prepared according to state and federal guidelines in order to minimize any inconsistencies.

As discussed earlier, an increased cancer risk of more than 10 in 1 million and acute or chronic noncancer risks indicated by hazard indices greater than 1 are considered significant by many regulatory agencies.

Voluntary and Involuntary Health Risks - A Perspective

Risks are either voluntary and involuntary. Many of our actions carry a high degree of risk, yet are acceptable in society. For example, although cigarette smoking is extremely hazardous, some people accept the risks of smoking voluntarily. In contrast, second-hand smoke is an involuntary exposure and is not accepted by many individuals. Similarly, the risk attributable to toxic air contaminant emissions from a neighboring business is usually the result of involuntary exposure. As a result of increased awareness and concern over these involuntary risks, laws and regulations have been developed to reduce these risks, even if they are lower than some voluntary risks.

Methodology for Identifying Expected Types of Toxic Air Contaminant Emissions from the Proposed Project

Table V.F.6 in Section V.F, Air Quality, lists air emissions representative of those that could be released from Commercial Industrial uses and UCSF. This list assumes that UCSF operations at Mission Bay would be similar to UCSF operations at Parnassus Heights. It further assumes that emissions from Commercial Industrial uses would be similar to those of UCSF or of a representative life-science research and development company. In keeping with the methodology and rationale presented under "Hazardous Materials Use, Storage, and Disposal" in Section V.I, Health and Safety: Impacts, Chiron Corporation's biotechnology campus in Emeryville, California, appears to be representative of possible Commercial Industrial activities. The possible air emissions described in Table V.F.6 include volatile chemicals from within the broad categories described in Table V.I.4 and Appendix Table H.1. Many of these substances would be toxic air contaminants as a result of their acute or chronic (including carcinogenic) toxicities. A few of the substances listed in Table V.F.6 (e.g., alkanes and alkenes) are not toxic but, if emitted from project sources, could contribute to air pollution.

NOTES: Appendix E, Air Quality

1. California Department of Transportation, *Transportation Project-Level Carbon Monoxide Protocol*, August 1995.

2. CAPCOA Air Toxics "Hot Spots" 1992 Revised Risk Assessment Guidelines, October 1993.

F. NOISE AND VIBRATION

SOME BASIC ENVIRONMENTAL NOISE CONCEPTS

Sound is a form of energy transmitted via atmospheric pressure variations. Its most obvious characteristics are amplitude, which we perceive as loudness, and frequency, which we experience as pitch. The standard unit of sound amplitude is the **decibel** (dB). Most common sounds contain many different frequency components. Because the human ear is not equally sensitive to all frequencies, a frequency-dependent weighting scheme is imposed whenever sound is measured. **A-weighted decibels** (dBAs) handle a sound's frequency components in a manner approximating that of the human ear. Table F.1 provides examples of the A-weighted sound levels associated with common situations.

The judgment of the listener is crucial in discriminating between sound and noise; **noise** is simply sound that is unacceptable to the listener for a variety of reasons. Intense noise, as it is experienced in certain industrial and commercial settings (e.g., steel mills, airports), can cause physiological damage. In most instances of environmental exposure, noise effects are typically limited to subjective effects such as annoyance or dissatisfaction, interference with sleep, speech, recreation, and work performance. Unfortunately, there is no completely satisfactory way to measure subjective effects, primarily because of the wide variation in individual thresholds of annoyance, and in individual habituation to noise based on past experience. Surveys allow the establishment of criteria that reflect the range of community responses to noise and changes in noise level.

Many quantitative indicators have been developed to measure environmental noise. All reflect the consensus among researchers that there is a correlation between the adverse impacts of noise and its loudness. Some indicators consider the time of noise occurrence. Three of the commonly used indicators that have been used in this analysis of the environmental noise impacts of the proposed project are:

- **Equivalent energy noise level** (L_{eq}) is the average acoustic energy content of noise for a stated period of time. The L_{eq} of two different time-varying noise events are the same if they deliver the same acoustic energy to the ear during exposure, no matter what time of the day or night they occur.
- **Day-night average noise level** (L_{dn}) is a 24-hour average L_{eq} with a 10 dBA "penalty" added to noise during the hours of 10:00 p.m. to 7:00 a.m. to account for the greater sensitivity of people to nighttime noises.
- **Community Noise Equivalent Level** (CNEL) is a 24-hour average very similar to the L_{dn} with an additional 5 dBA "penalty" added to noise during the evening hours of 7:00 p.m. to 10:00 p.m. to account for nighttime noise sensitivity.

TABLE F.1
TYPICAL SOUND LEVELS MEASURED IN THE ENVIRONMENT

A-Weighted Sound Level in Decibels	Noise Environments and Sources	Subjective Impression
140		
130	100 Feet From a Civil Defense Siren	
120	200 Feet From a Jet Takeoff	Pain Threshold
110	In Rock Music Concert Hall	
100	50 Feet From a Pile Driver or 100 Feet From an Ambulance Siren	Very Loud
90	Boiler Room or 50 Feet From Freight Cars	
80	In Kitchen with Garbage Disposal Running or 50 Feet From a Pneumatic Drill	
70		Moderately Loud
60	10 Feet From a Vacuum Cleaner or in a Department Store	
50	Private Business Office or 100 Feet From Light Traffic	
	200 Feet From a Large Transformer	
40		Quiet
30	Quiet Bedroom or 5 Feet From a Soft Whisper	
20	Recording Studio	
10		Threshold of Hearing
0		

Note:
This table is meant to give the reader a sense of A-weighted sound levels by providing an example of a noise source or an environment corresponding to a certain noise level. For example, a person at a rock music concert would experience noise levels of 110 dBA; a person standing 200 feet from a jet takeoff would experience noise levels of 120 dBA.

Source: EIP Associates.

REGULATORY CONTEXT

Local noise policies relevant to the current project are described in "Regulatory Framework," in Section V.G, Noise and Vibration: Setting. State and federal policies and criteria are described for informational purposes below. The current project is not specifically subject to these state and federal policies.

The U.S. Environmental Protection Agency (U.S. EPA) has compiled scientific information on the effects of noise exposure and defined acceptable exposure levels to protect public health and welfare with a margin of safety. These protective exposure levels are expressed in terms of suggested limits on the 24-hour average L_{eq} (55 dBA for outdoor areas where people spend limited amounts of time, such as school yards and playgrounds) or the L_{dn} (55 dBA in residential areas and other outdoor places where quiet is a basis for use). It is important to note that "public health and welfare" is an indivisible term; there are no separate "health" effects or "welfare" effects. Thus "public health and welfare" includes personal comfort and well-being, and the absence of mental anguish, disturbances, and annoyance, as well as the absence of clinical symptoms such as hearing loss or demonstrable physiological injury./1/ The EPA-defined acceptable noise exposure levels are conservative; they were developed without consideration of technical or economic feasibility and represent levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise. Because the suggested noise levels that will protect public health and welfare were developed by the U.S. EPA without regard for economic or technical feasibility, they should not be viewed as regulatory criteria or goals, but as "levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise."/2/

In order to limit population exposure to physically damaging and psychologically disruptive noise, the California Department of Health Services' (DHS) Office of Noise Control has issued noise exposure guidelines that established three categories of noise exposure severity in the <u>outdoor</u> environment:

- Normally Acceptable (for residential uses and hospitals, an L_{dn} of 60 dBA or less) – no undue burden on affected receptors, needing no special noise insulation;
- Conditionally Acceptable (for residential uses and hospitals, an L_{dn} between 60 dBA and 75 dBA) – requires some noise insulation as established by an acoustic study to reduce interior noise; and
- Unacceptable (for residential uses and hospitals, an L_{dn} greater than 75 dBA) – noise exposure is so severe that it is not generally feasible to provide adequate insulation for acceptable interior noise levels.

The DHS guidelines serve as a model for use by counties and cities in the state. Most have changed the original DHS range specifications to some extent to suit their local conditions.

NOISE MEASUREMENTS IN AND AROUND THE PROJECT AREA

Table F.2 provides a summary of the noise measurements taken in and around the Project Area for this SEIR. The purpose of these measurements was to calibrate the SOUND32 model. Table V.G.1 presents the existing ambient noise levels based on SOUND32 modeling results.

VIBRATION

Typical levels of ground-borne vibration are shown in Figure F.1.

NOTES: Appendix F, Noise and Vibration

1. Protestive Noise Levels: Condensed Version of EPA Levels Document, EPA 550/9-79-100, 1978.

2. Protestive Noise Levels: Condensed Version of EPA Levels Document, EPA 550/9-79-100, 1978, p. 24.

TABLE F.2
NOISE MEASUREMENT DATA SUMMARY/a/

Location Number /b/	Location Description	Measurement Period			Influential Noise Source(s)	Sound Levels (dBA)/c/	
		Date	Start Time	Duration		Leq	Lmax
1.	Residential Receptor Pennsylvania St., south of Mariposa St.	8/31/97	16:00	10 min.	Traffic on Pennsylvania	67.5	81.5
2.	Residential Receptor Potrero Ave., south of 16th St.	8/31/97	17:05	10 min.	Traffic on Potrero	73.5	82.6
3.	Church (Sensitive Receptor) Mariposa St., west of De Haro St.	8/31/97	16:35	10 min.	Traffic on Mariposa	69.7	86.4
4.	Other Study Location Berry St., west of Fourth St.	12/11/97	17:30	15 min.	Traffic on Fourth Street	64.2	76.8
5.	Other Study Location Third St., south of Mission Rock St.	8/31/97	15:45	10 min.	Traffic on Third Street	70.1	82.1
6.	Other Study Location /d/ Sixth Street, south of Channel St.	12/11/97	17:50	15 min.	Traffic on Sixth Street	63.7	77.0
7.	Other Study Location Minnesota St. (and future Fourth St.) south of Mariposa St./e/	8/31/97	15:20	10 min.	Traffic on Fourth Street	72.1	81.0

Notes:

a. All noise measurements were performed using a Larson Davis sound level meter, calibrated with a Quest CA-12B Sound Calibrator. The purpose of these measurements was to calibrate the SOUND32 model.

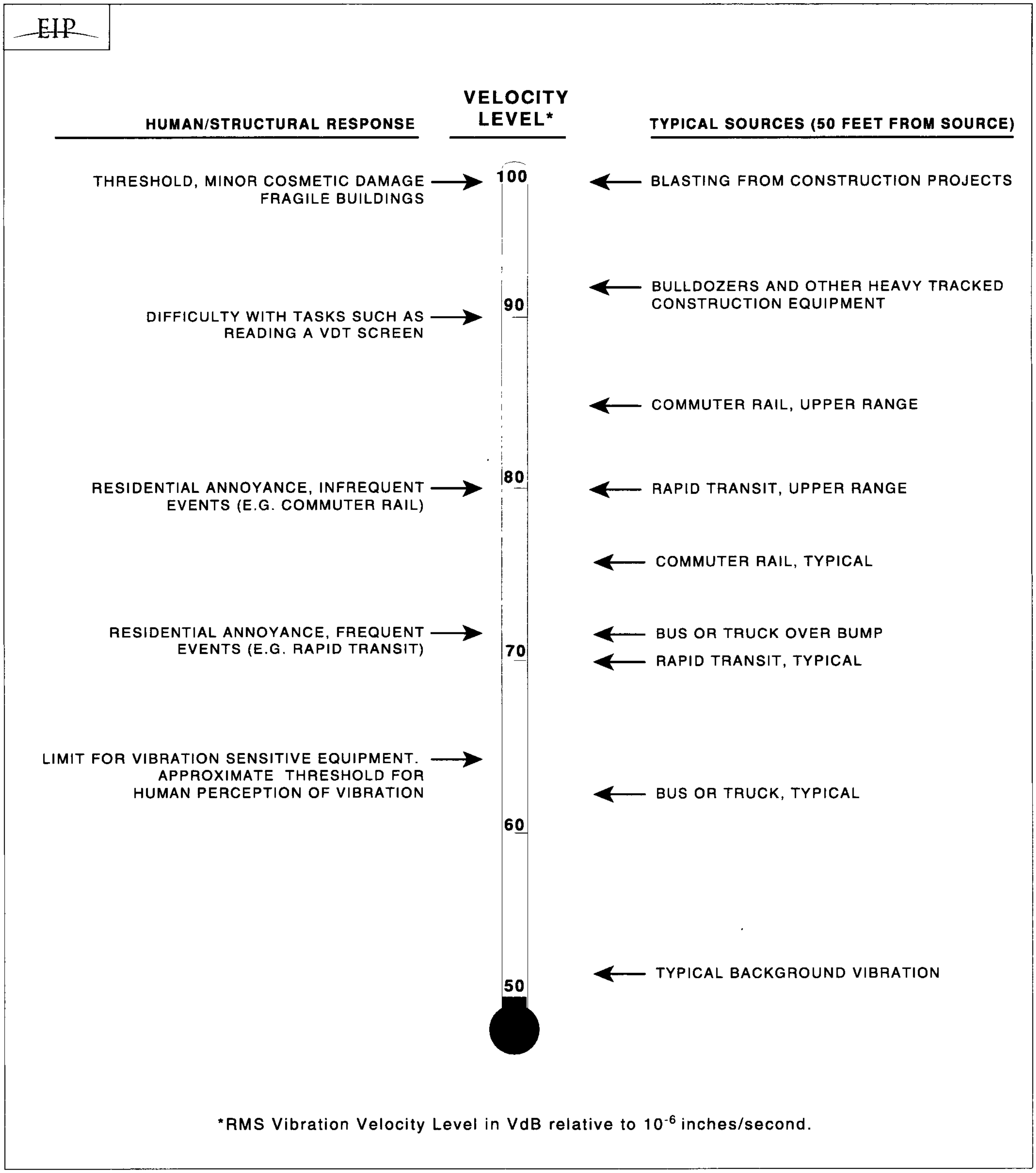
b. Figure V.G.2 shows the locations of these sites.

c. L_{eq} is the average noise intensity during the measurement period (10 minutes for these locations).
L_{max} is the highest instantaneous noise intensity during the measurement period.
L_{dn} is the 24-hour L_{eq} with a 10 dBA "penalty" added to nighttime noise.

d. Field measurements were taken on Sixth Street, south of Channel Street. This would be the location of the future Common Street roundabout, south of the future location of Owens Street.

e. The field data for this location were taken on the Minnesota Leg. These data were used to calibrate the model for the Mariposa and Fourth Street intersection.

Source: EIP Associates.



SOURCE Office of Planning, Federal Transit Administration, U S Department of Transportation, Transit Noise and Vibration Impact Assessment Final Report, April 1995, p 7-5.

FIGURE F.1 TYPICAL LEVELS OF GROUND-BORNE VIBRATION

G. SEISMICITY

RELATIONSHIP OF THE CURRENT STUDY TO THE 1990 FINAL ENVIRONMENTAL IMPACT REPORT FOR THE MISSION BAY PROJECT AREA

The Geology & Seismicity section of Volume I, Chapter II of the 1990 FEIR is incorporated by reference in this SEIR, and the relevant text is summarized in this appendix./1/ The Project Area being examined in this SEIR would occupy essentially the same area analyzed in the 1990 FEIR for the Mission Bay Project Area. Updated geologic and soils information is included in the Initial Study (Appendix A). Updated seismic information is included in the SEIR, and is cited in the endnotes of Section V.H, Seismicity, as well as in the endnotes of this appendix.

SUMMARY OF THE RELEVANT TEXT IN THE 1990 FINAL ENVIRONMENTAL IMPACT REPORT FOR THE MISSION BAY PROJECT AREA

The 1990 FEIR addresses settlement, foundation types, earthquakes, secondary earthquake hazards, earthquake damage, and measures to mitigate geo-seismic hazards throughout the Mission Bay Project Area. The inevitability of major earthquakes in the Bay Area, the exacerbation of seismic effects by artificial fill and Bay Mud underlying the Mission Bay Project Area, and the reduction of seismic hazards through the proper use of site-specific geo-seismic information in structural design are recognized in the context of the Mission Bay Project Area. The estimate (current in August 1990) of the time-frame in which a major earthquake is likely to occur is stated to be about 10% within the 20 years following 1984./2/ This estimate has been superseded by information from studies by the United States Geological Survey following the 1989 Loma Prieta earthquake. The updated estimate is 67% in the 30-year period between 1990 and 2020./3/

The Settlement subsection of the 1990 FEIR briefly describes the stratigraphy underlying the Mission Bay Project Area as an artificially filled tidal inlet containing as much as 57 feet of unengineered fill (sand, clay, bricks, cinder, concrete rubble, trash) overlying 20 to 120 feet of wet, compressible Bay Mud, and 15 to 75 feet of older, more stable sediments (sandy clays and clayey sands). Depth to Franciscan bedrock ranges from 50 to 200 feet. Thickness of deposits and depth to bedrock increases toward the Bay. Several feet of settlement has occurred since filling began in the late 1800's, and is expected to continue at a reduced rate, causing as much as another 6 inches of total settlement during the next 30 years (1990 - 2020). Differential settlement has occurred where adjacent areas have been loaded more or less heavily with different weight structures or filled to different depths with compressible material. The central and eastern portions of the Mission Bay Project Area are judged most susceptible to differential settlement. Heavy loads from buildings placed directly on the fill near

China Basin squeezed Bay Mud from beneath the structures into unconfined areas at the water's edge, reducing water depth, hindering navigation, and causing further settlement./4/

The Foundations subsection of the 1990 FEIR briefly describes the two types of foundations that could be used in the Mission Bay Project Area, and the criteria for selecting the appropriate type. Piles driven to the more stable material beneath the Bay Mud would be needed to support the foundations of structures more than five stories high, or where total settlement is expected to exceed 6 inches. Pile supported structures would not settle. In areas not subject to excessive settlement, one- to two-story structures could be supported on spread footings or stiffened slabs: compensating foundations (concrete slabs that float on a layer of engineered fill) could be used for two- to five-story structures. Spread footing or slab supported structures would settle at the same rate as the surrounding area./5/

The Earthquakes subsection of the 1990 FEIR briefly describes the San Andreas Fault System, being the boundary between two plates of Earth's crust, as the source of earthquakes in the Bay Area. The pattern of increasing seismic activity prior to a great earthquake is noted, as is the possibility that the Bay Area is entering another cycle of such activity. The most damage in San Francisco during the October 1989 Loma Prieta earthquake was caused in areas of filled land along the northern and eastern edges of the City. A maximum credible earthquake in the San Andreas Fault System would produce very strong to violent groundshaking in the Mission Bay Project Area./6/

The Secondary Earthquakes Hazards subsection of the 1990 FEIR describes the earthquake-induced ground failures that probably would occur in the Mission Bay Project Area. These include liquefaction, subsidence, and lateral spreading, all resulting from seismic vibration of saturated loose soil (Younger Bay Mud) or fill. Except for the northeast corner of the Mission Bay Project Area, where bedrock is exposed, all parts of the area had some potential for liquefaction and subsidence, with the greatest risk being north of China Basin Channel. The risk of lateral spreading is greatest within several hundred feet of China Basin Channel./7/

The Earthquake Damage subsection of the 1990 FEIR ranks various building types according to the damage they are expected to sustain during a major earthquake. Well-designed and carefully constructed buildings are not expected to collapse, but damage would range from slight, in light metal and wood frame structures, to severe, in tilt-up concrete structures. Damage is expected in all infrastructure (roads, bridges, pipelines, etc.), and access to the Mission Bay Project Area is expected to be limited, particularly south of China Basin Channel. Shattering windows and falling debris are expected to be the major source of injuries or deaths, the number of casualties depending on the number of people in the Mission Bay Project Area, and the time of day when the earthquake occurs./8/

The Mitigation Measures subsection of the 1990 FEIR states that measures are included in the Mission Bay project to eliminate, reduce, or avoid geo-seismic effects. These measures subsequently were incorporated into the *Mission Bay Monitoring Program* (September 20, 1990) as requirements for any development in the Mission Bay Project Area./9/ Implementation of the mitigation measures is the core of the mitigation program for the development of the Mission Bay Project Area as envisioned in the 1990 FEIR. The content of the measure is listed briefly in the following paragraphs. Many of these measures have been incorporated in the 1995 San Francisco Building Code and are required as part of all development projects in the City and County's or the Redevelopment Agency's jurisdiction. Some others have been incorporated in the 1997 Uniform Building Code and have been adopted by Catellus although they are not yet required by the San Francisco Building Code.

As envisioned in the 1990 FEIR, five measures to reduce or eliminate the effects of settlement would require soil engineering investigations, pile-supported or other appropriate foundations, reuse of existing piles where possible, leveling jacks or similar techniques for buildings with shallow foundations, and surcharging and draining of building sites where necessary. Basements would be constructed above the water table, thereby eliminating the need for dewatering. Drainage systems would be designed to accommodate settlement. Corrosive soils would be located and neutralized. The then-current San Francisco Building Code would be the minimum standard required to withstand seismic groundshaking.

Five other measures would reduce groundshaking hazards by restricting exterior building materials to less hazardous types, requiring peer review to ensure the use of state-of-the-art engineering practices, securing material and equipment in buildings under construction, requiring a certified Quality Assurance/Quality Control program for construction and materials, and requiring bracing of nonstructural building elements. Sandy soil would be compacted to reduce liquefaction potential. Automatic shut-off devices would be required on natural gas lines.

Five measures would improve emergency response by requiring an emergency response plan for the Mission Bay Project Area, specifying siting and design features for emergency facilities, requiring a mass care facility in the Mission Bay Project Area, installing cisterns and suction hydrants for bay water to increase fire-fighting capabilities, and storing heavy equipment within the Project Area to provide transport, to open access, and to clear debris after a major earthquake./10/

NOTES: Appendix G, Seismicity

1. San Francisco Planning Department, *Mission Bay Final Environmental Impact Report*, Planning Department File No. 86.505E, State Clearinghouse No. 86070113, certified August 23, 1990, Volume Two, Technical Analyses, Chapter VI, "Environmental Setting, Impact & Mitigation," Section K, Geology and Seismicity, pp. VI.K.1-VI.K.61.*

2. *1990 FEIR,* Volume One, p. II.76.*

3. Working Group on California Earthquake Probabilities, *Probabilities of Large Earthquakes in the San Francisco Bay Region, California*, United States Geological Survey Circular 1053, 1990, p. 29.

4. *1990 FEIR,* Volume One, pp. II.76 and II.77.*

5. *1990 FEIR,* Volume One, p. II.77.*

6. *1990 FEIR,* Volume One, pp. II.77 and II.78.*

7. *1990 FEIR,* Volume One, pp. II.78 and II.79.*

8. *1990 FEIR,* Volume One, pp. II.79 and II.80.*

9. San Francisco Planning Commission, *Mission Bay Master Plan*, File No. 86.505M, Resolution No. 12040, adopted September 27, 1990, Development Agreement Exhibit A-5 Mission Bay Monitoring Program, September 20, 1990, pp. A-30-A-44.*

10. *1990 FEIR,* Volume One, pp. II.80 and II.81.*

* A copy of this report is on file for public review at the Office of Environmental Review, Planning Department, 1660 Mission Street, San Francisco.

H. HEALTH AND SAFETY

This appendix contains supporting documentation to accompany Section V.I, Health and Safety. It is presented in parts:

- Definitions
- Examples of Laboratory Chemicals and Infectious Agents
- Regulatory Setting
- Standard Industry Practices
- Hazard Assessment

After defining "hazardous materials" and other terms used in this report, this appendix provides examples of the types of hazardous materials and infectious agents that could be handled by Commercial Industrial uses and UCSF. Because laws and regulations serve to control many potential health and safety hazards, this appendix summarizes the laws and regulations applicable to the project in more detail than provided in Section V.I, Health and Safety. Similarly, standard industry practices address some issues for which few or no laws or regulations apply; therefore, these standards are summarized following the detailed regulatory setting. This appendix ends with a hazard assessment that describes how applicable laws, regulations, and standards serve to control environmental impacts, and discusses areas where reliance on these laws, regulations, and standards may not adequately address certain issues. The hazard assessment is intended to provide sufficient background information to allow Section V.I, Health and Safety, to focus on issues of primary importance.

DEFINITIONS

For purposes of this SEIR, hazardous materials include hazardous chemicals, radioactive materials, and biohazardous agents, although these materials are often subject to different regulatory schemes. The term "hazardous material" is defined differently for different regulatory programs, but for this report, the definition is similar to that given in the California Health and Safety Code./1/

- ***Hazardous materials*** are materials that, due to their quantity, concentration, or physical or chemical characteristics, pose a significant hazard to human health and safety, or to the environment, if released into the workplace or the environment.

The definition of hazardous waste, which is a subset of hazardous material, is similar to that given in both the California Health and Safety Code and the California Code of Regulations./2/

- ***Hazardous wastes*** are wastes that, due to their quantity, concentration, or physical, chemical, or infectious characteristics, may either 1) increase mortality or serious illness, or 2) pose a substantial hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Hazardous waste includes any hazardous material that is discarded by such means as abandonment, disposal, or recycling./3/ The characteristics of hazardous materials and wastes are described further in the 1990 FEIR./4/

Terminology related to radioactive materials is discussed below.

- ***Radioactive materials*** contain atoms with unstable nuclei that spontaneously emit ionizing radiation to increase their stability.

- ***Radioactive wastes*** are radioactive materials that are discarded (including wastes in storage) or abandoned.

Radioactive atoms are called *radionuclides*. When a radionuclide emits radiation, it eventually becomes nonradioactive. The level of radioactivity decreases by one half after a period called a *half-life*. The half-lives of some radionuclides commonly used in laboratories are as follows: tritium (hydrogen-3 or ^{3}H), 12 years; phosphorus-32 (^{32}P), 14 days; carbon-14 (^{14}C), 5,700 years; iodine-125 (^{125}I), 60 days; and sulfur-35 (^{35}S), 88 days./5/ Radioactive materials with half-lives greater than 90 days are *long-lived radionuclides*; those with half-lives less than 90 days are *short-lived radionuclides*.

Terminology related to biohazardous materials is discussed below.

- ***Biohazardous materials*** are materials containing infectious agents that require Biosafety Level 2 or greater safety precautions or cells containing recombinant DNA molecules with codes that can be expressed to create a protein.

Infectious agents are microorganisms, bacteria, molds, parasites, or viruses that normally increase human mortality and include organisms capable of being communicated by invading and multiplying in body tissues./6/ *Biosafety levels* are levels of safety precautions defined by the U.S. Department of Health and Human Services for work with biological materials./7/ As described below under "Standard Industry Practices," four levels exist, Biosafety Levels 1 to 4, with Biosafety Level 1 being appropriate for the least hazardous biological materials. *Recombinant DNA* is DNA (deoxyribonucleic acid, the molecule that stores genetic information) made outside a living cell by joining natural or synthetic DNA together with DNA that a living cell can copy. All copies of such DNA are also considered recombinant.

- ***Medical waste*** is waste resulting from the diagnosis, treatment, or immunization of human beings or animals; research pertaining to these activities; or the production of biologics (naturally occurring therapeutic pharmaceutical products or their derivatives)./8/

For purposes of this SEIR, medical waste is a special type of hazardous waste that includes both *biohazardous waste* and *sharps waste* (items capable of cutting or piercing, such as hypodermic needles, razor blades, and broken glass, that may be contaminated with biohazardous material). With this definition, medical waste is not necessarily limited to wastes coming from medical facilities. However, medical waste *does not* include waste containing microbiological cultures associated with food processing or biotechnology that is not otherwise considered infectious.

EXAMPLES OF LABORATORY CHEMICALS AND INFECTIOUS AGENTS

As discussed under "Estimated Hazardous Materials Quantities" under "Hazardous Materials Use, Storage, and Disposal" in Section V.I, Health and Safety: Impacts, Commercial Industrial research and development in the Project Area would most likely relate to the life sciences as a result of the proximity of UCSF. Tables H.1 and H.2 list examples of laboratory chemicals and infectious agents similar to those that could be used by Commercial Industrial businesses and UCSF. The risk groups identified in Table H.2 generally correspond to biosafety levels.

Other types of research and development would be possible in Commercial Industrial areas, and these types of research and development could involve greater hazardous chemical use. For comparison, Table H.3 presents estimated chemical storage by Commercial Industrial uses and UCSF assuming that almost all Commercial Industrial research and development would relate to computer, semiconductor, and other "high tech" industries. The estimated quantities presented in Table H.3 are unlikely to be found in the Project Area, but Table H.3 does illustrate how hazardous chemical use varies with different types of research and development. Table H.3 contrasts with Table V.I.4, which assumes research and development would relate to the biological sciences. Chemical use tends to be greater in Table H.3; however, the estimates presented in Table V.I.4 are believed to be conservatively representative of likely project conditions.

The approach used to develop Table H.3 is the same as described in "Approach Used to Estimate Hazardous Materials Quantities" under "Hazardous Materials Use, Storage, and Disposal in Section V.I, Health and Safety: Impacts, except that data from Hewlett Packard Laboratories in Palo Alto, California, were used instead of data from Chiron Corporation in Emeryville. On the basis of the Hewlett Packard Laboratories data, Commercial Industrial activities in the Project Area could, in addition to the chemicals listed in Table H.3, involve up to 100,000 gallons of cryogenic (very cold) liquids, 6,800 cubic feet of flammable gases, 39,000 cubic feet of toxic gases, and 250,000 cubic feet

TABLE H.1
EXAMPLES OF LABORATORY CHEMICALS, BY TYPE

Flammable Materials

acetone	isopropanol
acetonitrile	2,6-lutidine
benzene	2-mercapto-ethanol
butanol	methanol
dimethylformamide	piperidine
1,4-dioxane	1-propanol
ethanol	pyridine
ether	sodium borohydride
ethyl acetate	sodium hydride
ethylene glycol	tetrahydrofuran
hexane	toluene
isoamyl alcolol	triethylamine
isobutanol	xylene

Corrosive Materials

acetic anhydride	phosphoric acid
ammonia	potassium hydroxide
ethylene diamine	sodium bisulfite
formic acid	sodium hydroxide
glacial acetic acid	sodium phosphate dibasic
hydrochloric acid	sodium phosphate tribasic
hydroxylamine hydrochloride	succinic acid
lactic acid	sulfuric acid
nitric acid	trichloroacetic acid
oxalic acid	trifluoroacetic acid

Oxidizers

ammonium persulfate	potassium permanganate
hydrogen peroxide	silver nitrate
perchloric acid	sodium nitrite
periodic acid	sodium perchlorate

(Continued)

TABLE H.1 (Continued)

Toxic Substances	
acrylamide	imidazole
benzyl alcohol	isopropyl-D-thiogalactopyranoside
cacodylic acid	methyl sulfoxide
cesium chloride	methylene blue
chloroquinine	morpholinoethane sulfonic acid
coomasie brilliant blue	N,N-methylene-bis-acrylamide
cyanogen bromide	N-tris-hydroxymethylmethylglycine
deoxycholic acid	ninhydrin
dimethylsulfoxide	phenol
diphenylamine	phenylmethylsulfonyl flouride
formamide	piperazine-N,N'-bis-2-ethanesulfonic acid
glycerol	potassium thiocyanate
guanidine hydrochloride	sodium azide
guanidine thiocyanate	sodium cyanoborohydride
1,1,1,3,3,3-hexafluoro-2-propanol	sodium thiocyanate
8-hydroxyquinoline	streptomycin sulfate
Other Materials	
amino acids	formaldehyde
ammonium acetate	mineral oil
ampicillin	phosphoramidite
ascorbic acid	polyethylene glycol
bleach	potassium dichromate
bromophenyl blue	potassium phosphate
chloroform	silica gel
citric acid	sodium bicarbonate
cobalt chloride	sodium carbonate
cupric sulfate	sodium chloride
dextran	sodium dodecylsulfate
dichloromethane	tetramethylethylenediamine
dithiothreitol	tris-hydroxymethylaminomethane
ethidium bromide	

Source: EIP Associates, based on information from City of Emeryville, *Chiron Development Plan Environmental Impact Report*, State Clearinghouse No. 94063005, June 1995.

TABLE H.2
BASIS FOR THE CLASSIFICATION OF BIOHAZARDOUS AGENTS BY RISK GROUP

Risk Group 1
Agents that are not associated with disease in healthy adult humans.

asporogenic *Bacillus subtilis*
Bacillus licheniformis
Escherichia coli-K12
adeno-associated virus types 1 through 4

Risk Group 2
Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are *often* available.

Bacterial Agents, Including Chlamydia

Acinetobacter baumannii (formerly *Acinetobacter calcoaceticus*)
Actinobacillus
Actinomyces pyogenes (formerly *Corynebacterium pyogenes*)
Aeromonas hydrophila
Amycolata autotrophica
Archanobacterium haemolyticum (formerly *Corynebacterium haemolyticum*)
Arizona hinshawii - all serotypes
Bacillus anthracis
Bartonella henselae, B. quintana, B. vinsonii
Bordetella including *B. pertussis*
Borrelia recurrentis, *B. burgdorferi*
Burkholderia (formerly *Pseudomonas* species) except those listed for risk group 3
Campylobacter coli, C. fetus, C. jejuni
Chlamydia psittaci, C. trachomatis, C. pneumoniae
Clostridium botulinum, Cl. chauvoei, Cl. haemolyticum, Cl. histolyticum, Cl. novyi, Cl. septicum, Cl. tetani
Corynebacterium diphtheriae, C. pseudotuberculosis, C. renale
Dermatophilus congolensis
Edwardsiella tarda
Erysipelothrix rhusiopathiae
Escherichia coli - all enteropathogenic, enterotoxigenic, enteroinvasive and strains bearing K1 antigen, including *E. coli* O157:H7
Haemophilus ducreyi, H. influenzae
Helicobacter pylori
Klebsiella - all species except *K. oxytoca* (risk group 1)
Legionella including *L. pneumophila*
Leptospira interrogans - all serotypes

(Continued)

TABLE H.2 (Continued)

Listeria

Moraxella

Mycobacterium (except those listed for risk group 3) including *M. avium* complex, *M. asiaticum, M. bovis* BCG vaccine strain, *M. chelonei, M Fortuitum, M. kansasii, M. leprae, M. malmoense, M. marinum, M. paratuberculosis, M. scrofulaceum, M. simiae, M. szulgai, M. ulcerans, M. xenopi*

Mycloplasma, except *M. mycoides* and *M. agalactiae* which are restricted animal pathogens

Neisseria gonorrhoea, N. meningitidis

Nocardia asteroides, N. brasiliensis, N. otitdiscaviarum, N. transvalensis

Rhodococcus equi

Salmonella including *S. arizonae, S. cholerasuis, S. enteritidis, S. gallinarum-pullorum, S. meleagridis, S. paratyphi,* A, B, C, *S. typhi, S. typhimurium*

Shigella including *S. boydii, S. dysenteriae,* type 1, *S. flexneri, S. sonnei*

Sphaerophorus necrophorus

Staphylococcus aureus

Streptobacillus moniliformis

Streptococcus including *S. pneumoniae, S. pyogenes*

Treponema pallidum, T. carateum

Vibrio cholerae, V. parahemolyticus, V. vulnificus

Yersinia enterocolitica

Fungal Agents

Blastomyces dermatitidis

Cladosporium bantianum, C. (Xylohypha) trichoides

Cryptococcus neoformans

Dactylaria galopava (Ochroconis gallopavum)

Epidermophyton

Exophiala (Wangiella) dermatitidis

Fonsecaea pedrosoi

Microsporum

Paracoccidioides braziliensis

Penicillium marneffei

Sporothrix schenkii

Trichophyton

Parasitic Agents

Ancylostoma human hookworms including *A. duodenale, A. ceylanicum*

Ascaris including *Ascaris lumbricoides suum*

Babesia including *B. divergens, B. microti*

Brugia filaria worms including *B. malayi, B. timori*

Coccidia

(Continued)

TABLE H.2 (Continued)

Cryptosporidium including *C. parvum*
Cysticercus cellulosae (hydatid cyst, larva of *T. solium*)
Echinococcus including *E. granulosis, E. multilocularis, E. vogeli*
Entamoeba histolytica
Enterobius
Fasciola including *F. gigantica, F. hepatica*
Giardia including *G. lamblia*
Heterophytes
Hymenolepis including *H. diminuta, H. nana*
Isospora
Leishmania including *L. braziliensis, L. donovani, L. ethiopia, L. major, L. mexicana, L. peruvania, L. tropica*
Loa loa filaria worms
Microsporidium
Naegleria fowleri
Necator human hookworms including *N. americanus*
Onchoerca filaria worms including *O. volvulus*
Plasmodium including simian species, *P. cynomologi, P. falciparum, P. malariae, P. ovale, P. vivax*
Sarcocystis including *S. sui hominis*
Schistosoma including *S. haematobium, S. intercalatum, S. japonicum, S. mansoni, S. mekongi*
Strongyloides including *S. stercoralis*
Taenia solium
Toxocara including *T. canis*
Toxoplasma including *T. gondii*
Trichinella spiralis
Trypanosoma including *T. brucei brucei, T. brucei gambiense, T. brucei rhodesiense, T. cruzi*
Wuchereria bancrofti filaria worms

Viruses

Adenoviruses, human - all types

Alphaviruses (Togaviruses) - Group A Arboviruses
- Eastern equine encephalomyelitis virus
- Venezuelan equine encephalomyelitis vaccine strain TC-83
- Western equine encephalomyelitis virus

Arenaviruses
- Lymphocytic choriomeningitis virus (non-neurotropic strains)
- Tacaribe virus complex

(Continued)

TABLE H.2 (Continued)

Bunyaviruses
- Bunyamwera virus
- Rift Valley fever virus vaccine strain MP-12

Calciviruses
- Coronaviruses

Flaviviruses (Togaviruses) - Group B Arboviruses
- Dengue virus serotypes 1, 2, 3, and 4
- Yellow fever virus vaccine strain 17D

Hepatitis A, B, C, D, and E viruses

Herpesviruses - except *Herpesvirus simiae* (Monkey B virus)
- Cytomegalovirus
- Epstein Barr virus
- Herpes simplex types 1 and 2
- Herpes zoster
- Human herpesvirus types 6 and 7

Othomyxoviruses
- Influenza viruses types A, B, and C

Papovariruses - All human papilloma viruses

Paramyxoviruses
- Newcastle disease virus
- Measles virus
- Mumps virus
- Parainfluenza virus types 1, 2, 3, and 4
- Respiratory syncytial virus

Parvoviruses
- Human parvovirus (B19)

Picornaviruses
- Coxsackie viruses types A and B
- Echoviruses - all types
- Polioviruses - all types, wild and attenuated
- Rhinoviruses - all types

Poxviruses - all types except Monkeypox virus and restricted poxviruses including Alastrim, Smallpox, and Whitepox

Reoviruses - all types including Coltivirus, human Rotavirus, and Orbivirus (Colorado tick fever virus)

Rhabdoviruses
- Rabies virus - all strains
- Vesicular stomatitis virus - laboratory adapted strains including VSV-Indiana, San Juan, and Glasgow

Togaviruses (see Alphaviruses and Flaviviruses)
- Rubivirus (rubella)

(Continued)

TABLE H.2 (Continued)

Risk Group 3
Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions *may be* available.

Bacterial Agents, Including Rickettsia

Bartonella

Brucella including *B. abortus, B. canis, B. suis*

Burkholderia (Pseudomonas) mallei, B. pseudomallei

Coxiella burnetii

Francisella tularensis

Mycobacterium bovis (except BCG strain), *M. tuberculosis*

Pasteurella multocida type B - "buffalo" and other virulent strains

Rickettsia akari, R. australis, R. canada, R. conorii, R. prowazekii, R. rickettsii, R. siberica, R. tsutsugamushi, R. typhi (R. mooseri).

Yersinia pestis

Fungal Agents

Coccidioides immitis (sporulating cultures; contaminated soil)

Histoplasma capsulatum, H. capsulatum var.. duboisii

Viruses and Prions

Alphaviruses (Togaviruses) - Group A Arboviruses

- Semliki Forest virus
- St. Louis encephalitis virus
- Venezuelan equine encephalomyelitis virus (except the vaccine strain TC-83)

Arenaviruses

- Lymphocytic choriomeningitis virus (LCM) (neurotropic strains)

Bunyaviruses

- Hantaviruses including Hantaan virus
- Rift Valley fever virus

Flaviviruses (Togaviruses) - Group B Arboviruses

- Japanese encephalitis virus
- Yellow fever virus

Poxviruses

- Monkeypox virus

Prions

- Transmissible spongioform encephalopathies (TME) agents (Creutzfeldt-Jacob disease and kuru agents)

(Continued)

TABLE H.2 (Continued)

Retroviruses
- Human immunodeficiency virus (HIV) types 1 and 2
- Human T cell lymphotropic virus (HTLV) types 1 and 2
- Simian immunodeficiency virus (SIV)

Rhabdoviruses
- Vesicular stomatitis virus

Source: U.S. Department of Health and Human Services National Institutes of Health, *Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines)*, January 1996, pp. 30-34.

of other compressed gases (assuming "high tech" laboratories would occupy 75% of the Commercial Industrial space). Health and safety issues related to all of these types of materials are addressed in Section V.I, Health and Safety: Impacts, as well as here in Appendix H. Risk Management Plan requirements could apply to the use of some of these compressed gases.

REGULATORY SETTING

Hazardous materials handling is subject to numerous federal, state, and local laws and regulations. Although the summary of laws and regulations provided below is not exhaustive, it includes those most important to the storage, use, and disposal of hazardous chemicals, radioactive materials, and biological materials.

Occupational Safety

The California Division of Occupational Safety and Health (Cal/OSHA) and the Federal Occupational Safety and Health Administration (Fed/OSHA) are the agencies responsible for ensuring worker safety in the handling and use of chemicals in the workplace. Under the authority of the Occupational Safety and Health Act of 1970, Fed/OSHA has adopted numerous regulations pertaining to worker safety. These regulations set standards for safe workplaces and work practices, including the reporting of accidents and occupational injuries. Fed/OSHA regulations also contain standards relating to hazardous materials handling, including workplace conditions, employee protection requirements, first aid, and fire protection.

In California, Cal/OSHA assumes primary responsibility for developing and enforcing workplace safety regulations. Because California has a federally approved OSHA program, it is required to

**TABLE H.3
ESTIMATED CHEMICAL STORAGE
BY COMMERCIAL INDUSTRIAL USES AND UCSF (Assuming Commercial Industrial Operations Primarily Related to "High Tech" Industries)**

Chemical Type	Chemical Storage (assuming "high tech" labs occupy 50% of the Commercial Industrial space (tons) /a/	Chemical Storage (assuming "high tech" labs occupy 75% of the Commercial Industrial space (tons) /a/
Flammable Materials (materials that can sustain a fire if ignited)	450	670
Corrosive Materials (acidic or basic materials, which can corrode living tissue and other materials)	360	540
Oxidizers (reactive materials that often release oxygen upon reaction)	24	36
Toxic Substances	3.7	5.6
Other Materials /b/	4.0	5.9
Commercial Industrial Subtotal	840	1,300
UCSF	250	250
TOTAL	**1,100**	**1,500**

Notes:
a. All figures have been rounded to two significant figures.
b. The "other materials" category could include some materials that are not hazardous.

Sources: EIP Associates, based on information from Hewlett Packard Laboratories, Palo Alto, California, Hazardous Materials Management Plans on file with the City of Palo Alto Fire Department, 1997, and John Shaver, UCSF Office of Environmental Health and Safety, data provided to Michelle Schaefer, Campus Planning Office, February 13, 1998.

adopt regulations that are at least as strict as federal requirements. Cal/OSHA regulations concerning the use of hazardous materials in the workplace require employee safety training, safety equipment, accident and illness prevention programs, hazardous materials exposure warnings, and emergency action plan and fire prevention plan preparation. Cal/OSHA enforces hazard communication program regulations, which contain training and information requirements, including procedures for identifying and labeling hazardous materials. The hazard communication program regulations also require that Material Safety Data Sheets (forms provided by manufacturers that identify and describe the hazardous constituents in their products) be available to employees and that employee information and training programs be documented. These regulations also require preparation of emergency action plans (escape and evacuation procedures, rescue and medical duties, and training in emergency evacuations).

Federal, state, and local laws include special provisions for hazard communication to employees in research laboratories, including training in chemical work practices. Chemical safety information must be available. Specific, more detailed training and monitoring is required for the use of carcinogens, ethylene oxide, lead, asbestos, and certain other chemicals. Both Fed/OSHA and Cal/OSHA have adopted Centers for Disease Control guidelines for safely handing specimens potentially infected with human bloodborne pathogens (disease-causing agents). The federal Occupational Exposure to Bloodborne Pathogens Standard requires the use of Universal Precautions in the workplace, which means all human blood and certain body fluids are to be handled as if they contain infectious agents, whether or not they do.

Hazardous Materials Management

State law requires detailed planning to ensure that hazardous materials are properly handled, used, stored, and disposed of, and to prevent or minimize injury to human health or the environment in the event that such materials are accidentally released. Federal laws, such as the Emergency Planning and Community-Right-to-Know Act of 1986, impose similar requirements. Because state law regarding hazardous materials management is generally more stringent than federal law, state law is emphasized below. For the most part, state laws are enforced by local agencies. In San Francisco, the local authority is the San Francisco Department of Public Health. As a Certified Unified Permitting Agency, it implements a variety of hazardous materials programs, including underground and above-ground storage tank requirements, hazardous waste generation and treatment permitting, and Risk Management Plans.

The Hazardous Materials Release Response Plans and Inventory Law of 1985 (Business Plan Act), which is implemented locally as part of San Francisco's Hazardous Materials Permit and Disclosure Ordinance, requires businesses that handle hazardous materials to document details of the facility, including floor plans, and business conducted at the site; the inventory of hazardous materials that are handled or stored on site; an emergency response plan; and safety and emergency response training for employees. San Francisco's ordinance establishes a system for processing hazardous material storage permits and monitoring the use and disposal of hazardous materials. The process provides for hazardous material identification, disclosure, and management plans, and intergovernmental notification and review of permits. The ordinance regulates the storage and labeling of hazardous materials, and specifies procedures for the installation, modification, and closure of hazardous materials storage facilities. These locally implemented requirements apply to state agencies, including UCSF.

In addition to the programs described above, businesses that use more than specified quantities of certain regulated substances (materials that pose extraordinary risks in the event of an accident, as defined by Health and Safety Code Section 25532[g]) must prepare Risk Management Plans. Because a significant number of facilities generate, store, treat, handle, refine, process, and transport hazardous materials, the California Legislature has recognized that, because of the nature and volume of chemicals handled at some facilities, their operations may represent a threat to public health and safety in the event of an accidental release./9/ The potential for explosions, fires, or releases of toxic chemicals into the environment exists. The protection of the public from uncontrolled releases or explosions of hazardous materials is of statewide concern. According to the Legislature, there is an increasing capacity to both minimize and respond to releases of toxic air contaminants and hazardous materials once they occur, and to formulate efficient plans to evacuate citizens if these discharges or releases cannot be contained. However, programs designed to prevent these accidents are the most effective way to protect the community health and safety and the environment. These programs should anticipate the circumstances that could result in explosions, fires, or releases and require the taking of necessary precautionary and preemptive actions, consistent with the nature of the hazardous materials handled by the facility and the surrounding environment. As part of the Risk Management Plan process, a business must undertake a hazards analysis that systematically assesses the operations of the business to determine the potential for releases. Risk Management Plans must 1) estimate the consequences of a worst case accident scenario, 2) describe measures the business will take to reduce potential hazards, and, because they are public documents, 3) notify neighboring residents and businesses of the risks posed to them. In California, the public must be given an opportunity to review Risk Management Plans before administering agencies can approve them. The level of detail required in a Risk Management Plan is determined in consultation with the administering agency (in this case, the San Francisco Department of Public Health). The level of detail must be sufficient for the administering agency to determine that the Risk Management Plan satisfies state and federal requirements.

Pursuant to the Emergency Services Act, California has developed an emergency response plan to coordinate emergency services provided by federal, state, and local governmental agencies and private citizens. Response to hazardous materials incidents is one part of this plan administered by the state Office of Emergency Services. The Office of Emergency Services coordinates the responses of other agencies, including the San Francisco Public Health and Fire Departments. Local agencies are required to develop area plans for response to releases of hazardous materials and wastes. San Francisco's area plan addresses pre-emergency planning, describes agency notification and coordination procedures, specifies personnel training, and lists supplies and equipment.

Building and Fire Safety

The San Francisco Municipal Code includes a Building Code and a Fire Code. These codes amend and otherwise incorporate the California Building Code and California Fire Code. The California codes, in turn, are based on the Uniform Building Code and the Uniform Fire Code. The San Francisco Fire Code specifies management practices for combustible materials, including flammable and explosive hazardous materials. For example, this code specifies the types of containers that can hold flammable materials and how these containers must be stored (e.g., in fire safety cabinets). The Fire Code also addresses appropriate fire abatement systems (e.g., fire alarms and sprinklers). The San Francisco Building Code defines building occupancy classifications on the basis of intended building uses. Occupancy classifications account for the quantity of hazardous material to be handled in an area and the number and types of individuals occupying the space. The San Francisco Building Code specifies appropriate separations (fire-resistive walls) to be constructed between portions of a building falling into different occupancy classifications. The San Francisco Fire Department and Department of Building Inspection review design plans for new buildings to ensure compliance with Fire Code and Building Code requirements.

As a state institution, UCSF must comply with the California Fire Code as enforced by the State Fire Marshal. UCSF must also comply with the California Building Code.

Hazardous Waste Management

The federal Resource Conservation and Recovery Act of 1976 creates a "cradle to grave" hazardous materials regulatory program administered by the U.S. Environmental Protection Agency (EPA). Under this law, individual states may implement their own hazardous waste programs in lieu of the federal program, as long as the state program is at least as stringent as federal requirements. EPA must approve state programs intended to implement federal regulations, and it has approved California's program.

Under California's Hazardous Waste Control Law, administered by the California Environmental Protection Agency's Department of Toxic Substances Control, California has adopted regulations governing the generation, transportation, treatment, storage, and disposal of hazardous waste. These hazardous waste regulations establish criteria for identifying, packaging, and labeling hazardous wastes; prescribe management methods for hazardous wastes; establish permit requirements for hazardous waste treatment, storage, disposal, and transportation; and identify hazardous wastes that cannot be disposed of in landfills. When transporting hazardous wastes, a hazardous waste manifest must accompany the shipment, describing the waste and its intended destination. A copy of each manifest must be filed with the Department of Toxic Substances Control, and the generator must match copies of hazardous waste manifests with receipts from treatment, storage, and disposal facilities.

Hazardous Materials Transportation

The U.S. Department of Transportation has the regulatory responsibility for the safe transportation of hazardous materials. Department of Transportation regulations govern all means of transportation, except for those packages shipped by mail, which are covered by U.S. Postal Service regulations. The State of California has also adopted the Department of Transportation regulations for the intrastate movement of hazardous materials.

The U.S. Environmental Protection Agency sets standards for transporters of hazardous waste, and the State of California regulates the transportation of hazardous waste originating in the state or passing through the state. The California Highway Patrol and the California Department of Transportation have primary responsibility for enforcing federal and state transportation regulations, and for responding to hazardous materials transportation emergencies. To prevent leakage and spills of material in transit and to provide detailed information to cleanup crews in the event of an accident, the California Highway Patrol enforces hazardous materials and hazardous waste labeling and packing regulations. Vehicle and equipment inspection, shipment preparation, container identification, and shipping documentation are the responsibility of the California Highway Patrol, which conducts regular inspections of licensed transporters to enforce regulatory compliance.

Common carriers conduct a large portion of their business in the delivery of hazardous materials. They are licensed by the California Highway Patrol, pursuant to the California Vehicle Code, which requires licensing of motor carriers who transport hazardous materials of the type requiring placards. Some Department of Transportation and U.S. Postal Service regulations apply to non-waste hazardous materials, but requirements for hazardous waste are more stringent. Hazardous waste packages must undergo tests that imitate some of the possible rigors of travel. While not every package must be put through every test, most packages must be able to be 1) kept under running water for a time without leaking; 2) dropped, fully loaded, onto a concrete floor; 3) compressed from both sides for a period of time; 4) subjected to low and high pressure; and 5) frozen and heated alternately. Biohazardous materials packages must provide secondary containment with shock absorbent material between containers. Radioactive materials packages must be constructed to provide appropriate shielding from radiation.

Radioactive Materials

The federal Atomic Energy Act applies to the use and control of radioactive material, and provides for states to be responsible for the use, transportation, and disposal of low-level radioactive material. California has accepted responsibility for the protection of the public from radiation hazards. The California Department of Health Services Radiologic Health Branch administers the California Radiation Control Law, which governs the storage, use, transportation, and disposal of sources of ionizing radiation (radioactive material and radiation-producing equipment). Radioactive materials regulations require registration of sources of ionizing radiation, licensing of radioactive material, and protection against radiation exposure./10/ The Radiologic Health Branch also regulates the transportation of radioactive materials and disposal of radioactive waste. Radioactive materials users must maintain detailed records relating to the receipt, storage, transfer, and disposal of such materials. The regulations specify appropriate use and disposal methods for radioactive substances, as well as worker safety precautions and worker health monitoring programs.

Biological Safety

The San Francisco Hazardous Materials Permit and Disclosure Ordinance tracks infectious agents handled by businesses. As discussed above, the California Division of Occupational Safety and Health has adopted the Occupational Exposure to Bloodborne Pathogens Standard. Additional laws and regulations apply to animal use and medical waste management.

The U.S. Food and Drug Administration requires animal testing of drugs intended for human use. The Animal Welfare Act, administered by the Department of Agriculture, applies to the transportation, purchase, sale, housing, care, handling, and treatment of animals by carriers or by persons or organizations engaged in using animals for research or experimental purposes. The law exempts mice and rats from regulation. Federal and state laws require research facilities to keep records of all acquisitions, including births, sales, disposals, deaths, and transportation of animals. In addition, annual reports that include the location of the facility and the names and numbers of animals that did or did not experience pain and distress must be filed. Organizations must also register with the U.S. Department of Agriculture and establish an Institutional Animal Care and Use Committee.

In San Francisco, the California Department of Health Services delegates the responsibility of enforcing the California Medical Waste Management Act to the San Francisco Department of Public Health. The law applies to the generation, transportation, treatment, storage, and disposal of medical waste, and imposes a "cradle-to-grave" tracking system for off-site treatment, and a calibration and monitoring system for on-site treatment. Facilities that treat medical wastes must obtain a permit and are subject to annual audits. Medical waste is to be transported in closed red bags marked "biohazard" and placed inside hard-walled containers with lids.

STANDARD INDUSTRY PRACTICES

The handling and use of biohazardous materials are not regulated in a manner similar to the handling and use of hazardous chemical materials and radioactive materials. The National Research Council and the U.S. Department of Health and Human Services Public Health Service, National Institutes of Health, and Centers for Disease Control have established standards for working with biohazardous materials, including infectious agents, infected animals, and recombinant DNA, but in many instances, following these guidelines is not necessarily required by any state or federal laws. However, the standards of these agencies are normally respected as guidelines for those who handle biohazardous materials. Often, following these guidelines is indirectly required by laws and regulations that incorporate the guidelines by referring to them. For example, institutions conducting research funded by Department of Health and Human Services agencies must follow these guidelines.

According to U.S. Department of Health and Human Services guidelines described in *Biosafety in Microbiological and Biomedical Laboratories* and *Guidelines for Research Involving Recombinant DNA Molecules* (*NIH Guidelines*), four levels of containment practices are used to ensure biological health and safety. These levels are called biosafety levels. Biosafety Level 1 is for the least hazardous biological agents and Biosafety Level 4 is for the most hazardous biological agents. No Biosafety Level 4 operations are foreseeable as part of the project. Work with dangerous or exotic organisms occurs at only a few U.S. laboratories that specialize in such operations. Biosafety Level 3 operations at Commercial Industrial facilities are possible, but they would occupy a relatively small portion of the UCSF and Commercial Industrial space. UCSF has indicated that its activities in the Project Area would probably be limited to those requiring Biosafety Level 1 or Biosafety Level 2 containment.

For infectious agents, biosafety levels are based on 1) the characteristics of the agent (virulence, ability to cause disease, routes of exposure, biological stability, and communicability); 2) the quantity and concentration of the agent; 3) the procedures to be followed in the laboratory; and 4) the availability of therapeutic measures and vaccines. Biosafety Level 1 agents pose minimal or no known potential hazard to individuals and the environment. Biosafety Level 2 agents are considered to be of ordinary potential hazard and may produce varying degrees of disease through accidental skin puncture wounds. However, Biosafety Level 2 agents may be effectively contained by ordinary laboratory techniques and specific laboratory equipment. Biosafety Level 3 agents pose more substantial risks; therefore, work with these agents must be conducted in contained facilities for which air flow is directed into the laboratory and access is controlled separately from public areas. Additional requirements apply to Biosafety Level 4 work, but these do not apply to the project.

Table H.4 summarizes the physical containment features that are appropriate for each biosafety level. Occupational and public safety are protected by selecting the appropriate biological containment and physical containment level for each biological material handled. For instance, manipulating a microorganism that is not normally known to cause disease requires the lowest level of physical containment, Biosafety Level 1.

For work with infectious agents and research animals, the practices, equipment, and facilities shown in Table H.5 apply. The principles behind animal biosafety levels are similar to those behind the basic biosafety levels presented in Table H.4. For more general animal research activities, the National Research Council has issued a *Guide for the Care and Use of Laboratory Animals*, which includes policies for monitoring the care and use of animals, their housing, their cleanliness, the structure and operation of the building housing the animals, and proper veterinary care. This handbook defines personnel qualifications and personal hygiene, and is designed to protect both animals and workers.

The National Institutes of Health Office of Recombinant DNA sets standards for work involving recombinant DNA molecules. These standards apply to worker safety, environmental control, contingency planning, and human clinical trials involving recombinant DNA techniques. These recombinant DNA guidelines incorporate safety precautions similar to the guidelines for handling infectious agents outlined in Tables H.4 and H.5.

HAZARD ASSESSMENT

This hazard assessment focuses on project-related businesses that would use relatively large quantities of hazardous materials. With the exception of UCSF, most of these businesses would occupy Commercial Industrial space. Detailed information about actual health and safety controls that would be implemented by specific businesses is unavailable because each business would likely develop its own strategy for complying with health and safety laws and regulations, and for implementing other appropriate safety programs. For this reason, this analysis assumes a variety of reasonably

TABLE H.4
SUMMARY OF RECOMMENDED BIOSAFETY LEVELS FOR WORK INVOLVING INFECTIOUS AGENTS OR ORGANISMS THAT CONTAIN RECOMBINANT DNA

Containment Level	Agents	Practices	Safety Equipment (Primary Barriers)	Facilities (Secondary Barriers)
Biosafety Level 1	Agents not known to cause disease in healthy adults.	Standard Microbiological Practices: • Limit access; • Wash hands after handling materials or removing gloves and before leaving; • Do not eat, drink, smoke, handle contact lenses, or apply cosmetics; • Do not mouth pipette; • Minimize splashes and aerosols; • Decontaminate work surfaces; • Decontaminate wastes before disposal; • Control insects and rodents; • Wear gloves and labcoat.	None required.	Open bench top sink required.
Biosafety Level 2	Agents associated with human disease. Routes of transmission may include cuts, ingestion, or mucous membrane exposure.	Biosafety Level 1 plus: • Limit access; • Post biohazard warning signs; • Take sharps precautions; • Implement any needed medical surveillance policies. • Dispose of medical waste properly.	• Primary barriers: biosafety cabinets or other physical containment devices used for all manipulations that can cause splashes or aerosols of infectious materials. • Personal protective equipment: laboratory coats; gloves; face protection, as needed.	Biosafety Level 1 plus: • Autoclave available.
Biosafety Level 3	Indigenous or exotic agents with the potential for aerosol transmission. Disease may have serious or lethal consequences.	Biosafety Level 2 plus: • Control access; • Decontaminate all wastes; • Decontaminate laboratory clothing before laundering; • Maintain baseline blood serum data.	• Primary barriers: biosafety cabinets or other physical containment devices used for all manipulations of agents. • Personal protective equipment: protective laboratory clothing; gloves; respiratory protection, as needed.	Biosafety Level 2 plus: • Physical separation from access corridors; • Self-closing, double door access; • Exhausted air not recirculated; • Directional airflow into laboratory.
Biosafety Level 4 (*not proposed at Mission Bay*)	Dangerous or exotic agents that pose a high risk of life-threatening disease or aerosol-transmitted laboratory infections; related agents with unknown risk of transmission.	Biosafety Level 3 plus: • Change clothing before entering; • Shower on exit; • Decontaminate all material that exits the facility.	• Primary barriers: all procedures conducted in biosafety cabinets *in combination with* full-body, air-supplied, positive pressure personnel suit.	Biosafety Level 3 plus: • Separate building or isolated zone; • Dedicated supply, exhaust, vacuum, and decontamination systems; • Various other requirements.

Source: U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, 3rd Edition, HHS Publication No. (CDC) 93-8395, May 1993.

TABLE H.5
SUMMARY OF BIOSAFETY LEVELS FOR ACTIVITIES IN WHICH SMALL INFECTED ANIMALS ARE USED

Containment Level	Agents	Practices	Safety Equipment (Primary Barriers)	Facilities (Secondary Barriers)
Animal Biosafety Level 1	Agents not known to cause disease in healthy human adults.	Standard Practices: • Limit facility access; • Wash hands after handling animals or removing gloves and before leaving; • Do not eat, drink, smoke, handle contact lenses, or apply cosmetics; • Minimize aerosols; • Decontaminate work surfaces; • Keep inward opening, self-closing doors closed; • Decontaminate wastes; • Implement an insect and rodent control program; • Wear gloves and labcoat.	As required for normal care of each species.	Standard animal facility. • No recirculation of exhaust air; • Directional air flow recommended.
Animal Biosafety Level 2	Agents associated with human disease. Routes of transmission may include cuts, ingestion, or mucous membrane exposure.	Animal Biosafety Level 1 plus: • Limit access to animal rooms; • Post biohazard warning signs; • Take sharps precautions; • Prepare a biosafety manual; • Decontaminate all infectious wastes and animal cages prior to washing.	Animal Biosafety Level 1 plus: • Primary barriers: containment equipment appropriate for animal species; • Personal protective equipment: laboratory coats, gloves, face and respiratory protection as needed.	Animal Biosafety Level 1 plus: • Autoclave available; • Handwashing sink in animal rooms.
Animal Biosafety Level 3	Indigenous or exotic agents with potential for aerosol transmission. Disease may have serious health effects.	Animal Biosafety Level 2 plus: • Control access; • Decontaminate clothing before laundering; • Decontaminate cages before removing bedding; • Use disinfectant foot bath, as needed.	Animal Biosafety Level 2 plus: • Primary barriers: containment equipment for housing animals and cage dumping activities; biosafety cabinets available for manipulative procedures (inoculation, necropsy) that may create infectious aerosols. • Personal protective equipment: respiratory protection.	Animal Biosafety Level 2 plus: • Physical separation from access corridors; • Self-closing, double door access; • Sealed penetrations; • Sealed windows; • Autoclave in facility.
Animal Biosafety Level 4 (*not proposed at Mission Bay*)	Dangerous or exotic agents that pose a high risk of life threatening disease or aerosol transmission; related agents with unknown risk of transmission.	Animal Biosafety Level 3 plus: • Enter through change room where personal clothing is removed and laboratory clothing is put on; • Shower on exiting; • Decontaminate all wastes before removing from facility.	Animal Biosafety Level 3 plus: • Primary barriers: maximum containment equipment (i.e., biosafety cabinet *in combination with* full body, air-supplied, positive-pressure personnel suit) used for all procedures and activities.	Animal Biosafety Level 3 plus: • Separate building or isolated zone; • Dedicated supply, exhaust, vacuum, and decontamination systems; • Other requirements.

Source: U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, 3rd Edition, HHS Publication No. (CDC) 93-8395, May 1993.

foreseeable practices that are common at similar developments. Some of these are specifically required by law, while others are simply common practice. The intent of this discussion is to demonstrate the extent to which complying with applicable laws and regulations, and implementing common practices that typically result from regulatory compliance, ensures a healthy and safe environment for workers, the public, and the environment.

The premise of this assessment is that, for health and safety effects to occur through project operations, exposure to a hazardous material must occur; therefore, this analysis examines the foreseeable effectiveness of the controls typically placed on potential pathways of hazardous materials exposure. Worker (local) exposure is considered first, followed by possible exposure of the larger community or the off-site environment (both within and outside the Project Area).

Worker (Local) Exposure

The effects of hazardous materials use are generally limited to the immediate areas where the materials are located. For this reason, the individuals most at risk due to the project would be the occupants of areas where hazardous materials are handled or stored. An individual can be exposed to a hazardous material through four pathways: 1) inhalation (breathing the substance), 2) ingestion (swallowing it), 3) direct contact with skin or eyes, or 4) injection (a skin puncture or cut). These pathways are addressed below for routine operations and upset conditions.

<u>Routine Operations</u>

Chemicals

Health effects of exposure to hazardous chemicals may be acute or chronic and vary considerably depending on each specific chemical. Acute effects, usually resulting from a single exposure, may include burns or other injuries to body organs or systems. Chronic effects, usually resulting from repeated or long-term exposure to a toxic material, could also include systemic or organ damage. Chronic toxic effects can also include birth defects and cancer.

To minimize exposure to chemicals in air, standard precautions include working under fume hoods or other forms of ventilation when using chemicals likely to present exposure hazards. Requirements for fume hoods are provided in the Uniform Mechanical Code. Proper ventilation may be used to keep indoor air concentrations below the Permissible Exposure Levels set by the U.S. Occupational Safety and Health Administration. Standard practice is also to keep contaminant concentrations at levels below the Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists./11/

To prevent exposure through skin contact, standard precautions include donning appropriate protective clothing, such as aprons, coats, gloves, and safety glasses. Proper washing after handling chemicals is also a standard practice. To prevent the potential ingestion of chemicals, eating, drinking, and smoking are routinely prohibited near hazardous materials. Training is a part of hazardous materials permitting, injury and illness prevention, and hazard communication requirements. It serves to increase the safety awareness of workers. This heightened awareness reduces the risks of exposure to hazardous chemicals through inhalation, absorption, ingestion, and injection.

Radioactive Materials

Radiation poses a health risk to those who are exposed, but exposure can be prevented with proper protective equipment and procedures. The potential health effects range from minor burns and headaches to cancerous tumors. Radioactive materials users must operate under licenses issued by the California Department of Health Services Radiologic Health Branch. Licensees must implement radiation safety programs designed to provide adequate protective measures against exposure to radiation sources. The Radiologic Health Branch routinely inspects radioactive materials licensees.

Like all hazardous materials, the effects of routine radioactive materials use are limited to areas where exposure may occur. These areas are located in the immediate vicinity of the radioactive materials themselves because the effects of radiation decrease rapidly with distance. For this reason, the individuals most at risk from radioactive materials use would be the occupants of the buildings, and more specifically the rooms, where radioactive materials would be handled. In addition to standard practices of good hygiene, exposure to radioactive materials is substantially controlled by shields made of materials that absorb radiation, such as lead and plexiglas. Radioactive materials that evaporate easily (e.g., radioactive iodine) are to be handled in fume hoods that draw the material away from the air a worker breathes.

The types of radioactive materials use foreseeable under the proposed project are similar to existing radioactive materials used at UCSF. According to UCSF, the natural background radiation levels in the San Francisco area are approximately 75 to 100 millirems (mrem) per year. The California Department of Health Services Radiologic Health Branch requires businesses to monitor worker exposure to radioactive materials in the workplace. Businesses use dosimetry badges and thyroid scans to monitor exposure. The doses to workers at UCSF facilities conducting biomedical research are estimated to be 0 to 20 mrem per year, a level similar to that of background radiation and below applicable standards./12/ Similarly, routine project-related radiation exposure would likely be below applicable standards.

Biohazardous Materials and Animals

Recombinant DNA organisms, infectious agents, and other biological agents are sometimes used in research laboratories. Hazardous organisms used in biotechnology and life science research have the potential to cause illness in those exposed. The type of potential illness depends on the type and amount of biohazardous material to which a person is exposed. Exposure to human pathogens can also occur in medical clinics. Most biological materials handled within a laboratory setting pose little hazard to workers due to their lack of viability in the environment; others pose more substantial hazards. Implementing Universal Precautions as defined in the Occupational Exposure to Bloodborne Pathogens Standards serves to protect workers from routine exposure in clinical settings.

To minimize worker exposure to biohazardous materials, standard guidelines suggest the establishment of a biosafety program, as is common practice. A biosafety committee is typically named to implement the program. To prevent exposure by skin contact, laboratory coats and gloves are normally worn when working with biohazardous materials. Policies banning eating in laboratories and requiring workers to wash properly after handling biohazardous materials decrease the potential for ingestion of biohazardous materials. Exposure to infectious aerosols (suspended droplets) is considered to be the most common source of reported worker infections./13/ Biohazardous aerosols are generated during the mixing and shaking of hazardous organisms. The potential for hazards is decreased when biohazardous materials are handled in biosafety cabinets, as is standard practice. Routine injection would not occur. See "Upset Conditions" below.

The use of animals in research laboratories also poses potential hazards to workers. The most typical injuries experienced by animal workers are bites and scratches. Bites or scratches could lead to illnesses if the offending animal were infected with an agent capable of causing a human disease. Illnesses could also conceivably be contracted through other routes, such as physical contact, inhalation, or disease-carrying organisms. Infections could also result from research with infectious agents or diseases that are endemic to the animal being handled. As mentioned before, the types of possible health effects depend on which particular infectious agents are involved.

Policies that require the use of protective wear, safe experimental procedures, and safe animal handling decrease the chance of disease transmittal and other work-related hazards. Workers who handle animals typically follow the National Research Council *Guide for the Care and Use of Laboratory Animals*./14/ Additionally, the National Institutes of Health guidelines set forth in

Biosafety in Microbiological and Biomedical Laboratories and *Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines)* define appropriate safety precautions for work involving animals./15/ Appropriate training and the use of protective equipment (such as laboratory coats and gloves) can prepare workers for the physical hazards of animal handling. Various controls (summarized in Table H.5) also limit the likelihood of contracting a disease from an animal. Operational controls routinely include limiting access, posting warning signs, and training employees in appropriate procedures.

Because implementing health and safety guidelines pertaining to biohazardous materials and animals is not required by law under all circumstances, this issue is discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

Upset Conditions

Chemicals and Radioactive Materials

Accidents are probable at the proposed laboratories and other industrial uses during the life of the project. Accidents during hazardous materials use would be more likely to occur than during hazardous materials storage. Although some relatively large quantities of hazardous materials could be stored at individual locations, most workers would handle relatively small volumes of hazardous materials at any one time. This would minimize potential accident consequences.

Emergency response planning is a critical component of many health and safety laws and regulations, including requirements for Injury and Illness Prevention Plans, Hazard Communication Plans, Chemical Hygiene Plans, and hazardous materials registration under the Hazardous Materials Permit and Disclosure Ordinance. Standard safety practices would also minimize the consequences of potential accidents. For example, employees who work around hazardous materials typically wear protective equipment to minimize hazards in the event of an accident. Protective equipment worn when handling hazardous substances may include lab coats, safety glasses, and gloves. Emergency safety equipment typically includes eyewashes, safety showers, fire extinguishers, spill kits, and other equipment. Requirements specified in the San Francisco Municipal Code (Fire and Building Codes) require building designs to reflect safety considerations.

If an on-site accident were to warrant off-site assistance, the San Francisco Fire Department would respond. It maintains a Hazardous Materials Emergency Response Team to stabilize and clean up after major hazardous materials incidents. Under optimal conditions, this special team can respond within 15 minutes of being called.

Biohazardous Materials and Animals

Worker exposure to biohazardous materials would be most likely to occur through accidental inhalation, cuts, ingestion, or absorption. Accidental exposure could cause an injury, illness, or fatality. Such exposure could occur if the Standard Microbiological Practices recommended in *Biosafety in Microbiological and Biomedical Laboratories* were not carefully applied, leading to incidents such as needle sticks, splashes, or animal bites. Accidents could happen as a result of the project, but most accidents would not result in exposure to biohazardous materials. For example, needle sticks occur occasionally in laboratories, but needle sticks do not necessarily result in exposure to biological materials. Many laboratories use only low-hazard biological materials, and Biosafety Level 1 materials are not known to cause disease in healthy adults.

Although the consequences of an accidental exposure could potentially be severe, the probability of serious illness or fatality as a result of project-related activities is believed to be low. The probability of relatively benign incidents (those that do not result in an illness) would be much higher. Using standard practices, equipment, and facilities when handling biohazardous materials (see Tables H.4 and H.5) would minimize both the probability of accidents occurring and the consequences of such accidents if they were to occur. The need for enforceable biohazardous materials management guidelines for the Project Area is discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

Summary for Worker (Local) Exposure

Standard industry practices would likely protect workers from serious injuries or illness due to hazardous materials exposure through inhalation, ingestion, skin or eye contact, or injection. These standards include those issued by the National Research Council and the U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control, and National Institutes of Health, which are not otherwise required by law in some circumstances.

A study of workers compensation claims at UCSF showed that the number of injuries and illnesses experienced by workers in laboratory and allied occupations was not substantially different from the number experienced by all employees. The most common injuries involved lacerations and punctures (18%), contusions and bruises (19%), and sprains and strains (32%)./16/ For this reason, the potential for work-related health and safety hazards at the project site would not be expected to differ substantially from health and safety hazards at most other locations in San Francisco, assuming that the same laws and regulations are enforced, the level of compliance is substantial, and common industry practices are implemented. Issues related to the reliable implementation of these standard practices are discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts. Similarly, the availability of appropriate hazardous materials emergency response services is discussed in "Emergency Response Capabilities" under "Other Issues" in Section V.I, Health and Safety: Impacts.

Larger Community Exposure (Off-Site Environment Within and Outside the Project Area)

The possible routes whereby project-related hazardous materials could expose off-site or public areas would be limited to 1) air emissions; 2) transport to, from, and around the site; 3) waste disposal; and 4) human contact. The potential for routine exposure through these routes is discussed briefly below, followed by an evaluation of the potential effects of accidents.

<u>Routine Operations</u>

Air Emissions

Toxic air contaminants would be emitted routinely from some foreseeable businesses and laboratory buildings. These emissions would be primarily chemical in nature, and the health effects of chemical emissions are addressed in "Potential Toxic Air Contaminant Emissions From the Proposed Project" under "Toxic Air Contaminants" in Section V.F, Air Quality: Impacts. Regarding possible routine radioactive emissions, studies conducted by UCSF conclude that the contribution of radioactive materials to the overall health risk of toxic air contaminants from biomedical and clinical health science laboratories is negligibly small/17/, and no other routine use of radioactive materials is foreseeable. Routine emissions of infectious agents would be controlled, when necessary, by handling these materials in biosafety cabinets that filter the infectious agents from the air. However, U.S. Department of Health and Human Services guidelines allow for substantial discretion regarding when potentially contaminated air must be filtered prior to discharge to the outdoors. The potential for project occupants to handle certain infectious agents (some of those requiring Biosafety Level 3 containment) without filtering air released to the outdoors is discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

Transportation

Hazardous materials transportation requirements (e.g., packaging) ensure that no hazardous materials are routinely released during transit. Releases during transit would be accidents, as discussed below.

Waste Disposal

Businesses that would generate relatively large volumes of hazardous waste would be subject to regulatory oversight. The environmental effects of routine hazardous waste disposal through approved means are discussed in "Larger Waste Generators" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

Human Contact

Workers handling hazardous materials would typically follow standard industrial hygiene practices to prevent routinely exposing the individuals (off-site or in public places) to hazardous materials through human contact. These standard practices would include wearing protective clothing, washing after handling hazardous materials, avoiding splashes, cleaning work areas, and leaving protective clothing at work. If exposure were to occur, it would be an accident, as discussed under "Upset Conditions."

Upset Conditions

Air Emissions

The health effects of chemical emissions are addressed under "Potential Toxic Air Contaminant Emissions From the Proposed Project" under "Toxic Air Contaminants" in Section V.F, Air Quality: Impacts. While most chemical emissions would be routine in nature, occasional accidents could contribute to overall emissions. Federal and state requirements for Risk Management Plans require users of the most hazardous types of materials (those that pose the greatest off-site risks) to study the potential risks posed by their operations and to implement measures to minimize these risks. The risks posed by potential accidents involving hazardous materials cannot be completely eliminated. Because the potential for accidents involving hazardous materials is believed to be of substantial public concern, the issue is discussed further and in more detail in "Risk of Upset" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

As noted previously, radioactive materials can pose health hazards to those exposed. Under foreseeable circumstances, project-related radioactive materials use would be limited to relatively small quantities at any particular time and location. Therefore, an accidental release would involve relatively little radioactive material and be of short duration, thereby minimizing the possible exposure of off-site individuals to accidentally released radioactive materials.

Work involving biohazardous aerosols is typically performed in a biosafety cabinet, which filters air inside the cabinet and recirculates it. If a biosafety cabinet were to fail, aerosol suspensions of infectious agents could be released to the room, not outdoors. Work would generally cease (along with the activity generating the aerosols), and the aerosols would settle. Installing air filters in areas where infectious agents pose potentially serious health consequences may be necessary as discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety.

Transportation

Hazardous materials would be transported to, from, and through the Project Area in motor vehicles. The longest distance across the Project Area is less than 1 mile. California Department of Transportation (Caltrans) accident rate data (discussed below) indicate that motor vehicle accidents involving hazardous materials and waste are infrequent events, and packaging requirements limit the potential consequences of these possible accidents.

The probability of an accident during transport can be evaluated by reviewing Caltrans data. On state highways, Caltrans has found that about 3.69 vehicle accidents occur per million miles traveled (assuming urban streets with four or more undivided lanes)./18/ These data apply to all types of vehicles and do not distinguish between accidents that involve hazardous materials and those that do not. Vehicles carrying hazardous materials (in addition to the fuel and other hazardous materials required to operate a vehicle) in the project vicinity would be expected to experience similar accident probabilities. However, only a fraction of the accidents involving vehicles carrying hazardous materials actually affect the integrity of the hazardous materials containers on board. To minimize the potential for accidental spills of hazardous materials during transit, suppliers and transporters are required to follow U.S. Department of Transportation and U.S. Postal Service regulations for packaging and handling. While these containment requirements are not as stringent as those for hazardous waste (discussed below), they would reduce the possibility of a release in the project area. Radioactive materials are shipped inside shielded containers. The required packaging for infectious agents is designed to withstand the rigors of travel. Special vendors deliver items such as cylinders containing compressed gases. Animals are transported in specially designed boxes. As a result of packaging requirements, few accidents involving vehicles carrying hazardous materials involve a release of those materials.

To minimize the potential for accidental spills of hazardous waste during vehicle transit (as opposed to hazardous materials in transit as discussed above), suppliers and transporters are required to follow U.S. Department of Transportation and California Department of Toxic Substances Control regulations for packaging and handling hazardous waste. Prior to off-site shipment by licensed hazardous waste haulers, wastes are to be packed in drums and containers that meet U.S. Department of Transportation requirements. Biohazardous waste must be placed in easy-to-recognize red bags, and sharps must be kept in hard-walled containers with lids. Most biohazardous waste sent off site for disposal would be solid; therefore, biohazardous waste would disperse little if released and would be relatively easy to clean up. Because of these strict requirements, containers are unlikely to release their contents in the event of an accident, and the consequences of a vehicle accident involving hazardous waste in the Project Area would be minimal.

Waste Disposal

Under certain circumstances, radioactive and treated biohazardous materials may be disposed of down drains if approved and overseen by the California Department of Health Services Radiologic Health Branch or Medical Waste Program, and the San Francisco Department of Public Health. Pouring hazardous chemicals down drains without a permit, or in excess of quantities allowed under permit, is prohibited by law. Similarly, disposing of hazardous materials with ordinary solid waste is prohibited by law. Invariably, some hazardous waste does get discharged to the sewer or placed with non-hazardous solid waste. Since inappropriate disposal practices should not be routine operating conditions for most businesses, such disposal is discussed here as "accidents."

Sewers

Because the project-related businesses that would store relatively large volumes of hazardous materials would typically handle relatively small volumes at any one time, the types of sewer discharge violations that could occur would, in most instances, be too small to have any noticeable physical effect on the wastewater treatment plant. Water from the Project Area would also be diluted by other San Francisco wastewater discharges. The issue of potential discharges from Commercial Industrial areas is discussed further under "Quality of Municipal Wastewater from the Project" in Section V.K, Hydrology and Water Quality: Impacts.

Solid Waste

The City and County of San Francisco and Norcal Waste Systems (the City's solid waste contractor) jointly implement a Waste Acceptance Control Program to prevent hazardous waste from posing a health risk to garbage collectors or going to the solid waste landfill. The program has both education and inspection components. Sanitary Fill, Sunset Scavenger, and Golden Gate Disposal Companies (subsidiaries of Norcal Waste Systems) notify customers about the kinds of waste that are prohibited (e.g., hazardous and infectious waste). Signs posted on collection company containers inform the public regarding California hazardous waste regulations. All garbage collectors are trained to identify hazardous waste. If hazardous waste is detected, the collector removes it or refuses to service the container, and informs the route supervisor. Customers are provided with recommendations and referrals for proper disposal.

Solid waste is also subject to visual inspection at San Francisco's solid waste transfer station at Tunnel and Beatty Avenues. On average, program compliance staff perform a complete inspection of at least five loads per week chosen at random. Customers or collection drivers are instructed to unload the waste for inspection before tipping the load into the transfer station pit. Prohibited waste is returned to the generator, if possible./19/

Human Contact

To prevent off-site exposure of the public and environment (both within and outside the Project Area) through direct or indirect contact, workers who handle hazardous chemicals and radioactive materials use standard hygiene practices as discussed above for routine operation. The potential is remote for accidental exposure of the public to chemical hazards sufficient to pose serious threats. The effect of any chemicals posing serious acute hazards would likely be noticed by workers before transferring enough of the material to cause trouble by direct or indirect human contact.

Cases of public exposure to infectious agents through human contact have been sporadic and infrequent. Laboratories where workers handle infectious agents have not been shown to pose a public health threat to the community./20/ Standard Microbiological Practices used to control exposure to infectious agents (described in Tables H.4 and H.5) include washing hands before leaving the facility and leaving protective equipment at work. These practices minimize the likelihood of accidental disease transmission to the public or other individuals off site. Because the likelihood of a serious accident would be low, the risk posed by such accidents would also be low.

The public (or wild or domestic neighborhood animals) is unlikely to be accidentally exposed to illnesses carried by animals because the animals would be unable to escape from their cages and through laboratory doors. Likewise, the public would not be physically injured (bitten or scratched) by animals because the animals would be caged and access to research animals would be controlled. Because of the multiple layers of control specified in applicable animal care and use guidelines, the potential for a serious accident involving research animals would be remote.

Summary for Larger Community Exposure (Off-Site Environment Within and Outside the Project Area)

Standard industry practices would likely protect the off-site community and environment from many types of serious injuries or illness due to routine hazardous materials exposure. However, air contaminated by some infectious agents requiring Biosafety Level 3 containment could pose public hazards if the laboratory exhaust is improperly filtered. Similarly, certain hazardous chemicals could pose substantial safety risks to the neighbors of proposed businesses if accidentally released. These issues are discussed in "Enforcement of Guidelines for Work Involving Biohazardous Materials and Animals" under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts. Likewise, the potential for accidents involving hazardous materials is further explored in "Risk of Upset"under "Potential Environmental Impacts of Hazardous Materials and Waste Management" in Section V.I, Health and Safety: Impacts.

NOTES: Appendix H, Health and Safety

1. California Health and Safety Code, Section 25501.

2. California Health and Safety Code, Section 25117, and California Code of Regulations, Title 22, Section 66261.2.

3. Code of Federal Regulations, Title 40, Section 261.2 (a)(2).

4. City and County of San Francisco, Planning Department, *Mission Bay Final Environmental Impact Report*, Planning Department File No. 86.505E, State Clearinghouse No. 86070113, August 23, 1990, Volume Two, pp. VI.N.21-VI.N.26.

5. Robert C. Weast, Ph.D., editor, *CRC Handbook of Chemistry and Physics*, 62nd. ed., CRC Press, Boca Raton, Florida, 1981-1982, p. B-255.

6. California Health and Safety Code, Section 25022.5, and Code of Federal Regulations, Title 40, Section 259.10.

7. a) U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, Third Edition, May 1993.

b) U.S. Department of Health and Human Services National Institutes of Health, *Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines)*, January 1996.

8. California Health and Safety Code, Section 25033.2.

9. California Health and Safety Code, Section 25531.

10. California Code of Regulations, Title 17.

11. American Conference of Governmental Industrial Hygienists, *1997 TLVs® and BEIs®*, 1997.

12. University of California San Francisco, *Revised Laurel Heights Plan; Center for Social, Behavioral and Policy Sciences, and Campus Administration Environmental Impact Report*, State Clearinghouse No. 95033072, September 6, 1995.

13. U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, Third Edition, May 1993.

14. National Research Council, *Guide for the Care and Use of Laboratory Animals*, 1996.

15. a) U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, Third Edition, May 1993.

    b) U.S. Department of Health and Human Services National Institutes of Health, *Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines)*, January 1996.

16. University of California San Francisco, *Revised Laurel Heights Plan; Center for Social, Behavioral and Policy Sciences, and Campus Administration Environmental Impact Report*, State Clearinghouse No. 95033072, September 6, 1995.

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    b) ENSR Consulting and Engineering, *Risk Assessment of the UC San Francisco-Mount Zion Hospital and Medical Center*, September 1989.

18. California Department of Transportation, *1996 Accident Data on California State Highways (Road Miles, Travel, Accident Rates)*, 1997.

19. Environmental Science Association, *Sanitary Fill Company Recycling and Solid Waste Systems Plan Draft Environmental Impact Report*, State Clearinghouse No. 90030932, February 24, 1995 (prepared for the City and County of San Francisco, which has neither completed nor certified this environmental impact report.)*

20. U.S. Department of Health and Human Services Public Health Service, Centers for Disease Control and Prevention, and National Institutes of Health, *Biosafety in Microbiological and Biomedical Laboratories*, Third Edition, May 1993.

* A copy of this report is on file for public review at the Office of Environmental Review, Planning Department, 1660 Mission Street, San Francisco.

I. CONTAMINATED SOILS AND GROUNDWATER

This appendix summarizes the investigation and methods used to evaluate the results presented in *Results of Investigation, Mission Bay North of Channel* ("1997 Mission Bay North report") and *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel* ("1998 Mission Bay South report"), prepared by ENVIRON International Corporation (ENVIRON). This section also summarizes additional methods used to evaluate existing conditions in the Project Area, as presented in *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area,* and *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, prepared by ENVIRON.

The section "Field Investigation and Sample Analysis Procedures" provides more details on methodologies ENVIRON used to sample soils and groundwater in Mission Bay North and Mission Bay South in preparing the Site Investigation Reports for the two parts of the Project Area. Reports and agency correspondence that were used to develop the scope of the field program are listed in Table I.1. Tables I.2 and I.3 summarize historic land uses and locations of underground storage tanks (USTs), respectively.

"Summary of Soil and Groundwater Sampling Results" summarizes the results of soil and groundwater testing, as presented in the 1997 Mission Bay North and 1998 Mission Bay South reports. Tables I.4 through I.15 list the chemical detected, the number of samples in which the chemical was detected, the number of detections of each chemical compared to the total number of samples analyzed for that particular chemical (frequency of detection), and the range of concentrations.

A discussion of the methods that were used to evaluate potential human and ecological effects under existing conditions is summarized in "Methodology for Evaluating Existing Human Health and Ecological Risks Due to Contaminants Detected in Soil and Groundwater in the Project Area Prior to Construction." This subsection also includes a discussion of methods used in the tidal influence study determine the extent to which the concentrations of chemicals in groundwater are reduced as groundwater adjacent to China Basin Channel and San Francisco Bay moves toward the tidally-influenced surface water bodies that border the Project Area.

Methods that were used to evaluate potential human health risks that could result from exposure to dust generated during construction activities, absent control measures, are presented in "Methodology to Evaluate Human Health Risk Due to Exposure to Uncontrolled Construction-Generated Dust." The purpose of the analysis was to identify worst-case risks that could occur if no dust controls were

TABLE I.1
SOIL AND GROUNDWATER INVESTIGATIONS AND PROJECTS COMPLETED SINCE 1990 IN THE MISSION BAY PROJECT AREA /a/

Date	Investigation Site (and report preparer)
March 1990	Underground Tank Removal, Santa Fe Realty Corporation, 1420 Fourth Street, San Francisco, California (Levine-Fricke)
August 1990	Mission Bay Hazards Mitigation Program (Environmental Science Associates)
September 1990	Esprit de Corp Phase II Site Investigation, 499 Illinois Street, San Francisco, California (ENSR Consulting and Engineering)
October 1992	Remedial Activities and Tank Removal Report, 195 Channel Street, San Francisco, California (Levine-Fricke)
April 1993	Report on Underground Tank Removal, 300 16th Street, San Francisco, California (Baseline Environmental Consulting)
July 1993	Report, Site Investigation, I-280, EA #280031, San Francisco, California (APEX)
August 1993	Report and Work Plan, Underground Tank Removal, 300 16th Street, San Francisco, California (Baseline Environmental Consulting)
October 1993	Proposed Area Wide Survey Plan, Mission Bay Project Area, San Francisco, California (Levine-Fricke)
July 1994	Underground Storage Tank Removal Report, 1355 6th Street, San Francisco, California (Levine-Fricke)
August 1994	Tank Removal Report and Investigation, 255 Channel Street, San Francisco, California (REACT Environmental Services Corporation)
May 1995	Summary of Chemical Data Collected at the Mission Bay Project Area (letter from Geomatrix Consultants to Catellus)
July 1995	Summary of Chemical Data Collected at the Mission Bay Project Area (letter from Geomatrix Consultants to Catellus)
January 1996	Soil Stockpile Completion Report, Mission Bay Project Area, San Francisco, California (Geomatrix)
June 1996	Request for Risk Management Plans for Six Former Underground Storage Tank Sites, Mission Bay, San Francisco, California (letter from RWQCB to Catellus)
August 1996	Extension of Workplan for Preliminary Survey at Mission Bay North of Channel (letter from RWQCB to Catellus)
October 1996	Risk Management Plans for Six Former Underground Storage Tank Sites at the Mission Bay Site, San Francisco, California (ENVIRON)
October 1996	Work Plan for Preliminary Survey, Mission Bay North of Channel, San Francisco (ENVIRON)

(Continued)

TABLE I.1 (Continued)

Date	Investigation Site (and report preparer)
November 1996	Approval of Workplan for Preliminary Survey at Mission Bay North of Channel (letter from RWQCB to Catellus)
February 1997	Underground Tank Site: Sixth and Berry, Mission Bay, San Francisco, California (letter from RWQCB to Catellus)
February 1997	Underground Tank Site: 1420 Fourth Street, Mission Bay, San Francisco, California (letter from RWQCB to Catellus)
March 1997	Report of Findings, Phase II Environmental Site Assessment, Former ATSF China Basin Railyard, San Francisco, California (ERM-West)
April 1997	Results of Site Investigation, Mission Bay North of Channel, San Francisco, California (ENVIRON)
April 1997	Sampling Program for Subsurface Investigation, Mission Bay: Area South of China Basin Channel (letter from Catellus/ENVIRON to San Francisco Regional Water Quality Board)
June 1997	Mission Bay, North of Channel, San Francisco (letter from RWQCB to Catellus)
June 1997	Environmental Assessment of RMC Lonestar Property (letter from ENVIRON to Catellus)
August 1997	Tentative Site Cleanup Requirements (letter from RWQCB to ARCO, Chevron, Phillips Petroleum, and UNOCAL)
September 1997	Site Investigation and Cleanup of Fuel and Oil Storage Area and Supply and Distribution Pipelines (letter from RWQCB to ARCO, Chevron, Phillips Petroleum, Texaco, and UNOCAL)
November 1997	Proposed Project Schedule for Environmental Activities in the Vicinity of Pier 64, San Francisco, California (Pacific Environmental Group)
November 1997	Work Plan for Site Assessment in the Vicinity of Pier 64, San Francisco, California (Pacific Environmental Group)
January 1998	Request for Revised Work Plan and Project Schedule for Environmental Activities in the Vicinity of Pier 64 (letter from RWQCB to ARCO, Chevron, Phillips Petroleum, Texaco, and UNOCAL)
February 1998	Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California (ENVIRON)
February 1998	Response to Comments on Joint Assessment Work Plan, Former Petroleum Terminals and Associated Pipelines, Vicinity of Pier 64 (letter from Pacific Environmental Group to ARCO, Chevron, Phillips, UNOCAL, and Texaco).
April 1998	*Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area* (ENVIRON)

(Continued)

TABLE I.1 (Continued)

Date	Investigation Site (and report preparer)
April 1998	*Technical Memorandum #2, Development and Screening of Remedial Alternatives for Free Product Area in Region of Former Oil Storage Facilities, Mission Bay Project Area* (ENVIRON)
April 1998	*Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area* (ENVIRON)

Notes:
Document preparer shown in parentheses.

a. List includes documents used to develop the work plans, sampling programs, evaluate results, and support conclusions presented in the 1997 Mission Bay North and Mission Bay South reports.

Source: ENVIRON International Corporation, 1997 Mission Bay North Report and 1998 Mission Bay South Report; EIP Associates, 1998.

implemented so that appropriate dust control measures could be developed for the Risk Management Plan (RMP) for the Project Area.

The section "Post-Development Risk Evaluation Methodology" describes the approach used to develop site-specific target levels of various chemicals found in soil or groundwater for the risk evaluations prepared by ENVIRON to determine potential effects after project completion and during long-term occupancy and operation of the proposed project.

FIELD INVESTIGATION AND SAMPLE ANALYSIS PROCEDURES

Mission Bay North

Between December 5, 1996, and February 17, 1997, the Mission Bay North investigation was conducted in the Mission Bay area of San Francisco, California. The work was conducted by ENVIRON on behalf of Catellus Development Corporation (Catellus). The investigation included the collection of 28 soil samples from 14 borings; the installation, development, and sampling of 14 groundwater monitoring wells; a tidal influence study; and the decommissioning of seven temporary wells. All work was conducted under the supervision of a California registered geologist. The procedures used during each of the above tasks are discussed below.

TABLE I.2
HISTORICAL SITE USAGE BY PARCEL

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
Mission Bay North			
3795-2	Ice company; hotel; meat packing company; furniture manufacturer; lumber company; mill; cooperage; rail yards and associated freight sheds	Parking area	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, WTCs, pesticides, HVOCs, metals
3795-3	Glass works; railroad storage sheds and concourse	San Francisco Recreational Vehicle Park	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, metals
3795-4	Glass works; building material storage yard; boat building shop; general merchandise warehouse; railroad passenger terminal and concourse	San Francisco Recreational Vehicle Park	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, metals
3796-3	Antimony French Star; grain warehouse; coal oil and lubricating oils; lumber storage; railroad freight sheds, offices, and tracks	Vacant (roadway construction)	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, HVOCs, metals
3797-2	Wharf area; Standard Oil warehouse; Studebaker warehouse; agricultural warehouse; wine warehouse; lumber storage yard; railroad tracks and related sheds	Vacant (roadway construction)	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, HVOC, metals
3798-1	Railroad tracks	Railroad tracks, storage sheds	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, HVOCs, metals
3798-2	Railroad tracks and loading platforms; railroad repair shop	Railroad tracks; roadway demolition debris; small food stand	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, pesticides, HVOCs, metals

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3804-2,4	Lumber mill and yards; vinegar works; railroad tracks and rail car parking	Vacant (roadway construction) Fourth Street Pumping Station	Acid and alkaline solutions, PAHs PCBs, petroleum fuel, WTCs, metals
3804-5	Planing Mill; lumber yard; box factory; coal, oil, and lubricant warehouse; Antimony French Shop	Vacant (roadway construction)	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, WTCs, HVOCs metals
3805-1	Municipal dump; shipbuilding yard; brewing company depot; artificial stone company; planing mill; woodenware and cooperage company; brick company; lumber yards; agricultural company; concrete mixer, sand and gravel bunkers	Vacant (roadway construction)	Acid and alkaline solutions, PAHs, PCBs, petroleum fuel, WTCs, HVOCs, metals, asbestos
Mission Bay South			
3805-1 (partial)	Fill material (from municipal dump); ship building yard; brewing company depot; artificial stone company; planing mill; woodenware and cooperage company; brick company; warehouse; lumber yards; agricultural company; concrete mixer; sand and gravel bunkers; parking.	Vacant (roadway construction).	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals, asbestos.
3806-6 (partial)	Fill material (from municipal dump); ship building yard; brick company; brick yard; oil/gasoline storage; lumber yard; building supplies and storage yard.	Channel Pumping Station.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals, asbestos.
3806-7	Fill material (from municipal dump); oil company including oil tanks and chemical mixing tanks; box factory; lithographic company; lumber and brick yard; lumber mill; scrap metal yard (cars, trucks, oil tanks, barrels); soil spoil storage and dumping.	Vacant (roadway construction).	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3806-9	Fill material (from municipal dump); oil barrel storage; hay warehouse; buggy shed; brick company; lumber yards; railroad tracks.	Channel Pumping Station; railroad tracks.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, metals, asbestos.
3809-2	Fill material (from municipal dump); lumber company and yard; planing mill; garage; wrecking company.	Open space (with dumping of garbage); container storage.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3809-4	Fill material (from municipal dump); lumber company; planing mill; lumber yard; metal and lumber storage; wrecking company; junk yard; building materials storage.	Golf driving range.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3809-6	Fill material (from municipal dump); lumber yard.	Open space used for spoil storage from Channel Pumping Station.	Alkaline and acid solutions, PAHs, PCBs, pesticides, WTCs, metals.
3809-7	Fill material (from municipal dump); lumber yard; railroad tracks; barrel storage; open space used for trash dumping.	Railroad tracks; open space.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3810-6	Fill material (partially from municipal dump); lumber yard; lumber company; wharf area; railroad buildings; garbage docks.	Asphalt road (Channel Street); parking.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3810-7	Fill material (partially from municipal dump); lumber yards; pipe yard; hay yard; garbage dock; icing platform; boiler house; warehouses; metal salvage company; rail-related activities including rail yard, railroad car parking, incinerator, scales, carpenter shop, storehouse, blacksmith shop, electrical shop, dryer shed, and aboveground tanks; automobile maintenance and repair; dumping of soil spoils; trucking company; Hills Bros. coffee.	Trucking and storage facilities; import and trading companies; food service distribution facilities; construction products company; automobile, bus, and truck maintenance facilities; other miscellaneous businesses.	Alkaline and acid solutions, HVOCs (including paint solvents), PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals, asbestos.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3813-1	Fill material; lumber yard; grain storage; warehouses; rail-related activities (including warehouses, train sheds, and an oil storehouse); dumping; dolly rental; construction company; food distribution centers; drive-in eatery.	Roller hockey rink.	Alkaline and acid solutions, PAH, PCBs, pesticides, petroleum fuel, WTCs, metals.
3819-2	Fill material (from municipal dump); lumber yard; rock-grinding company; lumber sheds and storage yard; lumber mill; metal working and auto repair; interstate construction yard; auto wrecking company; police impoundment lot.	Golf driving range.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals, asbestos.
3819-3	Fill material (from municipal dump); brick yard; metal working and auto repair; rock-grinding company; barrel storage; some dumping.	Mainly open space; Dispatch Transportation Company.	Alkaline and acid solutions, metals, asbestos.
3822-2	Fill material (partially from municipal dump); metal sheds; baled hay and cotton warehouses; corral; lumber company and yard; police impoundment lot; vehicle storage and vehicle crushing; some dumping; old oil/gasoline tank storage.	Golf driving range.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3822-3	Fill material (partially from municipal dump); brick company; roofing company; lumber company; fuel company.	Dispatch Transportation Company and associated parking; railroad tracks; open space.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3832-2	Fill material; brick yard; lumber yard; boat junk yard; metal storage yard; warehouse; some dumping; police impoundment lot.	Kirk Paper Company (retail); Shane-Hunter, Inc. (linen retail).	Alkaline and acid solutions, HVOCs (including paint solvents), PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3832-3	Fill material; warehouses; lumber companies and yards; junk yard; dumping.	Dispatch Transportation Company and associated parking; railroad tracks; open space.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3835-2	Fill material; furniture company; boiler works; lumber yard; pavement company; oil tank storage; dumping.	Dispatch Transportation Company, Bay Area Super Shuttle (some maintenance), railroad tracks.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3835-3	Fill material; baled paper warehouse; baled cotton storage; box company; fuel and road oil company; scrap metals company; garages (with oil separators, sump pumps, wash racks, and barrel storage yard); paint company; junk yard; freight related buildings; parking lots; auto repair; dumping; towing company; ice cream company.	Downtown Auto Sales; Globe-Bay Area Forklift Company; Kirk Paper Company (retail); open space.	Alkaline and acid solutions, HVOCs (including paint solvents), PAHs, PCBs, pesticides, petroleum fuel, metals.
3837-1	Fill material; possible former wharf; rail-related activities including oil house, material platform, coal bin, car repair shed, and railroad tracks.	Railroad tracks.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals.
3837-4	Fill material; possible former wharf; lumber shed; fire house.	Soup kitchen; railroad tracks.	Petroleum fuel.
3838-1	Fill material; possible former wharf; oil storage facilities; offices; water tanks; glass container warehouses; barrel storage; freight warehouse; truck parking.	Warehouse; asphalt parking area.	Alkaline and acid solutions, petroleum fuel, metals.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3838-2	Fill material; possible former wharf; street; parking area; freight warehouse and associated truck parking.	Warehouse; asphalt parking area.	Acid solutions, petroleum fuel.
3838-3	Fill material; possible former wharf; streets; dumping; parking areas; railroad tracks.	Warehouse; asphalt parking area; railroad tracks.	Pesticides, petroleum fuel.
3839-1	Fill material; open space; freight-related company; parking.	Parking/truck loading area; railroad tracks.	Acid solutions, petroleum fuel.
3839-2	Fill material; open space; freight-related company; railroad tracks; service station for rail cars including oil sumps and aboveground fuel storage area.	Railroad tracks.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals.
3840-1	Fill material; grain warehouse; oil warehouse with possible aboveground storage tank; lumber or metal yard; freight shed; railroad tracks; parking.	Warehouse; parking/truck loading area.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3840-2	Fill material; former street; parking; open space.	Warehouse; parking/truck loading area.	Acid solutions, petroleum fuel.
3840-3	Fill material; former street; lumber or metal yard; miscellaneous storage; parking.	Warehouse.	Acid solutions, petroleum fuel, WTCs.
3841-1	Fill material; railroad car repair yard; oil company (including railroad tracks and two aboveground storage tanks); coal depot; chemical warehouse; sand and gravel cement mixing.	Bode Gravel.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals, asbestos.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3841-3	Fill material; railroad car repair yard (including three aboveground storage tanks); open space; junk yard; sand and gravel cement mixing.	Bode Gravel.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, metals, asbestos.
3849-1	Fill material; rail-related activities including storehouse, coach shop, machine shop, boiler house, and railroad tracks; oil company; open space subject to dumping and possible use as a junk yard; sand and gravel cement mixing.	Bode Gravel.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals, asbestos.
3849-2	Fill material; rail-related activities including storehouse, coach shop, machine shop, boiler house, and railroad tracks; oil company; open space subject to dumping and possible use as a junk yard; sand and gravel cement mixing.	Bode Gravel.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals, asbestos.
3850-1, 1A, 1B	Fill material; packing company; truck and freight-related activities; junk yard; automotive center warehouse; parking.	Auto body shop; parking.	Alkaline and acid solutions, petroleum fuel, metals.
3850-2	Fill material; street; open space; parking associated with trucking and freight activities.	Warehouse; auto body shop; parking.	Acid solutions, petroleum fuel.
3851-1	Fill material; warehouses; dumping; railroad tracks; truck parking.	Parking/truck loading area; railroad tracks.	Alkaline and acid solutions, PCBs, pesticides, petroleum fuel, metals.
3852-1	Fill material; warehouse; rail yard; parking.	Parking; railroad tracks.	Alkaline and acid solutions, pesticides, petroleum fuel.
3852-2	Fill material; lime and hydrate company; lumber company and yard; railroad tracks; parking area.	Parking; railroad tracks.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3853-1	Fill material; stock corral; open space; junk yard; sand and gravel cement mixing.	Bode Gravel.	Alkaline and acid solutions, metals.
3880-1 (partial)	Fill material; rail-related activities including engine house, railroad car parking, freight sheds, above ground oil storage tanks, oil sumps, and numerous tracks; dumping; truck-related activities including shipping and receiving, warehousing, and maintenance.	Portion of parcel within site boundaries: parking; storage; open space; railroad tracks.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals.
3892-1	Fill material; oil companies and related activities including crude oil storage, aboveground storage tanks, underground pipelines, offices, and railroad tracks; lumber company; trucking-related activities; junk yard; maintenance and repair facilities.	Franciscan Bus Lines; Cresco Equipment Rentals; storage yard.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3940-2	Fill material; planing mill; lumber storage; railroad tracks; parking.	Railroad tracks.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals.
3941-1	Fill material; lumber company; shipbuilding company; transportation company; aircraft warehouse; boat building; rice company; asbestos company; shipping and receiving companies.	Esprit Factory Outlet parking (northern portion of lot); Blue Peter Inc.; junk yard.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, WTCs, metals, asbestos.
3942-2	Fill material; railroad tracks; open space; oil company; distribution company; parking lot.	Figone Cold Storage.	Alkaline and acid solutions, HVOCs, PAHs, PCBs, pesticides, petroleum fuel, metals.
3942-3	Fill material; vacant land; cold storage plant; railroad tracks; parking.	Figone Cold Storage.	Alkaline and acid solutions, HVOCs, PCBs, pesticides, petroleum fuel, metals.

(Continued)

TABLE I.2 (Continued)

Parcel No./a/	Previous Use/b/	Current Use/c/	Potential Chemicals of Concern/b/
3942-4	Fill material; oil company including 8,000-barrel oil tank and oil stored in barrels; corral; warehouse; railroad tracks; mill company; well casing company including four medium aboveground storage tanks; ship building; glass works; cold storage company; some dumping; building materials and cement company.	RMC Lonestar Construction Material Supply.	Alkaline and acid solutions, pesticides, petroleum fuel, WTCs, metals, asbestos.
3943-6	Large crude tank and oil sump associated with nearby railroad roundhouse; some dumping; parking.	Parking/truck loading area.	Alkaline and acid solutions, PAHs, PCBs, pesticides, petroleum fuel, metals.
3944-4	Fill material; steam pipe and boiler covering manufacturer; railroad activities including roundhouse, machine shop, boiler room, oil storage, engine house, oil sumps, propane tanks, paint shops, and railroad tracks; electric supplier; warehouse; glass works; some dumping; parking lots.	City Electric Supply; equipment rental; warehouses/distribution company; office space; parking/truck loading areas.	Alkaline and acid solutions, HVOCs (including paint solvents), PAHs, PCBs, pesticides, petroleum fuel, metals.
3948-1	Fill material; roofing company; paint mill; brass foundry; railroad tracks.	Open space; railroad tracks.	Alkaline and acid solutions, HVOCs (including paint solvents), PAHs, PCBs, pesticides, petroleum fuel, metals.

Notes:

a. See Figure I.1 for the locations of Assessor's Blocks and lots.

b. Information regarding historical site usage and potential chemicals of concern from *Mission Bay Hazards Mitigation Program* (ESA August 1990) and *Proposed Area Wide Survey Plan* (Levine-Fricke October 1993).

c. Information regarding current site usage from recent aerial photographs and ENVIRON observations during Mission Bay South field program.

WTCs = Wood Treatment Compounds (includes creosote, copper salts and pentachlorophenol)
HVOCs = Halogenated Volatile Organic Compounds
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls

Source: 1990 FEIR; ENVIRON International Corporation, 1997 Mission Bay North Report and 1998 Mission Bay South Report.

TABLE I.3
SUMMARY OF UNDERGROUND STORAGE TANKS IN PROJECT AREA

Map Location /a/	Status	Comments	References /b/
1	Removed	10,000-gallon gasoline tank removed 1988.	Levine-Fricke December 16, 1988a Levine-Fricke October 15, 1993 ENVIRON October 29, 1996 RWQCB February 20, 1997a
2	Removed		Levine-Fricke October 15, 1993
3	Existing		Levine-Fricke October 15, 1993
4,5	Removed	One 2,000-gallon and one 3,000-gallon gasoline and diesel tank removed 1988.	Levine-Fricke December 16, 1988b Levine-Fricke October 15, 1993 ENVIRON October 29, 1996
6,7	Removed	Two tanks installed in 1978: one 7,500-gallon gasoline tank and one 5,000-gallon diesel tank. Removed in 1994.	REACT August 30, 1994 Levine-Fricke October 15, 1993
8,9,10	Removed	Three tanks used for storage of diesel (10,000-gallon capacity), gasoline (10,000-gallon capacity), and waste oil (1,000-gallon capacity) removed in 1988.	Levine-Fricke December 16, 1988c Levine-Fricke October 15, 1993 ENVIRON October 29, 1996
11	Removed		Levine-Fricke October 15, 1993
12	Removed	One 500-gallon waste oil tank removed in 1992.	Levine-Fricke October 23, 1992 Levine-Fricke October 15, 1993 ENVIRON October 29, 1996

(Continued)

TABLE I.3 (Continued)

Map Location /a/	Status	Comments	References /b/
13	Removed		Geomatrix July 11, 1995
14, 15,16	Removed	One 1,000-gallon gasoline tank (T-14), one 2,000-gallon gasoline tank (T-15), and 1,000-gallon diesel tank (T-16) removed in 1988.	Levine-Fricke December 16, 1988d Levine-Fricke October 15, 1993 ENVIRON October 29, 1996
17, 18,19	Removed	One 500-gallon petroleum hydrocarbon tank (T-17) removed in 1994. One 5,000-gallon gasoline tank (T-18) and one 8,000-gallon diesel tank (T-19) removed in 1988.	Levine-Fricke December 16, 1988e Levine-Fricke July 25, 1994 Levine-Fricke October 15, 1993
20	Removed	1,000-gallon UST.	Levine-Fricke October 15, 1993
21	Unknown	Confirmed verbally; no records of tank based on recent ENVIRON environmental assessment of property.	Verbal communication from current tenant.
22	Removed		Levine-Fricke October 15, 1993
23	Removed		Levine-Fricke October 15, 1993
24	Removed	1,000-gallon UST removed in 1987.	Levine-Fricke October 15, 1993 Geomatrix May 8, 1995
25	Removed	Crude oil tank (1909 - 1960) also in vicinity.	Levine-Fricke October 15, 1993 Geomatrix May 8, 1995
26	Unknown	No indication of tank based on ENVIRON environmental assessment of property (location from Levine-Fricke report).	Levine-Fricke October 15, 1993 ENVIRON June 11, 1997
27	Removed	10,000-gallon diesel tank removed May 1997.	Levine-Fricke October 15, 1993 ENVIRON June 11, 1997

(Continued)

TABLE I.3 (Continued)

Map Location /a/	Status	Comments	References /b/
28	Removed	500-gallon waste oil tank removed 1990.	Levine-Fricke October 15, 1993 ENVIRON June 11, 1997
29,30	Removed	One 10,000-gallon diesel tank and one 5,000-gallon gasoline/diesel tank removed May 1993.	Levine-Fricke October 15, 1993 Baseline August 1993
31	Removed	400-gallon diesel tank removed February 1993.	Levine-Fricke October 15, 1993 Baseline April 1993
32	Removed		Levine-Fricke October 15, 1993
33	Removed	Tank removed May 1997.	Levine-Fricke October 15, 1993 Verbal communication from current property tenant.
34	Existing	Inactive, suspected UST within concrete pad; partially filled with hydrocarbon-like liquid.	ERM-West March 1997
35	Existing	Inactive, underground concrete vault containing water and hydrocarbons.	ERM-West March 1997
36,37, 38	Removed	One 1,000-gallon diesel tank, and two 10,000-gallon gasoline tanks removed January 1990.	Levine-Fricke March 15, 1990 Levine-Fricke October 15, 1993 ENVIRON October 29, 1996 RWQCB February 20, 1997b
39	Removed		Levine-Fricke October 15, 1993
40	Removed		Levine-Fricke October 15, 1993

(Continued)

TABLE I.3 (Continued)

Map Location /a/	Status	Comments	References /b/
41	Abandoned/ Removed		Levine-Fricke October 15, 1993
42	Removed	One approximately 13,000-gallon tank removed November 1997.	ENVIRON summary report in progress
43	Abandoned/ Removed		Levine-Fricke October 15, 1993

Notes:
a. See Figure V.J.2 in SEIR Section V.J, Contaminated Soils and Groundwater, for the location of underground storage tanks.
b. References (listed below) include removal/investigation reports as well as reports that reference location of tanks.

Source: Compiled from the following documentary ENVIRON International, February 1998.

Baseline Environmental Consulting. 1993. *Report on Underground Tank Removal, 300 16th Street.* April.
Baseline Environmental Consulting. 1993. *Report and Work Plan, Underground Tank Removal, 300 16th Street.* August.
ENVIRON. 1996. *Risk Management Plans for Six Former Underground Storage Tank Sites at the Mission Bay Site.* October 29.
ENVIRON. 1997. Letter to Catellus Development Corporation re: Environmental Assessment of RMC Lonestar Property. June 11.
ERM-West, Inc. 1997. *Report of Findings Phase II Environmental Site Assessment, Former ATSF China Basin Railyard.* March.
Geomatrix. 1995. *Work Plan for Investigation of the Proposed Home Depot Site.* May 8.
Geomatrix. 1995. Letter to Catellus Development Corporation re: Summary of Chemical Data Collected at the Mission Bay Project Area. July 11.
Levine-Fricke. 1988a. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 6th and Berry Street Site.* December 16.
Levine-Fricke. 1988b. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 1201-6th Street.* December 16.
Levine-Fricke. 1988c. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 205 Channel Street.* December 16.
Levine-Fricke. 1988d. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 1301-6th Street.* December 16.
Levine-Fricke. 1988e. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 1355-6th Street.* December 16.
Levine-Fricke. 1990. *Underground Tank Removal, Santa Fe Pacific Realty Corp., 1420 Fourth Street.* March 15.
Levine-Fricke. 1992. *Remedial Activities and Tank Removal Report, 195 Channel Street.* October 23.
Levine-Fricke. 1993. *Proposed Area Wide Survey Plan, Mission Bay Project Area.* October 15.
Levine-Fricke. 1994. *Underground Storage Tank Removal Report, 1355 6th Street.* July 25.
RWQCB. 1997a. Letter to Catellus Development Corporation re: Underground Storage Tank Site: Sixth & Berry, Mission Bay. February 20.
RWQCB. 1997b. Letter to Catellus Development Corporation re: Underground Storage Tank Site: 1420 Fourth Street, Mission Bay. February 20.
REACT Environmental Services Corporation. 1994. *Tank Removal Report and Investigation, 255 Channel Street.* August 30.

Soil Boring and Monitoring Well Installation

Drilling Procedures

Fourteen soil borings and monitoring wells were drilled and installed by Gregg Drilling Services of Martinez, California, using a Mobil B-53 hollow-stem auger rig. Soil borings completed as 4-inch-diameter monitoring wells (seven total) were advanced with 6-1/4-inch outside diameter (OD) augers and reamed with 10-1/4-inch OD augers. Soil borings completed as 2-inch-diameter monitoring wells (seven total) were both advanced and reamed with 8-1/4-inch OD augers.

An ENVIRON geologist was present during drilling to obtain samples of subsurface materials, maintain a log of the borings, make observations of the work area conditions, conduct health and safety monitoring for possible organic vapors during drilling, screen and log soil samples, and provide technical assistance as required. Relatively undisturbed soil samples were obtained using a 2-inch inside diameter (ID) split-spoon sampler. From each boring, soil samples were collected for chemical testing near the surface and from halfway between the surface and the groundwater table. Due to variations in undisturbed sample recovery and encountered groundwater elevations, shallow sample depths ranged from 0.5 to 2.5 feet below ground surface, and deeper sample depths ranged from 2.5 feet to 5.0 feet below ground surface. Samples were also taken from selected wells for physical testing at depths ranging from 11.5 to 15.0 feet below ground surface.

To collect a sample, the split-spoon sampler was driven into undisturbed soils using a hammer weighing 140 pounds and falling 30 inches. The soil samples were retained in pre-cleaned 6-inch-long stainless steel liner tubes. Prior to collecting each sample, the sampler was cleaned with Liquinox™ in water solution, then double rinsed with potable water, and reassembled with pre-cleaned stainless steel tubes. During the field program, two equipment blanks were taken. Deionized water was poured through the clean split-spoon sampler (with stainless steel sleeves) directly into sample containers. The equipment blank samples were immediately placed into coolers and transported to the laboratory following chain-of-custody protocols.

Well Installation Procedures

The wells were installed with either 2-inch- or 4-inch-diameter Schedule 40 PVC casing and screen (0.010-inch slot size), and fitted with a threaded PVC end cap. A locking expansion cap was placed on top of each well casing. Lonestar #2/12 sand or Lonestar #2/16 sand filter packs were placed in the annulus from the bottom of the borehole to approximately one foot above the top of the slotted screen (approximately 4.5 feet below ground surface). Filter pack size was chosen to correspond to observed lithologies within the screened interval. After installation of the sand filter pack, a bentonite pellet seal was added for a minimum thickness of 1 foot. An annular seal of cement or bentonite was placed on top of the bentonite pellet seal.

Monitoring wells MW-1 through MW-6 and MW-8 through MW-11 were finished with lockable metal standpipes that were cemented into place to a height of approximately three feet above ground surface. Monitoring wells MW-7, MW-12, MW-13, and MW-14 were finished with flush-mounted traffic-rated Christie boxes. To protect wells MW-1 through MW-6 from ongoing site development and construction activities, each was flanked with three metal stanchions. Wells MW-8 through MW-11 were protected using portable lighted traffic barricades.

Well Development

Blaine Technical Services, Inc. (Blaine Tech), of San Jose, California, performed well development on January 2 and 3, 1997, under the oversight of ENVIRON field staff. Well development procedures consisted of swabbing, surging, and pumping activities.

Well Sampling

Groundwater sampling was conducted by Blaine Tech under the oversight of ENVIRON field staff. Prior to sampling the wells, the water level and total depth of well were measured and the casing volume was calculated.

A minimum of three casing volumes of water was purged from each well prior to sampling to ensure that the sample represented aquifer conditions as much as possible. Monitoring wells MW-12, MW-13, and MW-14 dewatered during purging and were sampled after two, two, and one casing volumes, respectively. The wells were purged using either a Middleburg displacement pump or similar pump built by Blaine Tech, or a Grunfos submersible pump. Pump selection was based on well diameter, filter pack size, lithology, and anticipated recharge rates.

When water quality parameters had stabilized and, where possible, a minimum of three casing volumes of water had been evacuated from the well, a groundwater sample was collected for chemical analysis using a decontaminated (steam-cleaned) stainless steel bailer gently lowered down the well by hand. The sampling bailer had a small pouring port near the top of the bailer that allowed for controlled pouring of samples, minimizing aeration.

Following collection, all groundwater and quality control samples were placed in coolers containing ice. Samples were transported to Curtis & Tompkins, Ltd., of Berkeley, California, for analysis under chain-of-custody protocol.

Mission Bay South

From April 21, 1997, to June 24, 1997, a subsurface field investigation was conducted in Mission Bay South by ENVIRON International Company for Catellus Development Corporation. The following section discusses the scope of work of the field investigation.

Soil and groundwater samples were collected from a total of 111 borings and temporary monitoring wells as part of an investigation designed to assess whether or not chemicals of concern were present in the shallow soils and groundwater in the Mission Bay South area. Groundwater level measurements were also collected from temporary monitoring wells in order to evaluate groundwater flow patterns in the area.

An ENVIRON geologist was present during all field work to obtain samples of subsurface materials, maintain a log of borings, make observations of the work area conditions, conduct health and safety monitoring of possible organic vapors encountered during drilling and/or sampling, screen and log soil samples, and provide technical assistance as required. All field work for the investigation was conducted under the supervision of a California registered geologist.

Soil Investigation

A total of 111 soil borings were advanced in the Mission Bay South area to the top of groundwater using hollow-stem auger methods. Boring locations were selected in order to screen the Mission Bay South area for potential chemicals of concern. A description of the soil investigation area is presented below.

Soil Sample Collection

Two soil samples were collected from nearly every boring (100 out of 111 borings) to provide information on the possible vertical extent of chemicals. Due to the presence of debris, concrete, or railroad base rock, only one soil sample was collected from borings C33, C39, SF31, UC10, and UC14. (See Figure V.J.4 for locations of borings and monitoring wells.) In concurrence with the City and County of San Francisco, one boring (SF32), located on the parcel southeast of the intersection of Third and Fourth Streets, was advanced for the collection of a groundwater sample only. Soil samples were not collected from boring locations MW-C42, MW-C43, MW-C44, MW-C45, and MW-SF35 because these borings were included in the program to further investigate the extent of petroleum hydrocarbons encountered in local groundwater on port property in the southeast corner of the Project Area.

Except for the borings detailed above, a shallow surface soil sample was collected from a depth of approximately 0.5 to 1.5 feet below ground surface and a second soil sample was collected from a depth approximately half the distance from ground surface to the top of the water table. Since the top of the water table ranged from approximately 4 to 9 feet below ground surface in the Mission Bay South area, the depth of the second soil sample varied.

Soil Analytical Program

Soil samples collected during the investigation were tested for various chemical compounds associated with historical usage of the Mission Bay South area. Table I.2 provides a summary of historical usage of each parcel in Mission Bay South as well as a listing of possible chemicals of concern based on previous land use. Chemicals of concern for the Mission Bay South area based on historical usage are presented in the *Mission Bay Hazards Mitigation Plan*/1/ and are summarized in Table V.J.1 in this SEIR.

Due to the comprehensive nature of the investigation, all soil samples collected during the investigation were analyzed using U.S. EPA test protocols. Shallow soil samples were not tested for volatile organic compounds (VOCs) because volatile compounds do not tend to persist in surface soils. At the request of the City and County of San Francisco, soil samples collected from three borings located on the parcel southeast of the intersection of Third and Fourth Streets were also tested using the California waste extraction test (WET) for lead.

Physical Testing

Samples of the subsurface soils obtained during drilling were tested to evaluate their physical properties. Selected samples were submitted for grain size analysis, soil classification, Atterberg Limits, porosity, moisture content and dry density, and total organic carbon.

Groundwater Investigation

Groundwater samples were collected from borings and temporary monitoring wells installed during the Mission Bay South subsurface investigation. A description of the groundwater investigation conducted in the area is presented below.

Groundwater Grab Sample Collection

One-time groundwater grab samples were collected from 71 of the 76 soil borings located in the south of Channel area. With the concurrence of the City, three borings (SF31, SF33, and SF34) were not sampled for groundwater due to the close proximity of other groundwater sample locations. No groundwater was encountered in boring C29 despite deepening the boring through bedrock to 20 feet below ground surface and leaving the hole open overnight to collect any available groundwater. Due to its location in a narrow alley, boring SF26 was drilled with a limited access rig, which was unable to penetrate shallow bedrock and reach groundwater. Groundwater grab samples were, therefore, not collected from these two locations.

Grab groundwater samples were collected using either a Hydropunch™ system or PVC casing encased in a polyester filter sock to prevent sediment infiltration. Groundwater grab sampling was initially attempted using the Hydropunch™ method; however, if the aquifer yield proved insufficient to provide enough sample volume, or if lithologic conditions prevented the advancement of the Hydropunch™ tool, the alternative temporary casing method was used.

Well Installation and Groundwater Sample Collection

A total of 35 of the 111 soil borings were completed as temporary groundwater monitoring wells. With the exception of two locations, all wells were installed to a depth of approximately 15 feet below ground surface using 2-inch-diameter Schedule 40 PVC casing and a 10-foot section of screen (0.010-inch slot size) fitted with a threaded PVC end cap. Well MW-SF7 was installed to a total depth of 10.5 feet below ground surface (with a 50- foot section of screen) due to difficult drilling conditions at that location. Well MW-C45.was installed to a depth of 28.5 feet below ground surface (with a 5-foot section of screen) to evaluate the chemical concentrations in a lower water-bearing zone. Due to the petroleum hydrocarbons encountered in the shallow aquifer near well MW-C45, a steel conductor casing was installed at this location to prevent chemicals from moving to the deeper unit. A mud rotary rig was used to drill the borehole and install the conductor casing at well MW-C45.

Following installation, the wells were developed to provide groundwater samples relatively free of sediment and 34 of the 35 wells were sampled to quantify concentrations of chemicals in groundwater in the Mission Bay South area. Due to the thickness and viscosity of free product in well MW-C9, ENVIRON was unable to lower a bailer down the well to recover a groundwater sample.

Groundwater Analytical Program

Groundwater samples were tested for potential chemicals of concern in the Mission Bay South area. The groundwater samples were analyzed for compounds associated with historical usage as shown in Table I.2. Chemicals of concern for the Mission Bay South area, based on historical usage, are presented in Table V.J.1. The chemical testing protocol for the investigation was developed based on historical usage of the Mission Bay South area. All groundwater samples collected during the investigation were analyzed using that testing protocol.

Groundwater samples were not tested for pesticides and polychlorinated biphenyls (PCBs) due to their tendency to adhere tightly to soils, and their subsequent immobility. Groundwater samples were also not tested for asbestos because that compound is only considered hazardous if capable of being inhaled. At the request of the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), groundwater samples from wells MW-C8, MW-C10, MW-SF6, MW-SF7, MW-SF9, and MW-UC6 were tested for nitrate to evaluate natural bioremediation potential in the vicinity of these wells.

Groundwater Elevation Measurements

In order to evaluate flow conditions, groundwater levels were measured in all 35 monitoring wells. Three separate water level monitoring events were conducted at the Mission Bay South area over the course of one day to assess short-term fluctuations of the shallow water table due to tidal changes: one round of measurements was collected at approximately the same time as high tide, one round of measurements was collected at approximately the same time as low tide, and one round of measurements was collected between high tide and low tide times (mid-ebb tide).

Laboratory Methods for Sample Analysis

Samples collected from Mission Bay North and Mission Bay South were analyzed as follows:

- Volatile organic compounds (U.S. EPA Method 8260, for the Method 8240 list of compounds)
- Semivolatile organic compounds (U.S. EPA Method 8270)
- Pesticides and PCBs (U.S. EPA Method 8080)
- Metals (antimony, arsenic, arsenic, barium, beryllium, cadmium, cobalt, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc by U.S. EPA Methods 6010/6020/7470; hexavalent chromium (Cr VI) in soils by U.S. EPA Method

7196; Waste Extraction Test for lead for samples collected from borings SF31, SF33, and SF34 - see Figure V.J.4 for locations)

- Total petroleum hydrocarbons - gasoline fraction (U.S. EPA 8015, modified)
- Total petroleum hydrocarbons - diesel and motor oil fractions (U.S. EPA Method 8015, modified. Silica-gel column cleanup performed on Mission Bay South samples)
- Asbestos (Polarized Light Microscopy)
- Nitrate (U.S. EPA Method 300)

SUMMARY OF SOIL AND GROUNDWATER SAMPLING RESULTS

Results of a comprehensive program of soil sampling and analysis in Mission Bay carried out in 1996 and 1997 are summarized below. Unless otherwise noted, the reported concentrations of chemicals in soil and groundwater and the interpretation of the results are summarized from the 1997 Mission Bay North report and 1998 Mission Bay South report, both prepared by ENVIRON for Catellus./2/

Mission Bay North Soil Results

Results of soil sampling in Mission Bay North are summarized in Tables I.4 through I.10. Each table lists the chemical detected, the range of concentrations, and the number of detections of each chemical compared to the number of total samples. In addition, Figures V.J.5 through V.J.8 show the locations of borings where some of these chemicals were detected and the concentrations of those chemicals. A narrative summary of this information is provided below.

Volatile Organic Compounds

Acetone was the only volatile organic compound (VOC) detected in soil; it was detected in 4 out of 14 soil samples collected, three of which are in borings located south of King Street and one of which is north of King Street in the Project Area (see Figure V.J.5). Concentrations ranged from 25 micrograms per kilogram (μg/kg) to 71μg/kg at depths of 2.5 to 4.5 feet as listed in Table I.4. Acetone is a chemical used in analytical laboratory processes. It is possible that some of these results may be from the laboratory analyses, rather than actual detections in soil./3/ VOCs were not detected in soil borings adjacent to the China Basin Channel.

TABLE I.4
DETECTION OF VOLATILE ORGANIC COMPOUNDS (VOCs) IN SOIL

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/b/	Concentration Range (μg/kg)
Mission Bay North				
Acetone /c/	14	4	29%	25-71
Mission Bay South				
Freon 113	105	1	1%	8.2
Freon 11	105	1	1%	5
2-Butanone	105	9	9%	11 - 120
2-Hexanone	105	1	1%	16
Acetone /c/	105	24	23%	14 - 770
Benzene	105	6	6%	13 - 270
Carbon Disulfide	105	5	5%	5.2 - 43
Chloroform	105	1	1%	6.2
Ethylbenzene	105	5	5%	7.3 - 2,700
Methylene Chloride /c/	105	12	11%	10 - 110
Styrene	105	1	1%	51
PCE	105	1	1%	11
Toluene	105	11	10%	5 - 4,300
TCE	105	1	1%	110
m & p-Xylenes	105	7	7%	5 - 8,000
o-Xylene	105	5	5%	5 - 4,900

Notes:
μg/kg = micrograms per kilogram
PCE = Tetrachloroethene
TCE = Trichloroethene

a. Shallow soil samples were not tested for volatile organic compounds since it is unlikely these compounds would persist in surface soils due to their volatile nature.
b. Number of detections as a percent of the total number of samples.
c. Common laboratory contaminant.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 6.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-7.

Semivolatile Organic Compounds

Semivolatile organic compounds (SVOCs) were detected in 6 of 28 soil samples from five borings in Mission Bay North (see Figures V.J.6 and 7). With the exception of 4-methylphenol found in soil boring MW-8 (south of King Street, about 300 feet east of Seventh Street) and dibenzofuran in a soil sample from MW-5 (near Fifth Street just north of the Channel edge), the SVOCs detected were PAHs. (See Table I.5 for SVOCs detected that are not PAHs and Table I.6 for PAHs detected in soil.) PAHs are typically associated with heavy-end fuels and the combustion of organic material (such as coal and gas) and are pervasive at industrial sites. They are generally found tightly bound to soils.

Carcinogenic (cancer-causing) and noncarcinogenic PAHs were detected in the soil samples. Carcinogenic PAHs included benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3,-cd)pyrene. Concentrations of these compounds ranged from 340 to 9,900 micrograms per kilogram (μg/kg) (see Table I.6).

Noncarcinogenic PAHs that were detected included acenaphthene, acenaphthylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Detected concentrations for these PAHs ranged from 390 to 20,000 μg/kg (see Table I.6).

Total Petroleum Hydrocarbons

A total of 28 soil samples (2 samples from each of the 14 soil borings), were tested for TPH gasoline, diesel, and motor oil fractions during the investigation. TPH-gasoline was not found above a detection limit of 1.0 milligrams per kilogram (mg/kg) in soil in any of the soil samples collected. TPH-diesel and TPH-motor oil were detected in every soil boring in Mission Bay North. Twenty-five of the 28 soil samples had diesel and motor oil concentrations ranging from 2.7 mg/kg to 240 mg/kg and 9 mg/kg to 2,800 mg/kg, respectively (see Table I.7).

Polychlorinated Biphenyls and Pesticides

Two soil samples collected from each of the 14 borings were tested for polychlorinated biphenyls (PCBs) and pesticides. One PCB (Arochlor 1254) was detected in a soil boring sample from MW-5, adjacent to Fifth Street at the Channel (see Figure V.J.8) at a concentration of 390 μg/kg (see Table I.8). No PCBs were detected in a deeper sample from this boring or any of the other boring locations.

TABLE I.5
DETECTIONS OF SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs) IN SOIL

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/a/	Concentration Range (μg/kg)
Mission Bay North				
4-methylphenol	28	1	4%	460
Dibenzofuran	28	1	4%	1,800
Mission Bay South				
Dibenzofuran	205	1	<1%	2,000

Notes:
μg/kg = micrograms per kilogram
< = less than
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 6.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-5.

Components of the pesticide DDT (4',4-DDD and 4',4-DDT) were detected in samples at concentrations of 7.3 μg/kg and 18 μg/kg at MW-9 (northeast of Sixth and Berry Streets) and MW-4 (at the southwest corner of Fifth and Berry Streets), respectively, as shown in Figure V.J.8.

Metals

Twenty-eight samples from the 14 soil borings were tested for 18 metals. Metals were detected in all 28 samples. The ranges of metals detections are listed in Table I.9. Arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, vanadium, and zinc were detected in 75% of the samples tested. The higher concentrations of antimony, lead, mercury, and zinc were limited to soils collected from five of the 14 borings (MW-2, MW-4, MW-8, MW-9, and MW-14 [see Figure V.J.4 for boring locations]). The highest concentration of antimony and zinc (140 mg/kg and 6,500 mg/kg, respectively) were detected in MW-14, located west of Third Street and south of Townsend Street. Levels of mercury were highest in boring MW-8, between Sixth and Seventh Streets and south of Townsend Street. The maximum lead concentration detected in the soil was in one boring (MW-9), at 430 mg/kg.

TABLE I.6
DETECTIONS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) IN SOIL

Compound	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Concentration Range (μg/kg)
Mission Bay North				
Noncarcinogenic				
Acenaphthene	28	1	4%	2,900
Anthracene	28	1	4%	6,900
Benzo(g,h,i)perylene	28	3	11%	360 - 2,000
Fluoranthene	28	5	18%	390 - 17,000
Naphthalene	28	1	4%	2,400
Phenanthrene	28	3	11%	600 - 17,000
Pyrene	28	5	18%	580 - 20,000
Carcinogenic				
Benzo[a]pyrene	28	5	18%	420 - 7,800
Benzo[b]fluoranthene	28	3	11%	730 - 5,000
Benzo[k]fluoranthene	28	5	18%	370 - 7,700
Benz[a]anthracene	28	4	14%	850 - 9,300
Chrysene	28	5	18%	380 - 9,900
Indeno[1,2,3-cd]pyrene	28	3	11%	340 - 1,800
Mission Bay South				
Noncarcinogenic				
2-Methylnaphthalene	205	1	<1%	1,100
Acenaphthene	205	1	<1%	1,600
Acenaphthylene	205	2	1%	1,700 - 2,100
Anthracene	205	2	1%	2,500 - 6,900
Benzo(g,h,i)perylene	205	4	2%	340 - 2,600
Fluoranthene	205	10	5%	330 - 7,700
Fluorene	205	1	<1%	2,900
Naphthalene	205	1	<1%	1,500
Phenanthrene	205	14	7%	330 - 17,000
Pyrene	205	10	5%	370 - 14,000
Carcinogenic				
Benz[a]anthracene	205	7	3%	350 - 11,000
Benzo[a]pyrene	205	8	4%	390 - 8,700
Benzo[b]fluoranthene	205	13	6%	340 - 9,600
Benzo[k]fluoranthene	205	5	2%	410 - 3,000
Chrysene	205	8	4%	430 - 6,800
Dibenz[ah]anthracene	205	1	<1%	460
Indeno[1,2,3-cd]pyrene	205	4	2%	330 - 3,200

Notes:
μg/kg = micrograms per kilogram
< = less than
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 6.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-4.

TABLE I.7
DETECTIONS OF TOTAL PETROLEUM HYDROCARBONS (TPHs) IN SOIL

Compound	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Concentration Range (mg/kg)
Mission Bay North				
TPH Gasoline Range	28	0	0%	ND < 1.0
TPH Diesel Range	28	25	89%	2.7 - 240
TPH Motor Oil	28	25	89%	9.0 - 2,800
Mission Bay South				
TPH Gasoline Range	205	13	6%	1.2 - 490
TPH Diesel Range	205	51	25%	1.9 - 12,000
TPH Motor Oil Range	205	116	57%	5 - 4,300

Notes:
mg/kg = milligrams per kilogram
ND < 1.0 = Non-detect at a detection limit of 1.0 mg/kg.
TPH Gasoline Range = Includes compounds identified as total petroleum hydrocarbons (TPH) gasoline as well as hydrocarbons in the unknown volatile hydrocarbon range.
TPH Diesel Range = Includes compounds identified as TPH diesel as well as unknown hydrocarbons in the diesel range.
TPH Motor Oil Range = Includes compounds identified as TPH motor oil as well as unknown hydrocarbons in the motor oil range.
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 8.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-11.

Other Analyses/General Chemistry

Sulfide and cyanide, analyzed as part of the Article 20 list of chemicals to be tested, were not detected in any soil samples collected during the investigation. Chrysotile asbestos was detected in one sample at a concentration of 1 to 5% (see Table I.10). The asbestos was believed to be related to pieces of roofing material contained in the sample rather than to the soil.

Soil samples were also tested for flammability (ignitability) and methane. The results indicated that the material would not be classified as ignitable, and reported concentrations of methane ranged from 5.2 parts per million by volume (ppmv) to 11 ppmv. These concentrations are equivalent to 0.00052% methane to 0.0011% methane, which is well below the explosive range for methane (5 to 14%).

TABLE I.8
DETECTIONS OF PESTICIDES AND PCBs IN SOIL

Compound	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Concentration Range (µg/kg)
Mission Bay North				
4,4' - DDD	28	1	4%	7.3
4,4' - DDT	28	1	4%	18
PCB (Aroclor - 1254)	28	1	4%	390
Mission Bay South				
Aldrin	205	1	<1%	160
Dieldrin	205	1	<1%	120
Endosulfan I	205	1	<1%	160
Endrin	205	1	<1%	31
HCH (gamma) Lindane	205	1	<1%	160
Heptachlor	205	1	<1%	160
Heptachlor Epoxide	205	2	1%	12 - 160

Notes:
µg/kg = micrograms per kilogram
Polychlorinated biphenyls (PCBs) were not detected in soil samples collected during the South of Channel investigation.
< = less than
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 6.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-3.

Mission Bay North Groundwater Results

Results of groundwater sampling performed in Mission Bay North are summarized in Tables I.11 through I.15. Each table lists the chemical detected, the range of concentrations, and the number of detections of each chemical compared to the number of total samples. In addition, Figures V.J.6, and V.J.9 through V.J.13 show the location of monitoring wells where some chemicals were detected and the concentrations of those chemical. A summary of this information is provided below.

TABLE I.9
DETECTIONS OF METALS IN SOIL

Compound	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Concentration Range (mg/kg)
Mission Bay North				
Antimony	28	3	11%	6 - 140
Arsenic	28	28	100%	1 - 16
Barium	28	28	100%	15 - 1,100
Beryllium	28	25	89%	0.099 - 1.3
Cadmium	28	28	100%	0.32 - 2.2
Chromium	28	28	100%	12 - 75
Chromium VI	28	4	14%	0.11 - 0.19
Cobalt	28	28	100%	3 - 16
Copper	28	27	96%	0.78 - 220
Lead	28	28	100%	2.2 - 430
Mercury	28	21	75%	0.099 - 3.6
Molybdenum	28	2	7%	1.2 - 1.6
Nickel	28	28	100%	12 - 100
Selenium	28	26	93%	0.37 - 3
Silver	28	4	14%	0.58 - 0.83
Thallium	28	19	68%	0.31 - 3.1
Vanadium	28	28	100%	18 - 56
Zinc	28	28	100%	16 - 6,500
Mission Bay South				
Antimony	205	16	8%	6.2 - 325
Arsenic	205	183	89%	1.1 - 247
Barium	205	204	100%	2.0 - 5,250
Beryllium	205	120	59%	0.2 - 4.7
Cadmium	205	52	25%	0.52 - 15.2
Chromium	205	205	100%	6.4 - 1,710
Chromium VI	205	14	7%	0.05 - 4.4
Cobalt	205	204	100%	2.0 - 119
Copper	205	204	100%	2.9 - 3,520
Lead	205	192	99%	1.2 - 47,900
Mercury	205	128	62%	0.1 - 32.7
Molybdenum	205	8	4%	2.1 - 8.6
Nickel	205	204	100%	7.8 - 2,650
Selenium	205	1	<1%	0.88

(Continued)

TABLE I.9 (Continued)

Compound	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Concentration Range (mg/kg)
Mission Bay South (cont.)				
Silver	205	15	7%	1.0 - 4.6
Thallium	205	2	1%	0.78 - 1.0
Vanadium	205	205	100%	8.9 - 218
Zinc	205	205	100%	11 - 3,880

Notes:
mg/kg = milligrams per kilogram
ND = not detected
< = less than
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 13.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-9.

Volatile Organic Compounds

Volatile organic compounds (VOCs) were detected in 7 out of 14 groundwater samples collected in the Mission Bay North Project Area (see Figure V.J.9). Benzene at a concentration of 7 micrograms per liter (μg/L) was detected in samples collected from one monitoring well (MW-11 located about 200 feet west of Fourth Street between King and Berry Streets). Two chemicals, cis-1,2-dichlorothene and trichloroetheylene (TCE), were detected in MW-10 (about 200 feet east of Fifth Street between King and Berry Streets). Tetrachloroethene (PCE) was also detected in MW-10 at a concentration of 180 μg/L (see Table I.11 for a list of the ranges of VOCs in groundwater).

VOC concentrations in groundwater were not widespread. There appeared to be no pattern in levels of contamination, and the VOC concentrations did not correlate well with chemical concentrations in soil. This suggests that there is not a specific identifiable source area for VOC contamination in Mission Bay north of the Channel. The one location where BTEXs were detected in groundwater is likely attributed to the former UST on the Caltrain property located upgradient of Mission Bay North. VOCs near the Channel were found in low concentrations or were not detected.

TABLE I.10
DETECTIONS OF ASBESTOS IN SOIL

Area	Total Number of Samples	Number of Detections	Frequency of Detections/a/	Amount
Mission Bay North				
	14	1	7%	1-5%
Mission Bay South				
	205	29	14%	Trace (<1%)
	205	9	4%	1 - 5%
	205	6	3%	5 - 10%
	205	3	1%	10 - 30%
	205	2	1%	65 - 75%

Note:
a. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 6.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-14.

Semivolatile Organic Compounds

Semivolatile organic compounds (SVOCs) were detected in 3 of 14 groundwater samples, as shown in Figures V.J.6 and Figure V.J.10. Tables I.12 and I.13 show the numbers of detections and ranges of concentrations for SVOCs that are not PAHs and those that are PAHs, respectively. In groundwater samples collected from MW-9 (300 feet east of Sixth Street between King and Berry Streets) and MW-13 (west of Third and south of King Streets), one SVOC, bis(2-ethylhexyl)phthalate (DEHP), was detected at concentrations of 12 μg/L and 13 μg/L, respectively. DEHP is a common field and laboratory contaminant; therefore it is possible that groundwater in this area has little or no DEHP. One other SVOC, dibenzofuran, was detected in one sample, at 450 μg/L.

Samples from MW-11 contained five PAHs: naphthalene was detected at 5,500 μg/L; acenaphthene was detected at 830 μg/L; and fluorene was detected at a concentration of 520 μg/L. Phenanthrene was found at 690 μg/L and 2-methylnaphthalene at 1,400 μg/L.

SVOCs in the groundwater in Mission Bay North are not widespread, and the locations and concentrations suggest there is no identifiable source area of contamination.

TABLE I.11
DETECTIONS OF VOLATILE ORGANIC COMPOUNDS (VOCs) IN GROUNDWATER

Compound	Total Number of Samples /a/	Number of Detections	Frequency of Detections/b/	Concentration Range (μg/L)
Mission Bay North				
cis-1,2-DCE	14	1	7%	7.1
trans-1,2-DCE	14	1	7%	2.6
Benzene	14	1	7%	7.4
Carbon Disulfide	14	5	36%	1.1 - 14
Chloroform	14	1	7%	1.8
Ethylbenzene	14	1	7%	47
PCE	14	2	14%	2.8 - 180
Toluene	14	1	7%	16
TCE	14	1	7%	7.0
m & p-Xylenes	14	1	7%	46
o-Xylene	14	1	7%	43
Mission Bay South				
TCA	105	2	2%	1.5 - 2.6
1,1-DCA	105	1	1%	1.5
cis-1,2-DCE	105	1	1%	31
trans-1,2-DCE	105	1	1%	6.9
Acetone/c/	105	1	1%	5.5
Benzene	105	9	9%	1.0 - 240
Carbon Disulfide	105	3	3%	1.3 - 8.7
Chlorobenzene	105	1	1%	5.0
Chloroform	105	4	4%	1.0 - 23
Ethylbenzene	105	3	3%	1.3 - 2.4
PCE	105	1	1%	1.3
Toluene	105	4	4%	1.0 - 41
TCE	105	1	1%	3.6
m & p-Xylenes	105	7	7%	1.6 - 34
o-Xylene	105	3	3%	2.5 - 12
Vinyl Chloride	105	1	1%	38

Notes:
μg/L = micrograms per liter
TCA = 1,1,1-Trichloroethane
1,1-DCA = 1,1-Dichloroethane
cis-1,2-DCE = cis-1,2-Dichloroethene
trans-1,2-DCE = trans-1,2-Dichloroethene
PCE = Tetrachloroethene
TCE = Trichloroethene

a. Duplicate samples were not counted as additional samples. For the duplicate samples, a detection in either the primary or duplicate sample was called a detection. The higher of the two results is reported in the range.
b. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 7.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-8.

TABLE I.12
DETECTIONS OF SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs) IN GROUNDWATER

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/b/	Concentration Range (μg/L)
Mission Bay North				
DEHP/b/	14	2	14%	12-13
Dibenzofuran	14	1	7%	450
Mission Bay South				
2,4-Dimethylphenol	105	1	1%	47
2-Methylphenol	105	1	1%	33
4-Methylphenol	105	1	1%	79
DEHP/b/	105	1	1%	31
Phenol	105	1	1%	13

Notes:
μg/L = micrograms per liter
a. Duplicate samples were not counted as additional samples. For the duplicate samples, a detection in either the primary or duplicate sample was called a detection. The higher of the two results is reported in the range.
b. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 7.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-5.

Total Petroleum Hydrocarbons

A total of 14 groundwater samples were tested for total petroleum hydrocarbons (TPHs) in gasoline, diesel, and motor oil fractions (see Figures V.J.11, V.J.12, and V.J.13). TPH-gasoline was detected at a concentration of 8.3 milligrams per liter (mg/L) in MW-11. TPH-diesel was detected in groundwater samples from all 14 wells in concentrations ranging from 0.055 mg/L to 48 mg/L (see Table I.14). In areas sampled near China Basin Channel, concentrations ranged from 0.055 mg/L to 0.92 mg/L. The highest concentration, 48 mg/L, was found in MW-11, located downgradient from the Caltrain property near Fourth and King Streets. Seven of the 14 wells sampled contained TPH-motor oil. Concentrations ranged from 0.39 mg/L to 7.1 mg/L. As with the other TPH fractions, MW-11 had the highest concentration.

TABLE I.13
DETECTIONS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) IN GROUNDWATER

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/b/	Concentration Range (μg/L)
Mission Bay North				
Noncarcinogenic				
2-Methylnaphthalene	14	1	7%	1,400
Acenaphthene	14	1	7%	830
Fluorene	14	1	7%	520
Naphthalene	14	1	7%	5,500
Phenanthrene	14	1	7%	690
Carcinogenic				
none	14	0	0%	0
Mission Bay South				
Noncarcinogenic				
2-Methylnaphthalene	105	1	1%	270
Acenaphthene	105	3	3%	11 - 120
Fluoranthene	105	1	1%	32
Naphthalene	105	3	3%	17 - 1,400
Phenanthrene	105	3	3%	11 - 120
Pyrene	105	2	2%	13 - 42
Carcinogenic				
Benzo[b]fluoranthene	105	1	1%	22

Notes:
μg/L = micrograms per liter
a. Duplicate samples were not counted as additional samples. For the duplicate samples, a detection in either the primary or duplicate sample was called a detection. The higher of the two results is reported in the range.
b. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 7.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-6.

Metals

Twelve metals (antimony, arsenic, barium, chromium, cobalt, lead, mercury, molybdenum, nickel, thallium, vanadium, and zinc) were detected in groundwater in Mission Bay North. Arsenic, barium, and zinc were detected most frequently while antimony, chromium, cobalt, molybdenum, and vanadium were detected rarely (see Table I.15). Three metals detected in higher concentrations than

TABLE I.14
DETECTIONS OF TOTAL PETROLEUM HYDROCARBONS (TPHs) IN GROUNDWATER

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/b/	Concentration Range (mg/L)
Mission Bay North				
TPH Gasoline Range	14	1	7%	8.3
TPH Diesel Range	14	14	100%	0.055 - 48
TPH Motor Oil Range	14	7	50%	0.39 - 7.1
Mission Bay South				
TPH Gasoline Range	105	17	16%	0.052 - 36
TPH Diesel Range	105	40	38%	0.068 - 330
TPH Motor Oil Range	105	30	29%	0.13 - 4.7

Notes:
$\mu g/L$ = micrograms per liter
TPH Gasoline Range = Includes compounds identified as total petroleum hydrocarbons (TPH) gasoline as well as hydrocarbons in the unknown volatile hydrocarbon range.
TPH Diesel Range = Includes compounds identified as TPH diesel as well as unknown hydrocarbons in the diesel range.
TPH Motor Oil Range = Includes compounds identified as TPH motor oil as well as unknown hydrocarbons in the motor oil range.
a. Duplicate samples were not counted as additional samples. For the duplicate samples, a detection in either the primary or duplicate sample was called a detection. The higher of the two results is reported in the range.
b. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, April 1997, Table 9.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-12.

in other locations included antimony (0.2 mg/L in MW-10); nickel (0.190 mg/L in MW-13); and thallium (0.010 to 0.028 mg/L in MW-9, MW-10, and MW-13). Monitoring well locations are shown in Figure V.J.4. The data indicate that there is no specific pattern of metals in groundwater that would indicate a specific identifiable source area in Mission Bay North./4/

Mission Bay South

The Mission Bay South investigation was conducted from April 21 to June 24, 1997, including the Atcheson, Topeka and Santa Fe Railroad area. The study area included all Mission Bay South parcels owned by Catellus or by City agencies except the Channel Pump Station site. Parcels owned or operated by Esprit de Corp and Castle Metals were investigated independently; the results of the

TABLE I.15
DETECTIONS OF METALS IN GROUNDWATER

Compound	Total Number of Samples/a/	Number of Detections	Frequency of Detections/b/	Concentration Range (mg/L)
Mission Bay North				
Antimony	14	1	7%	0.220
Arsenic	14	10	71%	0.0057 - 0.038
Barium	14	14	100%	0.015 - 0.270
Beryllium	14	0	0%	--
Cadmium	14	0		--
Chromium	14	1	7%	0.013
Cobalt	14	2	14%	0.021 - 0.110
Copper	14	0		--
Lead	14	3	21%	0.0044 - 0.013
Mercury	14	5	36%	0.0002 - 0.0027
Molybdenum	14	1	7%	0.031
Nickel	14	3	21%	0.024 - 0.190
Selenium	14	0		--
Silver	14	0		--
Thallium	14	3	21%	0.010 - 0.028
Vanadium	14	1	7%	0.018
Zinc	14	11	79%	0.021 - 0.180
Mission Bay South				
Antimony	105	2	2%	0.061 - 0.064
Arsenic	105	80	76%	0.002 - 0.170
Barium	105	104	99%	0.018-9
Beryllium	105	0	0%	--
Cadmium	105	2	2%	0.0014 - 0.006
Chromium	105	80	76%	0.001 - 0.083
Cobalt	105	11	10%	0.011 - 0.025
Copper	105	80	76%	0.001 - 0.120
Lead	105	56	53%	0.001 - 0.370
Mercury	105	7	7%	0.0002 - 0.0015
Molybdenum	105	7	7%	0.020 - 0.087
Nickel	105	105	100%	0.0014 - 0.250
Selenium	105	11	10%	0.0022 - 0.0094
Silver	105	1	1%	0.0013
Thallium	105	0	0%	--
Vanadium	105	17	16%	0.010 - 0.069
Zinc	105	23	22%	0.020 - 0.700

Notes:
mg/L = milligrams per liter

a. Duplicate samples were not counted as additional samples. For the duplicate samples, a detection in either the primary or duplicate sample was called a detection. The higher of the two results is reported in the range.
b. Number of detections as a percent of the total number of samples.

Sources:
ENVIRON, Results of Investigation Mission Bay North of Channel, San Francisco, California, February 1997, Table 14.

ENVIRON, Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California, February 1998, Table 4-10.

Esprit investigations were considered in the evaluation of the Project Area. Results of the investigation of the Castle Metals site were considered and separately reported in the SEIR text in Section V.J, Contaminated Soils and Groundwater. Soil and groundwater samples were collected from a total of 111 borings and temporary monitoring wells as shown in Figure V.J.4. Two soil samples from each boring, ranging in depth from 0.5 to 8 feet below the ground surface, were collected and analyzed. All soil samples were analyzed for VOCs, pesticides and PCBs, TPH-gasoline, -diesel and -motor oil fractions, metals, and asbestos. Shallow soil samples were not tested for VOCs because volatile compounds do not tend to persist in surface soils. Groundwater from each soil boring that was converted into a temporary monitoring well approximately 15 feet deep or collected from a Hydropunch™ boring was tested for VOCs, SVOCs, metals, TPH, and pH. The metals sampling program included antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

<u>Mission Bay South Soil Results</u>

Results of soil sampling in Mission Bay South are summarized in Tables I.4 through I.10. Each table lists the chemical detected, the range of concentrations, and the number of detections of each chemical compared to the number of total samples. In addition, Figures V.J.5 through V.J.8 show the locations of soil borings where some of these chemicals were detected and the concentrations of these chemicals. A narrative summary of this information is provided below.

Volatile Organic Compounds

Volatile organic compounds (VOCs) were detected in nearly one-half of the soil borings in Mission Bay South (see Figure V.J.5). Most of the soils containing VOCs are generally located close to former USTs or to the former bulk petroleum storage, pipelines, and transfer facilities previously located in the southeast portion of the Mission Bay South area (UST locations are shown in Figure V.J.2, petroleum facilities in Figure V.J.3). Sixteen VOC compounds were detected in the samples collected. As shown on Table I.4, among the VOCs detected most frequently were acetone, 2-butanone, carbon disulfide, methylene chloride, benzene, toluene, ethylbenzene, and xylenes (the last four are collectively referred to as "BTEX" compounds).

Concentrations of BTEX compounds were more elevated in one boring (MW-C8, located northeast of the intersection of Illinois Street and 16th Street in the former bulk oil storage area) than at other locations. BTEX concentrations ranged from 270 to 8000 μg/kg. Other borings south of MW-C8 and a few near the northern end of Illinois Street also contained elevated concentrations of BTEX compounds; however, the concentrations were much lower than in MW-C8 (generally less than 100 μg/kg). Acetone and methylene chloride (to a lesser degree) were reported in samples collected from approximately one-half of the borings in which VOCs were detected. Acetone and methylene chloride are both chemicals used in analytical laboratory processes. As described for Mission Bay North above, it is possible that some of these results may be from the laboratory analyses, rather than actual detections in soil./5/

Semivolatile Organic Compounds

Semivolatile organic compounds (SVOCs) were detected in 16 borings in Mission Bay South. All but one of the SVOCs detected were PAHs, which are typically associated with heavy-end fuels (such as oils) and the combustion of organic material (such as coal and gas), and are commonly found at former industrial sites. The SVOC detected in soil was dibenzofuran, found in one soil sample at a concentration of 2,000 μg/kg, as indicated in Table I.5. As shown in Figure V.J.7, there were several PAH detections in borings in the vicinity of Third and Illinois Streets near Fourth Street (SF19, MW-C2, C21, SF23, MW-C12, MW-C41 boring locations also shown in Figure V.J.4). Other locations where PAHs were detected included: three borings on the UCSF site near Sixth Street (UC29, UC30, UC31); three borings between 16th Street and Mariposa Street (C25, MW-C6, and SF24), and scattered locations in the vicinity of the western part of China Basin Channel and west of Owens Street (SF12 and C23) and north of the UCSF site (C13 and SF21).

As shown in Table I.6, PAHs detected most frequently included: benzo(g,h,i)perylene, fluroanthene, phenanathrene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluroanthene, chrysene. Other PAHs detected at lesser frequency included 2-methylnaphthalene, acenapthene, acenaphthalene, anthracene, fluorene, naphthalene, dibenz[ah]anthracene, and indeno[1,2,3-cd]pyrene. Concentration ranges for each SVOC detected are also shown in Tables I.5 and I.6. For those SVOCs detected more frequently, the locations with the greatest number of contaminants detected and highest concentrations included: MW-C41 (benzo(g,h,i)perylene, phenanthrene, pyrene, benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluroanthene, chrysene, and others) in the former port area around Illinois and 16th Streets, and SF19 (contaminants similar to MW-C41) south of the intersection of Channel Street and Third Street.

Although PAHs were detected at various locations throughout Mission Bay South, the frequency of detections ranged from less than 1% to 7%. Based on the low frequency of detections, it appears that there is no pattern associated with the PAH detections, which indicates there is no specific identifiable source of PAHs in the soil in Mission Bay South.

Total Petroleum Hydrocarbons

Of the 205 soil samples taken from 105 borings, diesel and motor oil fractions of total petroleum hydrocarbons (TPH) were detected in about 25% and 60% of the samples analyzed, respectively. Relatively few (6%) of the soil samples contained detectable levels of TPH-gasoline (see Table I.7).

The maximum concentrations of TPH-diesel and TPH-gasoline were detected in samples from boring C36 (north of 16th Street just east of Illinois Street) at a depth of 6.5 feet below ground surface. Maximum concentrations for TPH-gasoline and TPH-diesel in soil were found to be 490 mg/kg and 12,000 mg/kg, respectively. TPH-motor oil was detected at a maximum concentration of 4,300 mg/kg at a depth of 3.0 feet from boring SF21 (about 400 feet east of Sixth Street, and 700 feet south of Channel Street).

Pesticides and PCBs

Organochlorine pesticides aldrin, dieldrin, endosulfan I, lindane, heptachlor, and heptachlor epoxide were detected in one soil boring on the UCSF site approximately 200 feet east of Third Street (location UC-12, Figure V.J.8). Concentrations ranged from 120 to 160 μg/mg. Endrin and heptachlor epoxide were detected in soil in another boring approximately 800 feet north of 16th Street, also on the UCSF site (location UC-11 in Figure V.J.8). Concentrations ranged from 12 to 31 μg/mg. Pesticides were not detected in any other soil sample collected from Mission Bay South. PCBs were not detected in any soil sample in Mission Bay South.

Metals

All 18 metals tested for were detected in soil borings in Mission Bay South (see Table I.9). Arsenic, barium, beryllium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc were detected most frequently (i.e., in more than 50% of the samples). Concentrations of most of these metals ranged from trace amounts (less than a few mg/kg) to higher values (upwards of 100 mg/kg). The geographic distribution of all metals detected suggests that the concentrations are likely representative of background conditions for Mission Bay fill materials and that there is no single, isolated source of metals in Mission Bay South soils.

Of all the metals detected, lead showed the greatest range in concentrations. The maximum concentration of lead detected was 47,900 mg/kg at one boring location (C18) at a depth of 2.5 feet below the ground surface, northwest of the Third and Fourth Streets intersection. At other locations, lead levels in soil in Mission Bay South generally ranged from 18 to 4,260 mg/kg.

Asbestos

Asbestos was detected in 38 soil borings in Mission Bay South. The detections are believed to be attributable to the construction debris and fill placed in Mission Bay South and are randomly distributed throughout the Project Area. Trace amounts (less than 1% concentration) were found in nearly two-thirds of the locations sampled (see Table I.10). Chrysotile asbestos (the friable form of which is subject to regulation) was found in the other locations, ranging in concentration from 1% to 75%. Serpentinite is one of several rock types surrounding and underlying the Project Area; and some of the material was used to fill Mission Bay. Consequently, the presence of chrysotile asbestos in soil from naturally occurring chrysotile fibers in serpentinite fill material is not unexpected. Two borings, MW-SF10 (west of Terry A. François Boulevard in Assessor's Block 3852, lot 2) and UC24 (east of Owens Street in Assessor's Block 3835, lot 3), had soil asbestos concentrations exceeding 65%.

Mission Bay South Groundwater Results

Results of groundwater sampling performed in Mission Bay South are summarized in Tables I.11 through I.15. Each table lists the chemical detected, the range of concentrations, and the number of detections of each chemical compared to the number of total samples. In addition, Figures V.J.6, and V.J.9 through V.J.13 show the locations of monitoring wells where chemicals were detected and the concentrations of the chemical. A summary of this information is provided below.

Volatile organic compounds, semivolatile organic compounds, PAHs, metals, and total petroleum hydrocarbons in gasoline, diesel, and motor oil fractions were detected in Mission Bay South groundwater samples. In addition, petroleum free product with a measurable thickness was found floating on top of the groundwater in an area east of Illinois and 16th Streets.

Volatile Organic Compounds

A total of 16 volatile organic compounds (VOCs) were detected in 21 groundwater samples collected during the Mission Bay South investigation. As Table I.11 shows, concentrations ranged from a low of 1.0 μg/L for concentrations of such chemicals as chloroform and toluene to a high of 240 μg/L for benzene. The frequency of detection for these 16 compounds ranged from 1% for perchloroethylene and other compounds to 9% for benzene. Detections of VOCs occur throughout Mission Bay South, but tend to be concentrated near the former bulk petroleum storage, pipelines, and transfer facilities previously located near the area east of Illinois Street on the port property. Figure V.J.9 shows the locations of VOCs detected in groundwater sampling locations in Mission Bay South.

Aside from the VOCs associated with petroleum contamination, most of the other VOCs were detected in one monitoring well (MW-C4), located south of 16th and east of Seventh Streets. A number of other chlorinated hydrocarbons were detected in MW-C4, including, but not limited to, TCE; 1,1-dichloroethane; cis-(1,2)-dichloroethane; and vinyl chloride. As shown in Table I.11, these chemicals comprise a small percentage of all VOCs detected.

Semivolatile Organic Compounds

Semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), were detected in groundwater samples; the frequency of detection of these compounds was low and ranged from 1% to 3%. Five SVOCs were reported in groundwater samples from two locations during the investigation, one west of Third Street between Fourth and 16th Streets (boring UC12) and the other between Seventh and Owens Streets south of Channel Street (boring C22), as shown in Figure V.J.6. The SVOCs in boring UC12 included phenol, 2-4 methylphenol, 2-methylphenol, and 4-methylphenol. Bis(2-ethylhexyl)phthalate (DEHP), a common laboratory contaminant was detected in water sampled from groundwater in boring C22. With a concentration of 31 μg/L, and no other detections at any of the sampling locations, it is unlikely that there is a source of DEHP on site. SVOCs other than PAHs were detected in approximately 1% of the samples analyzed. Table I.12 lists the concentrations of SVOCs detected.

Six groundwater samples show detectable concentrations of PAHs (see Figure V.J.10). Two are just west of Terry A. François Boulevard, near the oil facilities (MW-SF35 and SF27), two are north of Mariposa Street just west of the proposed extension of Fourth Street (C27 and SF25), and two are west of Third Street north of 16th Street (UC7 and UC12). Six types of PAHs were detected, including benzo[b]fluoranthene, a cancer-causing PAH which was detected in one sample collected from SF27 at a concentration of 22 μg/L.

The pattern of detections and concentrations of SVOCs in Mission Bay South groundwater indicates that there are no specific identifiable sources of contamination in the Project Area that could be attributed to the presence of these chemicals in Mission Bay South groundwater.

Total Petroleum Hydrocarbons

Total petroleum hydrocarbons (TPH) in the diesel, gasoline, and motor oil fractions were detected in groundwater samples obtained during the Mission Bay South investigations. TPH-diesel was detected in 38% of the samples (see Table I.14). TPH-gasoline and TPH-motor oil were detected at frequencies of 16% and 29%, respectively.

Most of the TPH gasoline detections were located on or near Assessor's Block 3892, lot 1, near former petroleum bulk storage, pipelines and transfer facilities (see Figure V.J.3 for locations of bulk storage facilities, and Figure I.1 for a map showing Assessor's Blocks and lots). Three groundwater samples from this area showed concentrations of TPH-gasoline greater than 1.0 mg/L. The maximum concentration of 36 mg/L was detected in boring C35 located about 100 feet north of 16th Street just east of Illinois Street (see Figure V.J.11).

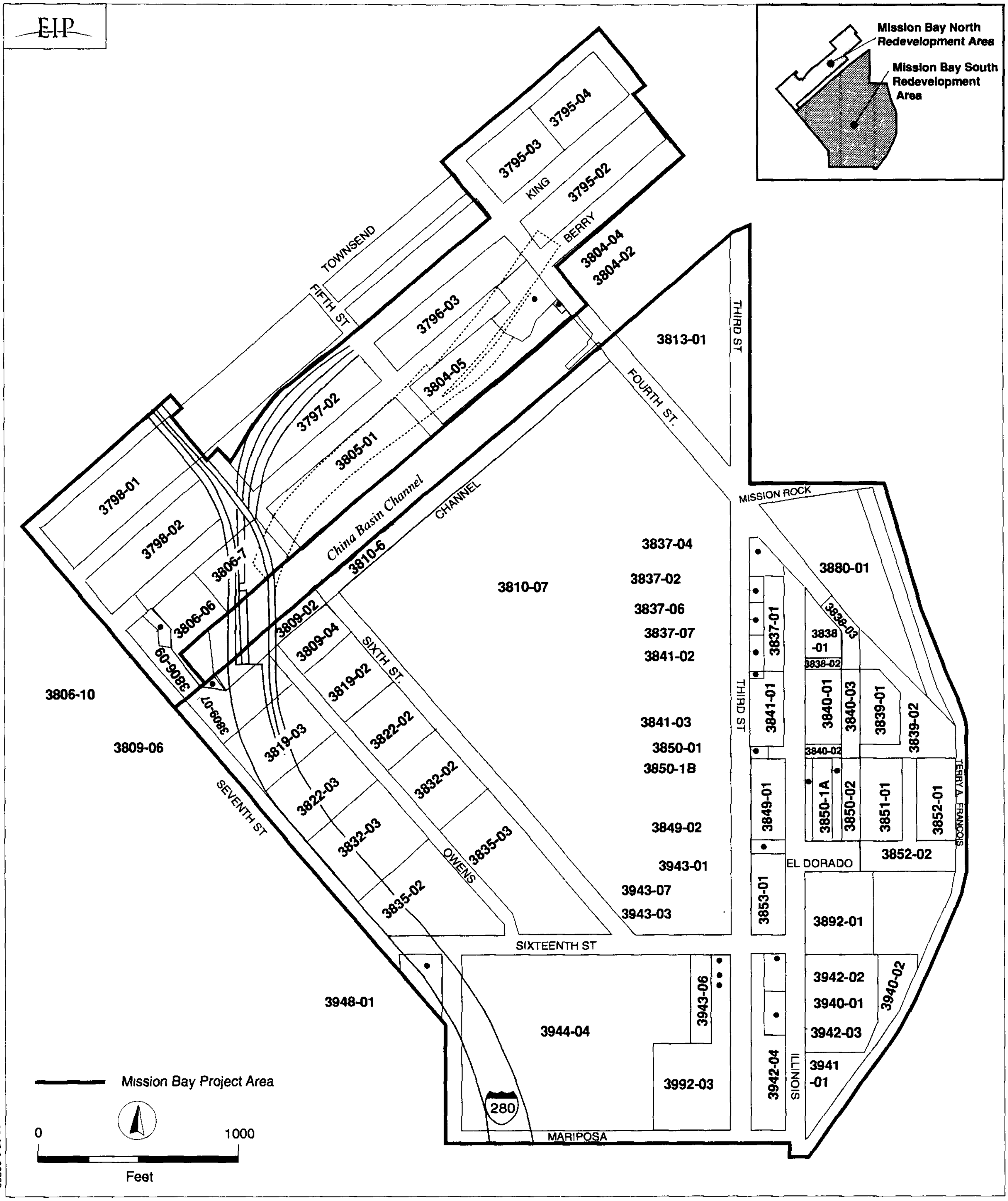
Detections of TPH-diesel in groundwater were scattered through the investigation area. Most of the higher concentrations (greater than 10 mg/L) were detected in the former petroleum bulk storage, pipelines, and transfer facilities. The highest concentration of 330 mg/L was detected in boring UC10, about 400 feet north of 16th Street west of Third Street (see Figure V.J.12).

As with TPH-diesel, detections of TPH-motor oil in groundwater were scattered throughout Mission Bay South (see Figure V.J.13). Most concentrations of TPH-motor oil were less than 1.0 mg/L with the exception of samples from the center of Mission Bay South (MW-UC1, UC11, UC12, and UC26) and three samples collected from east of Illinois Street (MW-C12, MW-SF6, and MW-SF8). The maximum concentration of TPH-motor oil (4.7 mg/L) was observed in MW-C12 east of Illinois Street, adjacent to the former USTs.

Petroleum Free Product

As discussed previously, based on observations made during drilling and sampling activities, a petroleum free product area was identified in the southeast portion of Mission Bay South. The approximate horizontal extent of free product with a measurable thickness greater than 0.01 inch is shown in Figure V.J.14. A free product thickness of 1.6 feet was measured by ENVIRON in monitoring well MW-C9, about 300 feet east of Illinois Street approximately in line with the extension of 16th Street (near the pipelines shown in 16th Street in Figure V.J.3).

Chemical analysis indicates that the free product is most likely weathered crude oil that had undergone moderate biodegradation. Some volatile (lighter end) hydrocarbons were also present in the free product. The chemical characteristics of the weathered crude oil are believed to be consistent with a release that may have occurred over 10 years ago. The presence of free product is likely related to the former petroleum bulk storage, pipelines and transfer facilities previously located on Assessor's Block 3892, lot 1 and on the Esprit property near the 16th and Illinois Streets intersection (Assessor's Block 3940), as well as the underground petroleum pipelines used by these facilities that run beneath 16th Street to Pier 64. These facilities, which handled products such as diesel, kerosene, gasoline, lubricating oil, crude oil, and bunker fuel oil, were active from the early 1900's to the 1960's and early 1970's.



SOURCE EIP Associates, San Francisco Department of City Planning

MISSION BAY SUBSEQUENT EIR

FIGURE I.1 ASSESSOR'S BLOCKS AND LOTS COMPRISING THE PROJECT AREA

Metals

All metals except beryllium and thallium were detected in groundwater in Mission Bay South. Arsenic, barium, chromium, copper, lead, and nickel were detected most frequently and at low concentrations, as shown in Table I.15. Lead was detected in approximately one-half of the samples, ranging in concentration from 0.001 to 0.370 mg/L.

A statistical analysis of upgradient versus down gradient concentrations of metals indicated that arsenic, barium, chromium, copper, lead, mercury, and nickel are not substantially higher down gradient than upgradient. This suggests that there is no significant detectable contribution of these metals from a major source area within Mission Bay South and no net gain of these dissolved metals as groundwater migrates under the Project Area. Thus, the source of metals detections in groundwater appears to be related to the fill materials placed in Mission Bay South rather than releases from specific identifiable sources such as industrial waste disposal or releases.

METHODOLOGY FOR EVALUATING EXISTING HUMAN HEALTH AND ECOLOGICAL RISKS DUE TO CONTAMINANTS DETECTED IN SOIL AND GROUNDWATER IN THE PROJECT AREA PRIOR TO CONSTRUCTION

The Project Area is located in a predominantly industrial and commercial area and is in proximity to off-site residential areas. Current uses include trucking and storage facilities, import and trading companies, automobile, bus and truck maintenance facilities, golf driving range, retail outlets, sand/gravel and cement operations, parking areas and vacant space. Businesses adjacent to the area include railroad facilities, light industrial, warehouse and storage facilities, retail outlets, office space, restaurants, and residences.

An analysis of existing conditions in the Project Area that could potentially impact human health and/or the ecological environment was prepared by ENVIRON International Corporation in February 1998. The results were presented in *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area and Technical Memorandum #2, Development and Screening of Remedial Alternatives for Free Product Area in Region of Former Oil Storage Facilities,* and *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area.* /6/ Unless otherwise noted, the following discussion of the methods that were used to evaluate potential human and ecological effects under existing conditions is summarized from information provided in those documents.

Analysis of Potential Immediate Adverse Human Health Effects Associated with Current Conditions in the Project Area

The agencies responsible for overseeing site remediation have not developed specific risk assessment guidelines to identify sites that require an immediate response. To determine the need for immediate control measures in the absence of specific regulatory criteria, ENVIRON developed a tiered approach, which is presented in *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area*. The process consisted of identifying chemicals of potential immediate concern (COPIC), identifying the levels of COPIC to which individuals could potentially be exposed, and then evaluating the potential for the levels of COPIC to which individuals may actually be exposed to represent a potential human health threat sufficient to warrant the implementation of immediate risk management measures. The evaluation of the potential human health impacts was based on the potential for short-term exposure to the COPIC present in the Project Area to cause cancer, noncancer, or acute health effects in the potentially exposed populations. The tiered approach consisted of the following two steps—identification of COPIC and the analysis of COPIC, which are summarized below.

Identification of COPIC: Comparison of Maximum Concentrations to U.S. EPA Region IX Industrial PRGs

Current populations in the Project Area could be directly exposed to chemicals present in the soils if direct contact with the soils were to occur. In order to identify which of these chemicals could potentially pose a risk to populations exposed in the short-term interval between the present and when the RMP is approved and implemented, the maximum concentrations of all chemicals detected in the soil anywhere in the Project Area in greater than 1% of the samples (i.e., in two or more samples) were compared to Region IX Industrial PRGs. The use of the Region IX Industrial PRGs as the initial point of comparison was considered a conservative screening approach, since the Region IX Industrial PRGs represent soil concentrations that are considered protective of long-term exposure scenarios. These scenarios assume exposure occurs via the inhalation of particulates, soil ingestion, and dermal contact pathway for an extended 25-year exposure scenario. Although used as initial screening criteria to identify COPICs, the Industrial PRGs are not appropriate criteria for evaluating post-development conditions, since when development is complete the existing soil would be completely capped by buildings, streets, sidewalks and landscaping. Given the limited time period between now and when the RMP would be submitted and approved, and the fact that the current land uses in the Project Area are industrial, not residential, the use of the Region IX Industrial PRGs as initial screening criteria to identify chemicals that could pose potential health impacts based on short-term exposures is conservative; chemicals with maximum detected concentrations below the Region IX Industrial PRGs would not likely represent an immediate health concern. The assumed total

25-year exposure in the development of the Region IX Industrial PRGs is likely to be significantly greater than the actual exposures that may occur in the short-term interval between now and when the RMP is developed and approved, which is likely to be no more than six months.

The comparison of the maximum concentrations of the volatiles, metals, PAHs, and TPH detected in soil samples collected in the Project Area to the risk-based Region IX Industrial PRGs is presented in Table I.16. The lower of either the carcinogenic PRG (protective of carcinogenic effects) or the noncarcinogenic PRG (protective of noncarcinogenic effects) was used, when both were available. Since U.S. EPA has not developed PRGs for the ranges of TPH, the criteria presented for TPH are the site-specific target levels (SSTLs) developed by ENVIRON in 1996 for on-site Project Area residents. These SSTLs are used as an initial point of comparison because they have been approved by the RWQCB for use at underground storage tank (UST) sites in Mission Bay. The use of residential SSTLs is considered conservative when applied to current industrial/commercial populations because they assume long-term exposures via the inhalation, ingestion and dermal contact pathways.

As shown in Table I.16, the maximum concentrations of arsenic, beryllium, lead, and various carcinogenic PAHs exceed the Region IX Industrial PRGs. Based on a comparison of the maximum detected concentrations to the Region IX Industrial PRGs, the chemicals that warrant further evaluation, and that were, therefore, identified as COPIC for the purposes of current conditions, include arsenic, beryllium, lead, and carcinogenic PAHs. The other chemicals detected in the soils across the Project Area were not detected at levels that would potentially warrant an immediate response. This includes the levels of TPH detected in the soils around the petroleum free product area.

Analysis of COPIC

Comparison of Concentrations in Exposed Soils to Region IX Industrial PRGs

As described above, the COPIC selected for additional evaluation include arsenic, beryllium, lead, and the carcinogenic PAHs. The purpose of the second tier of this evaluation was to determine whether the concentrations of the COPIC to which individuals could be exposed in the short-term interval would likely result in any long-term carcinogenic or noncarcinogenic adverse health impacts. This was accomplished by identifying the concentrations to which the current populations may actually be exposed, referred to by U.S. EPA as the reasonable maximum exposure concentrations, and then comparing the potential reasonable maximum exposure concentrations to Region IX Industrial PRGs. Because the potential for chemicals to cause cancer is a function of the cumulative

TABLE I.16
MAXIMUM SOIL CONCENTRATIONS IN ALL SOIL SAMPLES, MISSION BAY PROJECT AREA

Chemical	Maximum Soil Concentration (mg/kg)	Risk-Based USEPA Region IX Industrial PRG /a/ (mg/kg)
Volatiles		
Freon 113	0.0082	5600
Freon 11	0.005	1273
2-Butanone	0.12	27000
2-Hexanone	0.016	/b/
Acetone	0.77	8754
Benzene	0.27	1.4
Carbon Disulfide	0.043	24.5
Chloroform	0.0062	0.53
Ethylbenzene	2.7	230
Methylene Chloride	0.11	17.8
Styrene	0.051	680
PCE	0.011	16.7
Toluene	4.3	880
TCE	0.11	7
m & p-Xylenes	8	320
o-Xylene	4.9	320
Polycyclic Aromatic Hydrocarbons (PAHs) Noncarcinogenic PAHs		
Acenaphthene	2.9	11000 /c/
Acenaphthylene	2.1	
Anthracene	6.9	160000 /c/
Benzo(ghi)perylene	2.6	
Fluoranthene	17	27251 /c/
Fluorene	2.9	18000 /c/
Naphthalene	2.4	4400 /c/
Phenanthrene	17	
Pyrene	20	20000 /c/

(Continued)

TABLE I.16 (Continued)

Chemical	Maximum Soil Concentration (mg/kg)	Risk-Based USEPA Region IX Industrial PRG /a/ (mg/kg)
Sum of Noncarciongenic PAHs	74.1	
Carcinogenic PAHs		
Benz[a]anthracene	11	2.6
Benzo[a]pyrene	8.7	0.26
Benzo[b]fluoranthene	9.6	2.6
Benzo[k]fluoranthene	7.7	26
Chrysene	9.9	7.2
Dibenz[ah]anthracene	0.46	0.26
Indeno[1,2,3-cd]pyrene	3.2	2.6
Sum of Carcinogenic PAHs /d/	12.1054	
Metals		
Antimony	325	680
Arsenic	247	2.4
Barium	5250	10,000
Beryllium	4.7	1.1
Cadmium	15.2	850
Chromium	1710	/e/
Chromium, hexavalent	4.4	64
Cobalt	119	97,000
Copper	3520	63,000
Lead	47900	1,000
Mercury	32.7	68
Molybdenum	8.6	8,500
Nickel	2650	34,000
Selenium	3	8,500
Silver	4.6	8,500
Thallium	3.1	140
Vanadium	218	12,000
Zinc	6500	100,000

(Continued)

TABLE I.16 (Continued)

Chemical	Maximum Soil Concentration (mg/kg)	Risk-Based USEPA Region IX Industrial PRG /a/ (mg/kg)
Petroleum Hydrocarbons		
TPH-Gasoline	490	1230 /f/
TPH-Diesel	12000	23000 /f/
TPH-Residual	4300	210000 /f/

Notes:
mg/kg = milligrams per kilogram

a. From *Region IX Preliminary Remediation Goals* (USEPA August 1, 1996). A blank in this column indicates that no Region IX PRG exists.
b. Region IX has not developed a PRG for this compound. However, since 2-hexanone is a volatile compound, but is significantly less toxic than benzene, we would not expect the 2-hexanone to be selected as a COPIC.
c. These Region IX PRGs correspond to the risk-based levels, obtained on-line from USEPA's PRG table (http://www.epa.gov/region9)/) Also noted in the USEPA 1996 PRG table for these compounds are PRGs based on the soil saturation equation ("sat"). Since the soil saturation limit has no relevance to the potential for adverse health effects, the risk-based PRGs are used in preference over the soil saturation limit.
d. Carcinogenic PAHs are reported as benzo[a]pyrene-equivalents, using the potency-equivalency factors recommended by Cal/EPA (Cal/EPA 1993).
e. Although an industrial PRG of 450 mg/kg is presented for total chromium, this number is based on the potential for carcinogenic effects associated with hexavalent chromium, with an assumed hexavalent to trivalent chromium ratio of 1 to 6. Since the soil samples were speciated for hexavalent chromium, the hexavalent chromium data is compared directly to the hexavalent chromium PRG of 64 mg/kg; the PRG of 450 mg/kg is not relevant when site data present information on the presence of hexavalent form of chromium.
f. Site-Specific Target Levels developed for on-site residents, presented in *Risk Management Plans, Six Former Underground Storage Tank Sites in the Mission Bay Site* (ENVIRON 1996).

Source: ENVIRON International Corporation, *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area*, April 1998, Table 4-1.

lifetime dose, the Industrial PRGs for carcinogenic compounds have been adjusted to account for the limited six-month exposure period. Noncarcinogenic effects, however, can appear over a relatively short time period. Because noncarcinogenic effects can appear over a relatively short time period, and because the potential for noncancer effects is a function of an individual's annual average daily dose (as opposed to a cumulative dose), Region IX Industrial PRGs developed to protect from the onset of noncarcinogenic effects have not been adjusted to account for the limited six-month exposure period.

Consistent with U.S. EPA risk assessment guidance, the reasonable maximum exposure to which individuals could be exposed was determined by calculating the 95% UCL of the arithmetic mean concentration that is contacted over the exposure period. For the evaluation of potential carcinogenic and noncarcinogenic impacts associated with short-term exposures, the reasonable maximum concentration to which individuals could be exposed was estimated by calculating the 95% UCL of the arithmetic mean concentration of the COPIC detected in the exposed soils. This was accomplished by identifying all areas in both the North of Channel and the South of Channel where soils are currently exposed (i.e., not covered by asphalt, concrete, or structures). Exposed soils were identified by examining the boring logs prepared during the soil investigation programs. In addition, aerial photos and visual corroboration from a site walk-through were used. Fifty-seven of the 125 sampling locations in the 303-acre Project Area coincide with areas where exposed soils currently exist. Based on the overall objectives of the sampling program and the methods that were used in selecting the location and density of the samples, the 57 samples collected from the surface soils are sufficient to provide an estimate of the types of exposures that individuals could incur in the short term between now and when the RMP is approved and implemented.

Table I.17 presents the range of concentrations of the arsenic, beryllium, lead, and carcinogenic PAHs detected in the exposed soils, and the estimated 95% UCL of the arithmetic mean concentration in the exposed soils. The concentrations in the soils to which individuals could be exposed correspond to the concentrations detected in the shallowest sample (generally collected from between 0.5 and 1.5 feet below ground surface) collected from each of the 57 borings which were advanced in areas of exposed soils. Also presented in Table I.17 are the Region IX Industrial PRGs. As shown, the Industrial PRGs developed for the protection of cancer have been multiplied by 50, since the exposures that could occur in the immediate short-term six month interval are approximately one-fiftieth of the long-term exposure assumed in the Region IX Industrial PRGs (i.e., 0.5 year/25 years).

As indicated by the data, both the average and 95% UCL concentrations for arsenic, beryllium, lead, and the carcinogenic PAHs are all significantly below both the carcinogenic Region IX Industrial PRGs, adjusted to account for a limited short-term exposure, and the noncarcinogenic Region IX Industrial PRGs. Thus, short-term exposures to the levels of chemicals present across the Project Area would not result in adverse health impacts (either carcinogenic or noncarcinogenic) in individuals potentially exposed to the COPIC in the exposed soils.

TABLE I.17
RANGE OF METALS AND PAHs DETECTED IN EXPOSED SURFACE SOILS: COMPARISON TO USEPA REGION IX PRGs

Compound	Number of Samples	Number of Detections	Detection Frequency (%)	Exposed Soils/a/ Range (mg/kg)	Exposed Soils/a/ Average (mg/kg)/b/	Exposed Soils/a/ 95% UCL (mg/kg)/b/	USEPA Region IX Industrial PRG-Carcinogenic Effects: Adjusted for 6-Month Exposure (mg/kg)/c/	USEPA Region IX Industrial PRG Noncancer Effects (mg/kg)
Arsenic	55	52	95%	ND-247	20	30	120	380
Beryllium	55	30	55%	ND-0.67	0.22	0.24	55	8,500
Lead	55	53	96%	ND-1,780	250	333	1,000/d/	1,000
PAHs-Carcinogenic/e/	55	5	9%	ND-1.8	1.8	2.8	13	4,400 /f/

Notes:
mg/kg = milligrams per kilogram
ND = Not detected.
PRG = Preliminary Remediation Goals
95% UCL = 95% Upper Confidence Limit (UCL) of the arithmetic mean.

a. Corresponds to the shallowest samples collected from any exposed soils (i.e., areas not covered by asphalt, concrete, or structures). All borings considered to represent exposed soils are identified in the Project Area.
b. Consistent with U.S. EPA *Risk Assessment Guidance for Superfund* (RAGS), if the 95% UCL of the arithmetic mean is greater than the maximum detected concentration, then the maximum detected concentration is the level that should be used in estimating human exposures.
c. Corresponds to the Region IX Industrial PRG adjusted to account for the fact that the immediate exposure (prior to implementation of the Risk Management Plan) is expected to occur for approximately 6 months. Because the Industrial PRGs for carcinogenic effects assume a 25-year exposure period, the Industrial PRGs for carcinogenic effects were multiplied by 50.
d. Industrial PRG for lead is not based on carcinogenic effects. Thus, adjustment for 6-month exposure is not appropriate.
e. Represents the sum of all carcinogenic PAHs, converted to Benzo(a)pyrene-equivalents, using the potency equivalency factors recommended by Cal/EPA.
f. Corresponds to the risk-based US EPA Region IX PRG for naphthalene. Naphthalene, which is the lowest of the noncarcinogenic PAH values, is the most appropriate surrogate for noncarcinogenic toxicity of all PAHs.

Source: ENVIRON International Corporation, *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area*, April 1998, Table 4-3.

Comparison of Concentrations in Exposed Soils to Acute Thresholds Developed and Used at Other Sites in California

Chemicals detected in on-site exposed surface soils do not present an acute health threat (defined as due to one visit to a location, or as repeated daily visits over a period of two weeks) to children who could be exposed under short-term, high-exposure conditions. This determination was based on a comparison of the maximum concentrations of the COPIC to acute thresholds for chemical constituents developed to be protective of child populations (0-6 years)./7/ The methods used to calculate acute thresholds have been used and approved by the DTSC at other sites as immediate action levels, and were developed to be protective of short-term exposures to surface soil in a residential setting. Because children often have much greater soil ingestion rates than adults, particularly in relation to their smaller body weight, children are at a greater risk than adults from acute exposures to chemicals in soil. Thus, the acute thresholds were developed assuming that the exposed individual is a child. Acute thresholds developed to be protective of children would simultaneously be protective of adults.

Acute thresholds developed for arsenic, beryllium, lead, and PAHs are presented in Table I.18. As shown, the acute thresholds for arsenic, beryllium, lead, and PAHs are 525 mg/kg, 940 mg/kg, 3125 mg/kg, and 994 mg/kg, respectively. As indicated on Table I.18, even the maximum concentrations of arsenic, beryllium, lead, and PAHs in the exposed soils are all below the acute threshold levels.

Analysis of Potential Adverse Ecological Effects Associated with Current Conditions in the Project Area

As previously described, chemicals present in the soils could potentially impact the health of the ecological environment if terrestrial or nesting avian species come into direct contact with soils which contain elevated levels of chemicals, or if the chemicals in exposed soil were to be released into China Basin Channel or San Francisco Bay through surface water runoff. Additionally, chemicals present in the soil and groundwater could potentially impact the aquatic environment if the chemicals leach from the soil into the groundwater and subsequently migrate to China Basin Channel or San Francisco Bay.

As discussed in the 1990 Mission Bay Final Environmental Impact Report (FEIR), the current and future conditions within the Project Area do not provide a habitat capable of supporting a significant terrestrial or nesting avian wildlife community. Accordingly, potential exposures that terrestrial species could have with soils would not represent a significant effect on the terrestrial wildlife community.

TABLE I.18
COMPARISON OF CONCENTRATIONS IN EXPOSED SOILS TO ACUTE THRESHOLDS

	Exposed Soils		
Compound	**Range (mg/kg)**	**95% UCL (mg/kg)**	**Acute Threshold/a/ (mg/kg)**
Arsenic	ND-247	30	525
Beryllium	ND 0.67	0.24	940/b/
Lead	ND-1780	333	3125
PAHs-Total/c/	ND-19	26	994

Notes:
mg/kg = milligrams per kilogram
ND = Not detected
95% UCL = 95% upper confidence limit of the arithmetic mean.

a. Acute thresholds developed and applied at other sites in California.
b. Using an approach developed by ENVIRON in 1995, and the assumption that the acute toxicity of beryllium is approximately 10 times greater than the chronic toxicity of beryllium (where the chronic toxicity of beryllium is represented by the U.S. EPA chronic Reference Dose of 0.005 mg/kg-day), an acute threshold of 940 mg/kg was developed for this evaluation.
c. Represents the sum of all carcinogenic and noncarcinogenic PAHs. Since the acute threshold was developed to protect against short-term noncarcinogenic effects of the PAHs, all PAHs (carcinogenic and noncarcinogenic combined) were evaluated for their potential to cause acute health effects.

Source: ENVIRON International Corporation, *Technical Memorandum #1, Approach to a Plan for Risk Management*, Mission Bay Project Area, April 1998, Table 4-4.

A screening-level evaluation of the potential impact that the existing soils and groundwater conditions could have on the aquatic environment through the potential leaching of chemicals from the soils, into the groundwater, and the subsequent migration of the groundwater to the nearby China Basin Channel and San Francisco Bay was conducted by ENVIRON was presented in the 1998 Mission Bay South report./8/ The potential for chemicals to leach from the soil into groundwater, including leaching that may have occurred after storms, is reflected in the levels of constituents measured in groundwater. Thus, results of groundwater sampling and analyses provide a basis for estimating the potential impacts on the aquatic environment.

Methodology

The potential for chemicals detected in groundwater in the Project Area to pose a risk to aquatic organisms in adjacent water bodies was evaluated by identifying classes of chemicals of potential ecological concern (COPEC), evaluating the potential for those chemicals to migrate to surface water bodies, and determining whether those chemicals could be released in concentrations sufficient to pose a potential risk to the aquatic organisms. Results of these evaluations were presented in *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel* and *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, prepared by ENVIRON in 1998.

Identification of COPECs

The COPECs were identified by examining the frequency of detection of the chemicals in groundwater, assessing the location of detections relative to the surface water bodies, and examining the soil and groundwater data to evaluate whether significant source areas existed for the detected chemicals. The frequency of detection was an important consideration in a screening-level evaluation because many of the chemicals detected in the Project Area were detected in a small percentage of the samples. As noted by ENVIRON, results of U.S. EPA studies indicate that infrequently detected chemicals may be artifacts in the data and, therefore, may be unrelated to past operations or disposal practices. In such cases, U.S. EPA recommends that such chemicals could be eliminated from further consideration in the risk assessment. Five percent is a commonly used guideline when detection frequency is used as a criterion for determining whether a chemical is likely to be an artifact and should be excluded from the quantitative risk assessment. Another important aspect of the evaluation was whether a reported detection, however infrequent, would represent a significant risk if the detection actually represented the presence of a chemical. To address this uncertainty, U.S. EPA in their *Risk Assessment Guidance for Superfund* (RAGS) establishes that fate and transport considerations and modeling can be used to determine if infrequently detected chemicals should be excluded from further evaluation in the risk assessment.

Using the methodology described above, naphthalene, certain VOCs, metals, and petroleum hydrocarbons were identified as COPECs.

Evaluation of Potential Ecological Risks

The ecological risk evaluation included examining the frequency of detections of COPECs in groundwater in conjunction with the proximity of the detected constituents relative to nearby surface water bodies, comparing the concentrations of the detected chemicals to marine water quality standards applicable to San Francisco Bay, and estimating and modeling the attenuation of groundwater concentrations as they flow toward China Basin Channel and San Francisco Bay.

As noted by ENVIRON, no criteria have been developed for the assessment of risk to ecological receptors in the aquatic environment based on comparisons to groundwater chemical concentrations. However, ambient water quality criteria for the protection of marine (saltwater) organisms are used as a conservative means of evaluating the potential risk to surface water organisms. Aquatic criteria used for comparisons in the analysis included the chronic and acute water quality objectives (WQOs) published in the RWQCB's *Water Quality Control Plan* for the San Francisco Bay. The WQOs correspond to the U.S. EPA Ambient Water Quality Criteria (AWQC) for Saltwater. Where WQOs are not specified in the Water Quality Control Plan, the U.S. EPA Ambient Water Quality Criteria are used as the appropriate WQOs. WQOs have been established for most VOCs, metals, and several PAHs. The chronic WQOs are chemical-specific concentrations in the marine surface water body that are considered protective of the majority (i.e., 90%) of aquatic organisms over a given time period, typically four days. The U.S. EPA AWQC and Basin Plan WQOs are developed from an extensive database that includes toxicity information for multiple phyla and species, and the criterion is based on the most sensitive of the species and test endpoints (e.g., reproductive effects) evaluated. The WQOs are conservative in that they assume that the aquatic organisms are present in the affected water. However, because no marine aquatic organisms have been identified in groundwater at Mission Bay, comparison with such criteria is considered overly conservative with respect to contaminants in groundwater at Mission Bay.

Since metals were detected consistently across the Project Area and appear to be associated with the composition of the fill rather than a specific, identifiable source area, the potential impact of the metals on the aquatic environment has been evaluated by estimating the average concentration entering each surface water body. The potential effects of metals on the near-shore aquatic environment were evaluated for Mission Bay South by estimating the average chemical concentrations in groundwater located in a 500-foot-wide zone adjacent to China Basin Channel and San Francisco Bay and comparing the average concentrations to aquatic criteria. The use of the 500-foot-wide averaging zone was considered an appropriate method for evaluating the potential effects of metals on adjacent water bodies in Mission Bay South for existing conditions because concentrations in the 500-foot-wide zone are generally slightly greater than the average concentrations for the entire Mission Bay South area. In Mission Bay North, all data points except two (which are located approximately 800 feet from China Basin Channel) are located within the 500-foot-wide zone of China Basin Channel. The average concentrations of metals from all data points in Mission Bay North were used to provide a more comprehensive analysis than would occur from exclusion of the data from the two data points outside the 500-foot zone./9/

Because WQOs have not been established for TPH, toxicity information was derived from recent scientific peer-reviewed literature to provide a basis for assessing potential ecological risk to marine aquatic organisms in the near-shore environment of China Basin Channel and San Francisco Bay. As discussed in the 1998 Mission Bay South report, the majority of efforts to characterize adverse effects of petroleum products to marine aquatic organisms have been associated with toxicity testing of fresh crude oil and refined products in anticipation of surface-water oil spills. A variety of approaches have been used to evaluate potential effects, including preparation of emulsions, elutriates from petroleum-containing soil, and water-soluble fractions. To the extent possible, ENVIRON relied on the results of studies using water-soluble fraction methods that reflect dissolved constituents because the data would be more analogous to groundwater conditions in Project Area. This was considered a conservative approach because the weathered hydrocarbons contain reduced soluble constituents. The results of other water-soluble fraction studies were also used to identify appropriate EC25 values for comparison purposes. (EC25 represents the concentration at which 25% of the test species were affected and are based on a water-soluble fraction from fresh fuel.) Such methods were considered an appropriate and conservative basis for comparisons because they are based on fresh refined products, current toxicity test methods, and rely on sub-lethal developmental endpoints.

Tidal Influence Study

To supplement the direct comparison of measured groundwater concentrations to WQOs or TPH toxicity criteria, the results of a tidal influence study performed as part of the 1997 Mission Bay South investigation were used to determine the extent to which the concentrations in groundwater could be reduced as groundwater adjacent to China Basin Channel and San Francisco Bay moves toward the tidally influenced surface-water bodies that border the South of Channel area to the north and east. The results of the tidal influence model presented in the 1998 Mission Bay South report indicate that the concentration of chemicals will be reduced on average by 10-fold as groundwater flows within the last 50 feet toward China Basin Channel and the San Francisco Bay./10/ Therefore, the average concentration of metals in groundwater prior to entering the China Basin Channel and the San Francisco Bay would actually be lower than the chronic water-quality criteria. A brief description of the tidal influence model, its applicability to both the North of Channel and the South of Channel areas, and a discussion of the output is provided below.

The predictive model simulates how the tidal fluctuations in a surface water body, like the Bay or China Basin Channel, cause water elevations within adjacent groundwater systems to rise and fall and reduce chemical concentrations in the groundwater. Depending on the permeability of the adjacent groundwater system, the tidal effect will extend from a few tens of feet to over a hundred feet inland from the shoreline. As the surface water levels rise, water flows into the channel bank causing groundwater levels to also rise. When surface water levels then decline, water stored in the channel bank drains back to the surface water body. This process substantially reduces the concentration of chemical constituents before water enters the Bay or Channel. The interaction of surface water with the groundwater system occurs in the area where the tidal influence is pronounced. For the type of soils present at the Mission Bay Project Area, this includes areas within 50 feet of the shoreline.

The large concrete box sewers that roughly parallel China Basin Channel on the north and south sides appear to impede groundwater flow from upgradient areas into the Channel. These conditions were discussed in the 1997 Mission Bay North report and the 1998 Mission Bay South report prepared by ENVIRON./11/ The box sewer on the south side is about 100 feet from the Channel, and is over 200 feet from the Channel to the north. While these box sewers appear to impede the general flow of groundwater toward the Channel, their presence should not affect the tidally influenced attenuation which principally occurs within 50 feet of the shoreline. The attenuation produced by tidal fluctuations reduces chemical concentrations that exist in groundwater that lies between the box sewers and the Channel edge. The net effect of the box sewers is to simply reduce the amount of groundwater that enters this area rather than affecting the attenuation process itself.

Tidal fluctuations in the surface water body (the Bay or China Basin Channel) result in the attenuation and reduction of groundwater chemical concentrations through processes of dilution, dispersion, and sorption, all of which occur within the groundwater system prior to groundwater discharging into the Bay or China Basin Channel. The hydraulic interaction of surface and groundwater affects concentrations of both inorganic and organic COPECs that have been identified for the Mission Bay Project Area. The tidally influenced attenuation that reduces groundwater chemical concentrations before groundwater discharges to a surface water body will apply to the North and South of Channel areas because the hydraulic driving forces for the attenuation are common to both areas as are COPECs such as metals and TPH constituents. In Mission Bay North, soils are less permeable adjacent to China Basin Channel which results in tidal fluctuations occurring less far inland and in causing the attenuation process to occur closer to the shoreline than in other areas with higher permeable soils. The 1997 Mission Bay North report reported some fluctuations in groundwater levels in response to tidal variations but dynamic responses were not observed at distances equal to or greater than 70 feet from the shoreline./12/ Monitoring well MW-5 was the well closest to the shoreline to be used in the study. MW-5 is about 70 feet from the shoreline. The tidal attenuation model predicts that the effects of the tidal influence will be in a zone of less than 50 feet inland from the shoreline given the types of soils that are present along the shoreline in the North of Channel area. Therefore, the observations of small groundwater level changes at distances greater than 50 feet from the shoreline reported in the 1997 Mission Bay report is entirely consistent with the model's prediction that the tidal influence and attenuation zone will be active in an area less than 50 feet from the shoreline./13/

The quantification of the attenuation of groundwater chemical concentrations as groundwater approaches the San Francisco Bay or the China Basin Channel was estimated on a one-dimensional basis and is conservative because it does not allow for lateral dispersion, dilution, or sorption that occur in a three-dimensional system. If full three-dimensional mixing and attenuation were taken into account, the attenuation factor and the associated reductions in groundwater chemical concentrations would be greater than the 10-fold reduction presented above.

METHODOLOGY TO EVALUATE HUMAN HEALTH RISK DUE TO EXPOSURE TO UNCONTROLLED CONSTRUCTION-GENERATED DUST

A screening-level risk assessment was prepared by ENVIRON to assess human health risks that could occur during construction activities. The following subsection describes the methodology and assumptions used in that analysis of the potential human health impacts associated with exposure to dust emissions during construction activities at the Project Area, absent implementation of control measures. A screening-level evaluation was conducted that assessed the types of effects that could be encountered in a reasonable worst-case uncontrolled dust emission scenario. That evaluation, discussed below, concluded that the risks to nearby populations, even if continuously exposed to dust generated for 20 years, would be below the target levels specified by the RWQCB for the Project Area. The risk evaluation was conducted following standard regulatory risk assessment guidelines developed by the DTSC and U.S. EPA.

Chemicals of Concern

The screening-level human health assessment evaluated all chemicals found on-site capable of migrating with dust, absent implementation of control measures. Exposure to volatile organic compounds was not considered because volatile constituents generally do not adsorb to dust. Further, since pesticides and PCBs were detected in less then 1% of the samples, they were not included in the quantitative analysis.

Asbestos was detected in numerous samples across the South of Channel Area. Asbestos is naturally occurring in serpentine rock, found in many areas of California; the rock's presence in the fill is likely attributable to natural formations which originated in other areas of the city (such as Irish Hill) and were used to fill in the Mission Bay. The risk associated with exposure to asbestos fibers is related to the potential for the asbestos in the rock to be friable and become airborne and the size of the airborne fiber. Because it is not known to what extent the asbestos in the fill could become airborne, nor how much of any asbestos could be in the respirable size range, it is not typically quantitatively evaluated at construction sites and consequently has not been included here in this screening-level quantitative evaluation. Asbestos-containing rock is commonly found at many construction projects in San Francisco and other areas of California. Any potential impacts associated with emissions of respirable asbestos, however, would be managed as recommended by BAAQMD for PM_{10} emissions. Further, workers engaged in the construction activities within the Project Area will be subject to asbestos construction standard (Title 8 CCR Section 1529), if applicable.

Potentially Exposed Populations, Exposure Pathways, and Exposure Assumptions

Populations that could be exposed to the chemicals adsorbed to dusts during construction activities, absent implementation of control measures, include any in the nearby vicinity of the area being developed. As described above, the nearby populations include those populations that would be directly adjacent to the area being developed, in addition to populations located further away from the specific development area. For this screening-level analysis, ENVIRON assumed that nearby populations exposed to high dust levels could be either workers or residents and that the nearby populations would be located directly adjacent to the area under construction. The residential population assumption includes both adults and children. Risks to the construction worker engaged in the development of the Project Area have not been calculated since exposures to these workers would be controlled through Cal/OSHA requirements.

The primary pathway through which exposure to dusts could occur is the inhalation pathway. Exposure to dusts can also occur through secondary exposure pathways, such as the deposition of dusts onto nearby soils and subsequent dermal contact with the soils. The analysis prepared by ENVIRON provides a worst-case estimate of the exposures that could occur through the primary inhalation pathway. Exposures due to the secondary pathways would be small relative to the worst-case exposures that could occur from the primary inhalation pathway and would only minimally contribute to risks associated with the primary pathway.

The development of the Project Area is assumed to be complete by the year 2015. For purposes of this screening-level human health risk evaluation, ENVIRON assumed that the nearby populations would be located directly adjacent to the area under construction, that they could be exposed to high dust levels for eight hours per day, five days per week, 50 weeks per year, for the entire 20-year period. The basis for establishing the high dust levels used in this risk evaluation is described below. The exposure frequency and duration assumptions overestimate exposure significantly since it is highly unlikely that any one individual would be continuously adjacent to a construction area for the entire 20-year development period. It is more likely that an individual's exposure to construction dust, if uncontrolled, would occur periodically over a very short time period. For these reasons, the uncontrolled exposures estimated in the screening-level evaluation were used for purposes of conservative analysis and represent significant overestimates of the actual exposures that might be realized by individuals within the vicinity of the Project Area.

Toxicity Values

Both carcinogenic and noncarcinogenic effects were considered in evaluating the potential effects associated with uncontrolled dust emissions during construction activities. Further, as recommended by Cal/EPA, lead was evaluated using a separate mathematical model, the Cal/EPA Lead Spread Model. The specific toxicity values used in the screening-level evaluation were those recommended by the Cal/EPA and U.S. EPA. In the absence of chemical specific criteria from Cal/EPA or the U.S. EPA, other regulatory or scientific sources were utilized. For example, procedures established by the Massachusetts Department of Environmental Protection were used to identify indicator chemicals for TPH toxicity.

Exposure Concentrations

Estimating the concentration of chemicals in dusts to which nearby populations could be exposed involved the following two steps: 1) determining the representative concentration of each chemical in soil; and 2) determining the concentration of respirable particulate matter which could be generated during the excavation activities to which individuals could be exposed. Respirable particulate matter is defined as particulates less than 10 microns in diameter (PM_{10}). The analysis performed for each of these steps is summarized below.

<u>Representative Concentrations in Soil</u>

The representative chemical concentrations in soil were estimated from the results of the 1997 Mission Bay South investigation. Consistent with U.S. EPA recommendations for risk assessment, the representative chemical concentration in soil was assumed to be the 95% upper confidence limit (UCL) of the arithmetic mean concentration detected during the Mission Bay South soil investigation.

All soil laboratory analytical data collected from Mission Bay South were included in the screening-level evaluation. Use of these results for the analysis was considered conservative and applicable to the entire Project Area since the concentrations of chemicals in Mission Bay South were consistently greater than those found in Mission Bay North.

Dust Levels Generated During Construction Activities

Construction-related emissions of PM_{10} are generally temporary in duration. Furthermore, the emissions result from a variety of activities and are highly dependent on several factors, such as the specific activities taking place, weather and climate, and soil conditions. This multitude of factors makes estimation of emissions difficult, and often the estimates are inaccurate. Thus, BAAQMD recommends that, for the purposes of a California Environmental Quality Act (CEQA) evaluation of PM_{10} emissions, the emphasis of the analysis should focus on the "effective and comprehensive implementation of control measures rather than detailed quantification of emissions." For this reason, the analysis did not include detailed quantification of PM_{10} emissions.

Rather than conducting detailed emissions estimates, nearby populations (defined as populations directly adjacent to the construction zone) were assumed to be exposed for an entire 20-year period to a worst-case, annual average, airborne dust concentration of 250 micrograms per cubic meter ($\mu g/m^3$) respirable dust generated from construction activities, absent implementation of control measures. The rationale for this assumption is provided below.

Based on the information in the scientific, peer-reviewed literature as well as recommendations provided by DTSC, the on-site ambient dust concentration directly within the construction zone during dust-generating activities was assumed to be 1000 $\mu g/m^3$ of PM_{10}. Because only certain activities associated with the development of a parcel would actually consist of significant dust-generating activities, ENVIRON assumed that dust-generating activities would occur approximately 25% of the total construction time. Thus, the annual average level of PM_{10} in the ambient air to which nearby populations (i.e., populations directly adjacent to the construction zone) would be exposed for an entire 20-year period was assumed to be 250 $\mu g/m^3$ of PM_{10}. This value is considered to be extremely conservative; the actual concentrations to which an individual could be exposed likely will be much lower for the following reasons:

- The figure of 1,000 $\mu g/m^3$ of PM_{10} was based on a review of typical concentrations of dust on active construction sites, where ambient concentrations have been measured at levels such as 150 $\mu g/m^3$ of total suspended particulate (TSP), 450 $\mu g/m^3$ of PM_{10}, and 1,000 $\mu g/m^3$ of PM_{10}. While it is possible that certain activities could result in periodic ambient dust levels of 1,000 $\mu g/m^3$ within the construction zone, it is highly unlikely that the average concentration would be as high as 1,000 $\mu g/m^3$ during the periods of time when dust-generating activities are occurring.

- Dust levels outside of the construction zone would be significantly lower than the dust levels within the construction zone as the distance from the dust-generating activity increased.
- Specific soil conditions, such as moisture content and particle size distribution, will affect the rate at which dust is generated.
- Dust levels in the indoor environment, where the nearby populations would be spending the majority of their time, would be significantly lower than the levels that could be present outdoors.
- A person would only be exposed to dust from the construction activity for the percentage of time when the person was downwind of the activity. Based on variability in both wind direction and wind speed, a person would only be directly downwind of the construction zone for a fraction of the year.
- Precipitation will significantly reduce dust emissions from construction activities.
- ENVIRON assumed that dust-generating activities would occur 25% of the total 20 year construction time. Considering the various different construction activities associated with the development of the Project Area, such as paving the building foundations, structural work, and exterior and interior detailing, it is likely that dust-generating activities will occur for significantly less than 25% of the total construction time.
- Since the total development of the Project Area is expected to occur over a 20- year period, it is highly unlikely that any one individual would be exposed continuously to dust emissions generated from the project development for that 20-year period.

POST-DEVELOPMENT RISK EVALUATION METHODOLOGY

A human health and ecological risk evaluation was prepared by ENVIRON for constituents present in the soil and groundwater in the Mission Bay South area. Soil in Mission Bay South is principally fill materials placed in the late 1800's and early 1900's, largely comprised of soil and debris originating in other parts of San Francisco. The risk evaluation was conducted following the standard regulatory risk assessment guidelines promulgated by the California Environmental Protection Agency (Cal EPA) and the United States Environmental Protection Agency (U.S. EPA). The human health risk evaluation was conducted to assess whether the levels present in the soil and groundwater in the Mission Bay South area would present a risk to the future populations that may be present after project completion. Similarly, the ecological risk evaluation was conducted to ascertain whether the constituent levels present in the soil and groundwater would pose a risk aquatic organisms in nearby China Basin Channel and San Francisco Bay after project completion. A brief description of the methodology, assumptions, and conclusions of the human health and ecological risk evaluation are presented below.

Human Health Risk Evaluation

Introduction

The human health risk evaluation was conducted by developing site-specific target levels (SSTLs) for each of the chemicals present in the soil and groundwater to which humans may be exposed. The SSTLs were developed using standard risk assessment techniques and regulatory assumptions; they represent the concentrations of individual chemicals that could be present in the soil or groundwater that are protective of the human populations that might be present in Mission Bay South. A comparison of the concentration of chemicals detected in the soil and groundwater to the health-based SSTLs provides the basis for determining whether the chemicals present in the Mission Bay South area would pose a risk to human health and provides a basis for identifying areas where risk management measures may be needed. The SSTLs developed for Mission Bay South were applied also to Mission Bay North because the populations that would be present in Mission Bay North at build-out and the type of development would be generally the same as that proposed for Mission Bay South./14/

The SSTLs were developed using methods consistent with the Risk-Based Corrective Action (RBCA) methodology, as developed by the American Society for Testing and Materials (ASTM) and described in ASTM E-1739, *"Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, 1995."* RBCA represents a streamlined process for assessing and responding to releases of chemicals, including hydrocarbons and, therefore, is appropriate for assessing potential risk due to contaminants that have been detected in soil and groundwater in the Project Area. The RBCA approach integrates U.S. EPA risk assessment practices with traditional site investigation and remedy selection activities in order to determine cost-effective measures for protection of human health and environmental resources. ENVIRON used the RBCA Guidance, combined with specific methods and assumptions developed and/or recommended by U.S. EPA, San Francisco Regional Water Quality Control Board (RWQCB), Cal/EPA's department of Toxic Substances Control (DTSC) and the U.S. EPA in the development of SSTLs.

The human health risk evaluation was conducted under the assumption that Risk Management Plan (RMPs) would be used to guide the development and subsequent management of activities in the Project Area with respect to contaminated soil and groundwater. The RMPs would provide a framework to manage residual chemicals in soil and groundwater in a manner consistent with intended land use and to be protective of both human health and the environment.

The development plans for the Project Area would result in all currently exposed soils being covered by parking areas, sidewalks, roadways, building foundations, landscaping, or public parks, Further, all landscaping and public parks would consist of horticultural-quality fill on top of existing soil. Thus, all future residents, commercial and retail workers, and visitors who may be present in the Project Area would not have direct contact with native soil. The only future populations that may have direct contact with the native soils and groundwater would include construction workers involved in the development of the property, or future maintenance workers involved in subsurface work, such as sewer pipe repair. Exposures incurred by the construction or maintenance workers would be mitigated through the implementation of a worker health and safety plan and the establishment of worker health and safety training requirements. The health and safety training requirements and the development and implementation of a health and safety plan would also be delineated in the RMPs prepared for each development site.

Potentially Exposed Populations and Pathways

To determine whether the levels of constituents present in the soil and the groundwater would pose a health risk to the human populations that may be present in the Mission Bay South area under the proposed project, it is necessary to identify both the populations that may potentially be exposed to the chemicals present in the area and the pathways by which exposures may occur.

Identification of the potentially exposed populations requires evaluating the proposed human activity and land use patterns planned for the proposed project. Once the potentially exposed populations are identified, the complete exposure pathways by which individuals may contact chemicals present in the soil and groundwater must be determined. An exposure pathway is defined by U.S. EPA as "the course a chemical or pollutant takes from the source to the organism exposed." As noted in the 1998 Mission Bay South report, the U.S. EPA defines exposure route as "the way a chemical or pollutant enters an organism after contact." A complete exposure pathway for chemicals on a site requires four key elements: chemical sources; migration routes (i.e., by mouth, skin, or inhalation). An exposure pathway is not complete unless all four elements are present.

Conceptual Site Model

A Conceptual Site Model is used to show the relationship between chemical sources, exposure pathways, and potential populations (often referred to as "receptors"). The Conceptual Site Model identifies the following: 1) plausible chemical sources; 2) the potentially impacted media; and 3) the potential receptors and their exposure routes for contacting the impacted media. The source-pathway-receptor relationships provide the basis for quantitative exposure assessment. Complete source-pathway-receptor relationships are included in the quantitative risk assessment and those that are incomplete are screened from further evaluation. There are many plausible historical sources of chemicals in the Project Area. First, shallow soils across most of the Project Area are comprised of fill materials placed beginning in the mid-1800's to the early 1900's. The fill materials contain a variety of chemicals, particularly metals, depending on the precise origin history of the fill area within Mission Bay being investigated. Additionally, sources of chemicals may have included spills and/or leaks from underground storage tanks (USTs) or above-ground storage tanks (ASTs), and releases from numerous industrial facilities, such as the bulk oil storage facility, underground pipelines, lumberyards, railroad yards, auto repair shops, and shipbuilding facilities. Once released into the surface or subsurface soils, the potential secondary release mechanisms include the following:

- Volatilization of constituents into ambient (i.e., outdoor) or indoor air;
- Migration of constituents down to the groundwater;
- Volatilization of constituents in groundwater up through the soil column into ambient or indoor air; and
- Migration of constituents in groundwater into surface water.

Exposed Populations

The proposed redevelopment of Mission Bay North and Mission Bay South would include a variety of land uses, including: multi-family housing; commercial, entertainment, and retail uses; a hotel; a possible police and fire station; open space and parks; and office/research and development facilities. Child care centers could also be located within each of the major land use designations, and it is anticipated that a single site anywhere in the Project Area could be developed as a school, most likely a primary school. In addition, approximately 43 acres within the Mission Bay South would be transferred to the University of California San Francisco (UCSF) for construction of additional research space. Based on the present development plans, the populations that would be present in the Project Area include the following:

- On-site and off-site retail and commercial workers (including maintenance and construction workers);
- On-site and off-site residents (both adults and children);
- Park visitors (both adults and children);
- Visitors to and shoppers at commercial and retail establishments;

- Child care and school facility attendees (both adults and children); and
- Students, faculty, and support staff at UCSF.

Maintenance and construction workers would be present in the future and may have occasion to dig into the subsurface soil; their exposure and protection would be addressed as part of the RMPs to be prepared for each development site.

Exposure Pathways

Given the stated development plans, the potential human populations may come into contact with constituents present in the soils or groundwater through the following pathways:

- Inhalation of vapors from soil
  - vapors present in ambient (i.e., outdoor) environment
  - vapors that have accumulated in indoor spaces
- Inhalation of vapors from groundwater
  - vapors present in ambient (i.e., outdoor) environment
  - vapors that have accumulated in indoor spaces

Because the existing soil and other areas would be covered by buildings, paving, or landscaping in raised beds, access to the existing native soil by commercial workers, residents, park visitors, or any other populations in the Project Area would be precluded. An important component of this conclusion is that the project would not include single family residences with frontyards or backyards where soil disturbance or unrestricted access to the native subsurface soil could occur. RMPs are proposed to specifically include measures to prohibit uncontrolled direct contact with native soil and groundwater. Thus, direct contact with existing soil in the Project Area and direct contact with groundwater as a result of subsurface digging are considered "incomplete pathways" for future commercial workers, residents, or park visitors.

The shallow groundwater is not suitable as a drinking water source because of limited quantity and high total dissolved solids (TDS). Furthermore, any future use of the groundwater for commercial or industrial purposes is proposed to be prohibited as a condition of site development, and would be clearly specified as such in RMP. Thus, exposure to constituents in groundwater through ingestion and dermal contact is considered an incomplete exposure pathway in the analysis.

The only future populations that may have direct contact with the soils and groundwater would be construction workers involved in the development of the property, or future maintenance workers involved in subsurface work, such as sewer pipe repair. Exposures incurred by the construction or maintenance worker would be minimized through the implementation of a worker health and safety plan and the establishment of worker health and safety training requirements. Exposures to nearby residents/commercial workers that may occur during the development of the Project Area would be addressed in the RMPs.

Chemicals of Potential Concern

The selection of chemicals included in the health risk evaluation was based upon the Project Area history, the analytical results from the soil and groundwater investigations conducted in Mission Bay South, and the pathways through which exposures to the chemicals may occur.

The groups of chemicals that were detected in the soil and/or groundwater include the following:

- Trace levels of pesticides;
- Other semivolatile organic chemicals (including polycyclic aromatic hydrocarbons (PAHs), and trace levels of di-n-butylphthalate, phenol, and methylphenols)
- Various volatile organic chemicals;
- Metals;
- Asbestos; and
- Total petroleum hydrocarbons (TPH).

Future populations in the Project Area may be exposed to chemicals through the inhalation of vapors that migrate from the soil or groundwater, up through the soil column, into the indoor or outdoor air. Accordingly, SSTLs have been developed for all volatile chemicals detected in either the soil or groundwater. Additionally, since petroleum hydrocarbons consist of a complex mixture of a wide range of chemicals, including some in the volatile range, SSTLs have been calculated for TPH-gasoline, TPH-diesel and TPH-motor oil using an "indicator chemical" approach. The indicator chemical approach for the three ranges of TPH has been used and approved by regulatory agencies, including the DTSC and the RWQCB at other sites in California./15/

In summary, the compounds within the Project Area for which SSTLs have been calculated include all volatile organic chemicals that were detected in the soil and/or groundwater and the three ranges of TPH. It was assumed that there would be no exposures to the nonvolatile constituents detected in the soil and groundwater in the Mission Bay South area, such as metals, asbestos, trace levels of pesticides and PAHs, because existing soil would be covered either by buildings, paving, or additional soil.

Fate and Transport Modeling

In order to determine the concentration of the constituents present in the soil and groundwater to concentrations that would be expected in the indoor and ambient air, a U.S. EPA-approved transport computer model, VLEACH 2.2a, was used to develop transfer coefficients. VLEACH is a one-dimensional finite-difference vadose zone leaching model simulates the movement of organic constituents as they migrate from the original source media (i.e., soils) to other media (i.e., air and groundwater). An indoor- and outdoor-box model is then used to predict the concentrations of the chemicals that would be present in the indoor and outdoor air. The chemical-specific soil-to-air transfer coefficient is defined as the ratio of the concentration of a chemical in air to that in soil. Similarly, the groundwater-to-air transfer coefficient is the ratio of the concentration of a chemical in air to that in the groundwater. The fate and transport modeling conducted for estimating concentrations present in ambient air assumed that barriers (e.g., pavement, roads, or topsoil) do not exist. Fate and transport modeling used to estimate indoor concentrations of volatiles was conducted using standard regulations assumptions regarding building foundations.

Toxicity Assessment

Chemicals are evaluated for their potential health effects in two categories, carcinogenic and noncarcinogenic. Consistent with regulatory guidance, both carcinogenic and noncarcinogenic effects were considered in the development of the SSTLs for soil and groundwater. The specific toxicity values used in development of the SSTLs were those recommended by the Cal/EPA in "Memorandum to Cal/EPA Departments, Boards, and Offices from Standards and Criteria Work Group, Office of Environmental Health Hazard Assessment re: California Cancer Potency Factors" dated November 1994 and the U.S. EPA's Integrated Risk Information Service (IRIS). In the absence of chemical-specific criteria from Cal/EPA or the U.S. EPA, other regulatory or scientific sources were used. For example, the Massachusetts Department of Environmental Protection *Interim Final Petroleum Policy: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter* (1994) was used to identify indicator chemicals for TPH toxicity.

Development of Health-Based Site-Specific Target Levels

The development of the soil and groundwater SSTLs was based on the relationship between the intake level for the particular compound, the toxicity of the compound and target levels of risk. Consistent with current regulatory policy at both the RWQCB and the Cal/EPA's DTSC, the cancer risk criterion used for the evaluation is 10 in 1 million (1×10^{-5}). For noncancer health hazards, a target hazard index (HI) of one (1) is used. The basic methodology used to derive the SSTLs for the selected chemicals of concern was based on guidance provided in the four documents listed below./16/

- American Society for Testing and Materials, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM-E 1739-95, 1995.
- U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A), Interim Final*, EPA/540/1-89/002, December 1989.
- U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual* (*Part B: Development of Risk-Based Preliminary Remediation Goals*), Publication 9285.7-01B, December 1991.
- Massachusetts Department of Environmental Protection, Office of Research and Standards, *Interim Final Petroleum Policy: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter*, June 1994.

The SSTLs are based on the relationship between the intake level for the particular compound, the toxicity of the compound, and an established level of risk (i.e., a criterion or threshold). To estimate the concentration of a given chemical that corresponds to an established health risk-based criterion, chemical exposures are quantified using mathematical modeling. The quantitative estimates of exposure are then combined with a toxicity value for that chemical to calculate the concentration of chemical that could be present that corresponds to the established risk criterion. A comparison of the concentration of chemicals detected in the soil and groundwater to the health-based SSTLs provides the basis for determining whether the chemicals present would pose a risk to human health. The model establishes the relationship between the concentration of a chemical in the soil or groundwater and the concentration that would be present in the air.

The SSTLs shown in Tables I.19 and I.20 represent the theoretical concentration of each chemical that could be present in the soil and groundwater and that would not exceed established risk criteria (i.e., cancer risk level of 10 in 1 million and a Hazard Index of 1), and therefore, would be protective of human health. As indicated in Table I.19, many of the SSTLs calculated to protect

TABLE I.19
COMPARISON OF STRICTEST SOIL SITE-SPECIFIC TARGET LEVELS (SSTLs) AND MAXIMUM DETECTED SOIL CONCENTRATIONS FOR MISSION BAY PROJECT AREA /a/

Chemical	SSTL Future On-Site Resident[b] Adult (mg/kg)		SSTL Future On-Site Resident[b] Child (mg/kg)		Maximum Detected Soil Concentration (mg/kg) Mission Bay North	Maximum Detected Soil Concentration (mg/kg) Mission Bay South
TPH-Gasoline	SAT	(14,000)	SAT	(1,200)	ND	490
TPH-Diesel	SAT	(150,000)	SAT	(28,000)	240	12,000
TPH-Motor Oil	SAT	(> 1,000,000)	SAT	(790,000)	2,800	4,300
1, 1, 1-Trichloroethane	SAT	(74,000)	SAT	(6,300)	ND	ND
1, 1, 2-Trichloro-1, 2, 2-trifluoroethane	SAT	(> 1,000,000)	SAT	(660,000)	ND	0.0082
1, 1-Dichloroethane		460		460	ND	ND
1, 2-Dichloroethane (cis)	SAT	(2,600)		220	ND	ND
1, 2-Dichloroethylene (trans)	SAT	(5,200)		450	ND	ND
2-Butanone (MEK)	SAT	(770,000)	SAT	(73,000)	ND	0.12
2-Hexanone		1,800		150	ND	0.016
Acetone	SAT	(310,000)		29,000	0.071	0.77
Benzene		26		26	ND	0.27
Carbon disulfide	SAT	(52,000)	SAT	(4,400)	ND	0.043
Chlorobenzene	SAT	(5,300)	SAT	(460)	ND	ND
Chloroform		140		140	ND	0.0062
Ethylbenzene	SAT	(75,000)	SAT	(6,400)	ND	2.7
m & p-Xylene(s)	SAT	(530,000)	SAT	(45,000)	ND	8.0
Methylene chloride		780		780	ND	0.11
o-Xylene	SAT	(530,000)	SAT	(45,000)	ND	4.9
Styrene	SAT	(78,000)	SAT	(7,900)	ND	0.051
Tetrachloroethylene (PCE)	SAT	(120)	SAT	(120)	ND	0.011
Toluene	SAT	(30,000)	SAT	(2,600)	ND	4.3
Trichloroethylene (TCE)		260		160	ND	0.11
Trichlorofluoromethane	SAT	(77,000)	SAT	(6,600)	ND	0.0050
Vinyl Chloride		10		10	ND	ND

Notes:
mg/kg = milligrams per kilogram
ND = chemical not found above laboratory detection limits
SAT = The calculated SSTL exceeds soil saturation limit

a. See discussion under "Potential Effects on Human Health After Development."
b. The SSTL indicated in parentheses represent an SSTL that is greater than the soil saturation limit for that compound. These SSTLs, even if greater than the soil saturation limit, represent a conservative, health-protective estimate of the concentration of chemical that can be present in the soil without exceeding the established risk criteria, and has been provided in order to estimate the cumulative risk associated with the presence of multiple chemicals. See text under "Human Health Risk Assessment" for further explanation of the SSTLs.

Source: ENVIRON International Corporation, Addendum 1 to the *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, April 1998, Table 5-6.

human health exceed the soil saturation limit (the maximum amount of that chemical that can be in soil, indicated by an "SAT") for that compound. Similarly, many of the SSTLs in Table I.20 exceed the solubility limit (the maximum amount that can be dissolved in groundwater, indicated by an ">S") for that particular compound. For these situations, the health-based SSTL is indicated in parentheses following the "SAT" or ">S" notation. An SSTL value not preceded by an "SAT" or ">S" does not exceed its soil saturation limit or solubility limit. When the health-based SSTL for a compound exceeds the soil saturation limit or the solubility limit for that compound, the presence of saturated soil or groundwater does not, itself, constitute a significant risk to human health. For example, the soil saturation limit for o-xylene is 82 mg/kg. The soil SSTL for the future onsite resident child, however, is 45,000 mg/kg. Thus, the presence of xylene-saturated soil assuming that the measured concentrations are below 45,000 mg/kg, would not adversely impact the health of the child resident exposed under the conditions assumed in this evaluation./17/

Many of the uncertainties in the exposure assumptions, combined with the toxicity assumptions, overestimate the potential risk. This results in SSTLs that are lower than those required to protect public health. Because the SSTLs are based on the risk assessment principles and basic methods described in the documents listed above, the results of the risk assessment and the risk-based target levels presented are directly comparable to the results of other risk assessments prepared following the basic principles identified in U.S. EPA's RAGS Manual. Both the U.S. EPA and Cal/EPA risk assessment guidelines are based on RAGS principles. More specifically, the methods of calculating a lifetime incremental probability of cancer for carcinogenic chemicals and the methods of calculating a hazard index as described in RAGS is the same core evaluation used in the calculation of the SSTLs prepared for Mission Bay South. The method used for selecting chemicals for risk assessment was based on chemical selection criteria outlined in RAGS, and the toxicity factors used in the document are the same factors used by the U.S. EPA and Cal EPA. The approach used here to develop toxicity factors, when U.S. EPA and Cal EPA toxicity factors are lacking, is the same basic indicator chemical approach described by the U.S. EPA in RAGS, supplemented by specific recommendations for the selection of indicator chemicals recommended by the Massachusetts Department of Environmental Protection. The exposure quantification element of the evaluation was based on the concept of Reasonable Maximum Exposure (RME) described in RAGS. According to the concept of RME, risk assessments should be designed to quantify a level of exposure that would capture 90 to 95% of the exposed population, so only 5 to 10% of the population would have an exposure greater than that quantified in the risk assessment. Quantifying an RME level of exposure is typically achieved through the use of default exposure assumptions listed in U.S. EPA's "Supplemental Guidance - Standard Default Exposure Factors" included in *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B: Development of Risk-Based Preliminary Remediation Goals*) and recommended parameter values for chemical fate and transport modeling.

TABLE I.20
COMPARISON OF STRICTEST GROUNDWATER SITE-SPECIFIC TARGET LEVELS (SSTLs) AND MAXIMUM DETECTED GROUNDWATER CONCENTRATIONS FOR PROJECT AREA /a/

Chemical	SSTL Future On-Site Resident[b]				Maximum Detected Groundwater Concentration (mg/L)	
	Adult (mg/L)		Child (mg/L)		Mission Bay North	Mission Bay South
TPH-Gasoline		68		29	8.3	36
TPH-Diesel	>S	(17,000)	>S	(11,000)	48	330
TPH-Motor Oil	>S	(130,000)	>S	(82,000)	7.1	4.7
1, 1, 1-Trichloroethane		1,500		670	ND	0.0026
1, 1, 2-Trichloro-1, 2, 2-trifluoroethane	>S	(5,600)	>S	(2,400)	ND	ND
1, 1-Dichloroethane		50		50	ND	0.0015
1, 2-Dichloroethane (cis)		100		44	0.0071	0.031
1, 2-Dichloroethylene (trans)		230		100	0.0026	0.0069
2-Butanone (MEK)	>S	(> 1,000,000)	>S	(570,000)	ND	ND
2-Hexanone		320		140	ND	ND
Acetone		490,000		210,000	ND	0.0055
Benzene		2.6		2.6	0.0074	0.24
Carbon disulfide		880		380	0.014	0.0087
Chlorobenzene		460		200	ND	0.005
Chloroform		24		24	0.0018	0.023
Ethylbenzene	>S	(3,700)	>S	(1,700)	0.047	0.0024
m & p-Xylene(s)	>S	(29,000)	>S	(13,000)	0.046	0.034
Methylene chloride		190		190	ND	ND
o-Xylene	>S	(29,000)	>S	(13,000)	0.043	0.012
Styrene	>S	(10,000)	>S	(5,000)	ND	ND
Tetrachloroethylene (PCE)		2.8		2.8	0.18	0.0013
Toluene	>S	(1,500)	>S	(640)	0.016	0.041
Trichloroethylene (TCE)		15		15	0.007	0.0036
Trichlorofluoromethane		390		170	ND	ND
Vinyl Chloride		0.046		0.046	ND	0.038

Notes:
mg/L = milligrams per liter
ND = chemical not found above laboratory detection limits
S = The calculated SSTL exceeds the solubility limit for that compound.
a. See text under "Health Risks to Future Occupants and Visitors."
b. The SSTL indicated in parentheses represents an SSTL that is greater than the maximum possible dissolved concentration. These SSTLs, even if greater than the solubility limit, represent a conservative, health-protective estimate of the concentration of chemical that could be present without exceeding the established risk criteria, and has been provided in order to estimate the cumulative risk associated with the presence of multiple chemicals. See text under "Human Health Risk Assessment" for further explanation of the SSTLs.

Source: ENVIRON International Corporation, Addendum 1 to the *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, April 1998, Table 5-7.

Where agency default values are absent (i.e., frequency and duration of park visits), site-specific assumptions intended to capture the 90th percentile of the potentially exposed populations are used.

In addition to the use of site-specific exposure assumptions for factors for which the agencies have not developed default recommendations, site-specific conditions were included in the fate and transport modeling conducted for the Mission Bay South area. Thus, the SSTLs presented are based on a conservative combination of agency default values and site-specific factors designed to protect human health.

Although there are limited documented cases of both synergism and antagonism, additivity is the standard default assumption in human health risk assessment, and is considered the only practical way of accounting for multiple effects from simultaneous exposure to more than one chemical. Accordingly, in the human health risk evaluation for the Mission Bay Project Area, it was assumed that both the cancer and noncancer cumulative risks resulting from simultaneous exposure to the multiple chemicals in multiple environmental media are additive. As recommended by current guidance, the human health risk evaluation did not attempt to account for either potential synergistic effects, or for potential antagonistic effects, because the existing toxicity data are not sufficient to determine the practical or quantitative significance of toxic interactions at environmental levels of exposure./18/

Ecological Risk Evaluation

Risks to the ecological environment under post-development conditions were qualitatively evaluated in *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area* prepared by ENVIRON. Once development of the Project Area is complete, terrestrial and nesting avian species would not be exposed to exposed soils that may contain contaminants. Based on the results of the ecological risk assessment described above, current groundwater conditions are not considered to present an adverse risk to the near-shore aquatic environment (with the exception of the petroleum free product area). Development of the Project Area, which would include implementation of RMPs, would reduce potential effects under future conditions. Rainwater infiltration through soils containing residual contaminants and subsequent migration of the chemicals into the marine ecosystem would be reduced. Stormwater runoff controls would also minimize the potential for contaminants to be discharged to surface water.

NOTES: Appendix I, Contaminated Soils and Groundwater

1. Environmental Science Associates, *Mission Bay Hazards Mitigation Program*, August 1990.

2. ENVIRON International Corporation, *Results of Investigation, Mission Bay North of Channel, San Francisco, California,* April 22, 1997; ENVIRON International Corporation, *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, February 1998.

3. As discussed in Section 2.3.3.3 of *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area,* prepared by ENVIRON in April 1998, the detection of acetone (or methylene chloride) in field and laboratory control samples does not compromise the accuracy or precision of any other analytical result for any other chemical constituent.

4. ENVIRON International Corporation, *Results of Investigation, Mission Bay North of Channel, San Francisco, California,* April 22, 1997, p. 3-11.

5. As discussed in Section 2.3.3.3 of *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area,* prepared by ENVIRON in April 1998, the detection of acetone (or methylene chloride) in field and laboratory control samples does not compromise the accuracy or precision of any other analytical result for any other chemical constituent.

6. ENVIRON International Corporation, *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area,* April 1998; *Technical Memorandum #2, Development and Screening of Remedial Alternatives for Free Product Area in Region of Former Oil Storage Facilities*, April 1998; and *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, April 1998.

7. Developed by ENVIRON in 1995 and presented in Appendix E of *Derivation of Interim Remediation Goals for Acute Exposures to Chemical in the Soil, Draft Remedial Work Plan, Former Alhambra Manufactured Gas Plant Site, Alhambra, California.*

8. See also ENVIRON International Corporation, *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, April 1998.

9. ENVIRON International Corporation, *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, April 1998, Section 4.2; ENVIRON International Corporation, *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel, San Francisco, California*, February 1998, p. 5-27.

10. ENVIRON International Corporation, *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, February 1998, pp. 5-21 and 5-27 to 5-29, and Appendix H.

11. ENVIRON International Corporation, *Results of Investigation, Mission Bay North of Channel, San Francisco, California,* April 22, 1997, p. 4-1; ENVIRON International Corporation, *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, February 1998. p. 4-3.

12. ENVIRON International Corporation, *Results of Investigation, Mission Bay North of Channel, San Francisco, California,* April 22, 1997, p. 4-1.

13. ENVIRON International Corporation, *Technical Memorandum #3, North of Channel Screening-Level Ecological Risk Evaluation, Mission Bay Project Area*, April 1998, Section 4.2.

14. ENVIRON International Corporation, *Technical Memorandum #1, Approach to a Plan for Risk Management, Mission Bay Project Area*, Appendix C, April 1998, p. C-1.

15. The approach for using indicator chemicals to establish SSTLs for petroleum hydrocarbons is explained in detail in Appendix F of *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, ENVIRON International Corporation, February 1998.

16. See ENVIRON International Company, *Site Investigation and Risk Evaluation Report: Mission Bay South of Channel*, Appendix F (February 1998) for additional technical memoranda and other guidance documents used in the development of the SSTLs.

17. It should be noted that if the concentration of the compound in soil exceeds saturation (i.e., if compound-saturated soils are present), the model used to calculate the SSTL is no longer strictly physically valid. In this application, however, where the exposure occurs only through the inhalation pathway, the model provides a conservative estimate of the risk posed by the compound because the model will overpredict the amount of chemical that would be present in the air. Thus, even if compound-saturated soils or free products are present, the use of the SSTLs to estimate cumulative risk associated with exposure to multiple chemicals is health-protective and will overstate the actual risk that may be posed by the presence of the compound in saturated soils.

18. ENVIRON International Corporation, Addendum 2 to the *Site Investigation and Risk Evaluation Report, Mission Bay South of Channel*, April 1998.

J. HYDROLOGY AND WATER QUALITY

OPERATION OF COMBINED SEWER SYSTEM

San Francisco's combined sewer system (see Figure J.1) performs three basic steps of operation:

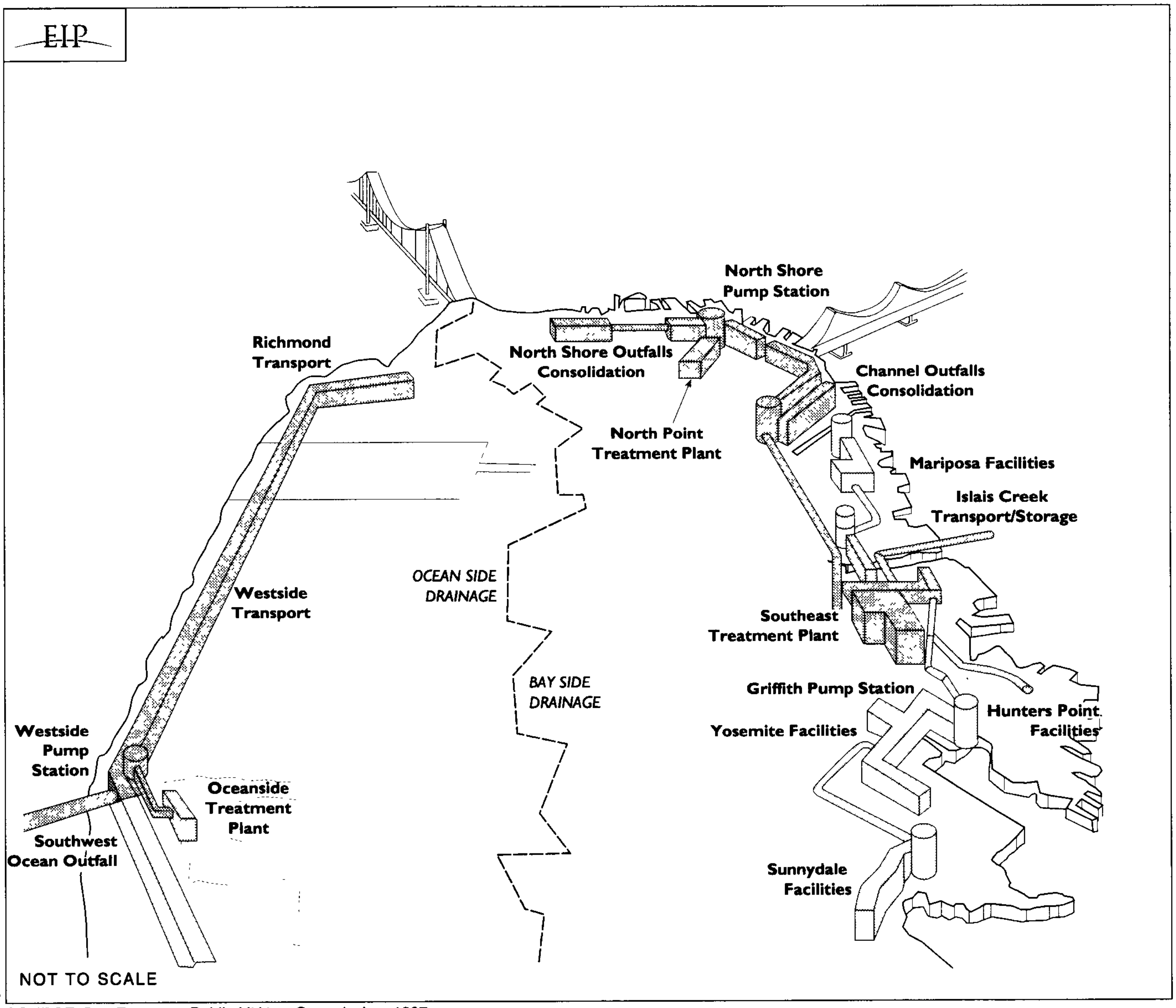
- A series of transport/storage facilities around the perimeter of the City captures the City's combined sewage (municipal wastewater and stormwater runoff).
- The combined sewage stored in the transport/storage facilities flows either directly to a treatment plant, or to a pump station, which pumps the combined sewage to a treatment plant.
- The combined sewage is treated and discharged into the San Francisco Bay or ocean.

Transport/Storage Facilities

The transport/storage facilities are very large-sized, underground, mostly-rectangular tunnels ringing the City. They are operated in conjunction with the pump stations to provide large-volume storage needed during wet weather for later treatment at the treatment plants. Combined sewage is stored until treatment capacity becomes available at the treatment plants. Up to 195 million gallons can be stored in the City's transport/storage facilities. In general, total storage capacity is equivalent to two days of waste flow during dry weather. The transport/storage facilities provide "flow-through treatment" consisting of settling and removal of floatable materials prior to conveyance of combined sewage to the treatment plants. Treated combined sewer overflows (CSO) to the near-shore environment occur when the storm flows exceed the system's total storage capacity (including the storage/transports and the capacity of the treatment plants).

Treatment Plants

The Southeast Water Pollution Control Plant near Third Street and Evans Avenue treats combined sewage from the eastern side of the City. The Oceanside Water Pollution Control Plant located near the San Francisco Zoo treats combined sewage from the western side. The Southeast Plant and the Oceanside Plant provide full secondary-level treatment for a combined maximum of 107 million gallons per day (MG/day) during dry weather. Average current dry-weather sewage generation by the City is about 84 MG/day. During storms, Southeast Plant and Oceanside Plant operators can double or triple the normal rate of waste treatment in order to treat wet-weather flows. Prior to a storm, plant operators increase the population of bacteria, which consume and stabilize the pollutants in the combined sewage. Together, the two plants have a maximum wet-weather capacity of 315 MG/day—193 MG/day of secondary-level treatment and 122 MG/day of primary-level treatment.



SOURCE: San Francisco Public Utilities Commission, 1997

FIGURE J.1 SAN FRANCISCO CLEAN WATER PROGRAM COMBINED SEWER SYSTEM CONCEPTUAL DIAGRAM

During wet weather, both the Southeast Water Pollution Control Plant and the North Point Water Pollution Control Plant provide treatment for stormwater runoff for the Bayside. During dry weather, the entire flow is pumped to the Channel Outfalls Consolidation, and the North Point Plant remains idle. The North Point Plant is activated when the stored volume of combined sewage in the North Shore Outfalls Consolidation reaches a certain level, providing primary-level treatment for combined storm flows up to 150 MG/day. Generally, the North Point Plant serves the northern half of the Bayside drainage.

Pump Stations

The major pump station facilities exist near the transport/storage sewers. Generally, municipal wastewater flows to pump stations by gravity through transport/storages or other smaller sewer lines, and is pumped to the treatment plants for treatment. The pump stations have a maximum rate at which sewage can be pumped, but that pump flow capacity is greater than the volume that can be treated. Therefore, pump station capacity is not a limiting factor in the overall wastewater system.

System Efficiency

Wastewater facilities operators utilize three major components of the sewer system to optimize its efficiency—the transport/storage sewers, the wastewater treatment facilities, and the pump stations. During dry-weather conditions the amount of municipal wastewater entering the sewer system fluctuates throughout the day. The system equalizes this by storing wastewater sewage in the transport/storages when generation is high during early afternoon hours, then releasing the stored sewage to the treatment plants when treatment capacity becomes available during early morning hours. The pump stations play an integral role in this system by regulating the inflow of wastewater to the treatment plants. Similarly, different areas of the City experience variable amounts of rainfall during storm events. Pump stations can move the combined sewage toward the treatment plants or to the transport/storages to accommodate these differing rainfalls.

The completion of the Wastewater Master Plan has enabled San Francisco to provide secondary treatment to all dry-weather discharges. The number of treated CSOs has been reduced from 46 to 81 times per year to an average of 1 to 10 times per year. This discharge consists of approximately 8% sewage and 92% stormwater and has received primary-level treatment. Of the total annual wet-weather discharge volume, approximately:

- 66% receives secondary-level treatment;
- 11% receives primary-level treatment;

- 12% receives flow-through treatment in the transport/storage sewers and is discharged into the Bay; and
- 11% receives flow-through treatment in the transport/storage sewers and is discharged into the ocean where it dilutes rapidly./1/

METHODOLOGY OF SELECTION OF INITIAL FLOW DESIGN VOLUME

Federal regulations require stormwater management programs to reduce the discharge of pollutants to the maximum extent practicable (MEP). MEP has not been defined by the federal regulations, but Best Management Practices (BMP) are typically used to achieve MEP, with the ultimate goal being protection of the receiving water. BMPs are selected for their effectiveness based on site-specific characteristics. Some applicable BMPs may be rejected because other effective BMPs serve the same purpose. Other reasons for rejecting certain BMPs are that the BMP would not be technically feasible, or the cost would be prohibitive. BMPs can be either source control BMPs or treatment control BMPs. The initial-flow diversion system proposed by the project is a treatment control BMP.

The success of treatment control BMPs is typically measured against performance standards, which are often related to the type or size of storm that should be used for the design of treatment control BMPs. Treatment control BMPs are commonly designed to control small rainfall events, which generally are storms that occur more frequently than four times per year on average, and to control the initial flows of larger rainfall events. The state's *Municipal Best Management Practice Handbook* recommends the use of runoff-capture curves to develop cost-effective BMPs. The runoff-capture curves relate basin volume to cost, converting the curves to cost-effectiveness curves. The "knee of the curve" is the point at which little increase in percent runoff captured occurs with the increased cost associated with increasing the basin volume. The representative curve for San Francisco/2/ shows that the performance standard for the project to achieve MEP should be capture of 80% of the annual runoff volume, or the runoff resulting from 16.8 inches of San Francisco's average annual rainfall of 21 inches. Catellus' review of historical City rainfall data/3/ indicated that to capture 80% of the annual average rainfall volume would require collecting up to 1 inch of rainfall from each storm./4/ One inch of rainfall is equivalent to a 3-month storm frequency for San Francisco./5/ Thus, the initial-flow diversion system is proposed to capture 80% of the average annual runoff volume from the Project Area.

The City developed and performed a computer simulation specifically for the purpose of verifying that the proposed initial-flow diversion system could capture 80% of the annual average runoff from the Central/Bay Basin. A set of 5-minute rainfall data spanning 14 years was used./6/ Variable inputs into the model included variations in sewer system operating policies, pumping rates, and inline storage (available capacity within the proposed sewer lines themselves). The results confirmed that 78% of the annual runoff volume could be captured by the initial-flow diversion system if: 1) the proposed pumps can pump 90 cubic feet per second; 2) inline storage is 750,000 gallons; and 3) pumping to the large-capacity Channel box sewer (paralleling China Basin Channel on its south side) stops when capacity in the box sewer is reached. The average annual rainfall during those 14 years of data is 23.7 inches, a slightly wetter period than during the entire 70 years of recorded rainfall data, which averages 21 inches annually. Seventy-eight percent of 23.7 inches is 18.5 inches, which is about equivalent to 88% of the long-term average annual rainfall of 21 inches. Thus, the model results confirm that at least 80% of the average annual rainfall can be captured by the proposed initial flow diversion system.

BAYSIDE PLANNING MODEL

The Bayside Planning Model was developed to meet the City's growing need for a systemwide planning approach to the sizing of storage and pumping facilities. The model simulates wet-weather operations in all CSO facilities on the Bay side. The model can also be used to predict incremental changes in the frequency, duration, and volume of treated CSOs. The model examines changes in watershed parameters and modifications of the CSO system that might occur with large-scale development projects. The model is intended for use as a planning tool to assist the City in sizing its CSO facilities and meeting its permit requirements, and is not intended as a means of monitoring permit compliance.

The primary variable input to the model is hourly rainfall at a single point over a given period of time. In using the model as a planning tool to size CSO facilities or analyze their long-term performance, a 70-year record of historic hourly rainfall at a National Weather Service rain gauge in downtown San Francisco was input into the model to develop the required long-term statistical information./7/ The primary fixed inputs to the model include watershed areas, runoff coefficients, pumping rates, and storage volumes.

CATELLUS' FEASIBILITY ASSESSMENT OF ALTERNATIVE WASTEWATER TREATMENT TECHNOLOGIES FOR THE MISSION BAY PROJECT

Catellus assessed the feasibility of alternatives to reduce the effects of treated wastewater and stormwater discharges to San Francisco Bay. The alternatives assessed for stormwater treatment included vortex-type sediment traps, cartridge leaf filters, and constructed wetlands. The feasibility study found that each of these technologies has the potential for removing suspended solids (particulate matter) and associated toxic chemicals (primarily heavy metals) associated with stormwater runoff./8/ The study concluded that the level of performance would be equivalent to the performance of the proposed initial-flow diversion system.

Satellite water-recycling systems designed to minimize water supply demand were also considered as an alternative to the City's proposed Recycled Water Master Plan concept. The analysis concluded that although local water recycling could reduce the volume of wastewater generated, pollutants removed by the recycling process would still require treatment at the Southeast Plant. As the same treatment would be applied to these pollutants as under the project, the effect on the Bay would be similar to the proposed project./9/

Technologies to increase treatment efficiency and to reduce the pollutant loadings to the Bay were also analyzed. The technologies included effluent filtration, nitrification, nutrient removal, and dissolved pollutants removal (i.e., reverse osmosis). Catellus' analysis concluded that, while these technologies would reduce pollutant loading, they were generally not necessary as the Southeast Plant has available capacity to handle the increased dry-weather flow, and could meet its NPDES permit. Catellus also concluded that the additional loading would have no significant impact on the receiving water as the 2.4 MG/day corresponds to a small fraction, 0.75%, of the total municipal wastewater discharges to the Bay south of the Bay Bridge./10/

NOTES: Appendix J, Hydrology and Water Quality

1. San Francisco Public Utilities Commission, *The Clean Water Act - 25 Years of Progress in San Francisco*, June 1997.

2. San Francisco Stormwater Quality Task Force, *Municipal Best Management Practice Handbook*, prepared by Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning Associates, Appendix D, Unit Control Volumes, March 1993, p. D-8.

3. City and County of San Francisco, Clean Water Program, and Hydroconsult Engineers, *Hydrometeorological Report for the City and County of San Francisco*, Table 5-4, Storm "Duration vs. Depth" Frequency Matrix, based on National Weather Service, Federal Office Building Hourly Rainfall for July 1907 - June 1978 (71 years) and the 6-Hour Between Storm Definition, 1984. unpublished.

4. Beth Goldstein, Hydrologic Planning Group, Bureau of Engineering, Department of Public Works, City and County of San Francisco, memorandum to John Bouey, Branch Manager, Lee & Ro, November 10, 1997.

5. Roesner, L.A., E.H. Burgess, J.A. Aldrich, "The Hydrology of Urban Runoff Quality Management," presented at American Society of Civil Engineers (ASCE), Water Resources Planning and Management Conference, New Orleans, LA, May 20-22, 1991, 7 pp.

6. Leah Orloff, San Francisco Water Department, City and County of San Francisco Public Utilities Commission, memorandum to Beth Goldstein, Hydrologic Planning Group, San Francisco Department of Public Works, City and County of San Francisco, re: Mission Bay, November 18, 1997.

7. The 70-year rainfall record includes El Niño events, which occur on the order of once every four years or so. In particular, the rainfall data includes the two wettest El Niños for California—1982-83 (180%-200% of normal) and 1957-58 (170%-190% of normal). (Monteverdi, J., and Null, J., "The Impact of El Niño on Winter Precipitation in the West," Natural Hazards Observer, Vol. XXII, No. 3, January 1998, 3 pp.)

8. Lee and Ro, letter to David Knadle, Project Manager at Catellus Corporation, Subject: Alternative Water Quality Control Technologies for Mission Bay Project, February 20, 1998.

9. Lee and Ro, letter to David Knadle, Project Manager at Catellus Corporation, Subject: Alternative Water Quality Control Technologies for Mission Bay Project, February 20, 1998.

10. Lee and Ro, letter to David Knadle, Project Manager at Catellus Corporation, Subject: Alternative Water Quality Control Technologies for Mission Bay Project, February 20, 1998.

TABLE J.1 ● CHANGES IN EFFLUENT, OVERFLOW, AND STORMWATER VOLUMES

	Bayside Base Case	Bayside Base Case + Project		Bayside Base Case + Mitigation A			Bayside Base Case + Mitigation B		
	Flow Volume	Flow Volume	Change from Base Case (%)	Flow Volume	Change from Base Case (%)	Change from Base + Project (%)	Flow Volume	Change from Base Case (%)	Change from Base + Project (%)
Bayside Effluent (Deep Water) (MG/yr)	30,203	31,045	842 (2.8%)	31,047	844 (2.8%)	2 (0.0064%)	30,992	789 (2.6%)	-53 (-0.17%)
Bayside Overflows (MG/yr)	910	912	2 (0.22%)	910	0 (0%)	-2 (-0.22%)	877	-33 (-3.6%)	-35 (-3.8%)
Project Area Stormwater Discharge (MG/yr) /a/	15.6	15.9	0.4 (2.6%)	15.9	0.4 (2.6%)	0 (0%)	107.2	91.6 (590%)	91.3 (570%)
Other Bayside (Non-Project Area) Stormwater Discharge	N/A	N/A	N/A N/A	N/A	N/A N/A	N/A N/A	N/A	N/A N/A	N/A N/A
Near-Shore Discharges /b/ (MG/yr)	>926	>928	2.4 (0.22%)	>926	0 (0%)	-2 (-0.22%)	>984	58 (6.3%)	56 (6.0%)

Notes:

MG/yr = million gallons per year
N/A = not available

a. The stormwater discharges under the Base Case, Project, and Mitigation Scenario A are much less than under Scenario B because under the first three, most of the Project Area stormwater would go to the combined sewer system.
b. Near-shore waters include China Basin Channel and the Bay waters adjacent to the Bayside. Data are not available from which to derive volumes and quality of direct stormwater discharges from outside the Project Area. The sum of Bayside CSOs plus direct discharges of stormwater along the Bayside understates the actual total near-shore discharge volume. Therefore, the percentage changes shown for the project and Mitigation Scenarios A and B overstate the volume changes from Base Case and Base-Case-plus-Project conditions.

Source: City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c; EIP Associates.

**TABLE J.2 ●
ESTIMATED ANNUAL MASS POLLUTANT LOADING TO BAY
FROM BAYSIDE EFFLUENT DISCHARGES**

	Bayside Base Case /a/	Bayside Base Case + Project	Bayside Base Case + Mitigation A	Bayside Base Case + Mitigation B
Effluent Volume (MG/yr) /b/	30,203	31,045	31,047	30,992
Change in Volume from Base Case (%) /c/	—	842 (2.8%)	844 (2.8%)	789 (2.6%)
Change in Volume from Base +Project (%) /c/	—	—	2 (0.0064%)	-53 (-0.17%)
Monitored Pollutant Load (lb/yr)				
Total Suspended Solids	4,100,000	4,200,000	4,200,000	4,200,000
Ammonia, Nitrogen	5,100,000	5,200,000	5,200,000	5,200,000
Oil and Grease	1,300,000	1,300,000	1,300,000	1,300,000
Polynuclear Aromatic Hydrocarbons	36	37	37	37
Arsenic	530	550	550	540
Cadmium	54	55	56	55
Chromium	250	260	260	260
Copper	2,100	2,200	2,200	2,200
Lead	880	910	910	900
Mercury	17	18	18	18
Nickel	1,000	1,000	1,000	1,000
Silver	530	550	550	540
Zinc	13,000	13,000	13,000	13,000
Selenium	180	190	190	180
Cyanide	2,500	2,600	2,600	2,600

Notes:

MG = million gallons
lb = pounds
yr = year

a. Derived from data in City and County of San Francisco, Public Utilities Commission, Bureau of Water Pollution Control - Southeast Plant, Southeast WPCP Monitoring Report December 1997, January 16, 1998.
b. Derived from data in City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c.
c. The percentage change in load is assumed to be the same as the percentage change in volume. While the percentage change reflects the incremental change that would occur in each analysis scenario, there is a level of imprecision associated with the load calculations. Therefore, all load values have been rounded to two significant figures to reflect the statistical uncertainty of the calculations. The significance of each change was evaluated by determining whether the change falls within the range of uncertainty.

Source: EIP Associates.

**TABLE J.3 ●
ESTIMATED ANNUAL MASS POLLUTANT LOADING TO BAY
FROM BAYSIDE TREATED OVERFLOWS**

	Base Case Bayside/a/	*Bayside Base Case* + Project	*Bayside Base Case* + Mitigation A	Bayside Base *Case +* Mitigation B
Overflow Volume (MG/yr) /b/	910	912	910	877
Change in Volume from Base Case (%) /c/	—	2 (0.22%)	0 (0%)	-33 (-3.6%)
Change in Volume from Base +Project (%) /c/	—	—	-2 (-0.22%)	-35 (-3.8%)
Monitored Pollutant Load (lb/yr)				
Total Suspended Solids	680,000	680,000	680,000	660,000
Ammonia, Nitrogen	9,600	9,600	9,600	9,200
Oil and Grease	61,000	61,000	61,000	59,000
Polynuclear Aromatic Hydrocarbons	4.1	4.1	4.1	4.0
Arsenic	60	60	60	57
Cadmium	17	17	17	16
Total Chromium	91	91	91	88
Copper	300	300	300	290
Lead	470	470	470	450
Mercury	2.8	2.9	2.8	2.7
Nickel	160	160	160	150
Silver	37	37	37	36
Zinc	2,400	2,400	2,400	2,300
Selenium	6.5	6.5	6.5	6.2
Cyanide	38	38	38	37

Notes:

MG = million gallons; lb = pound; yr = year

a. Derived from the following data sources provided by Jim Salerno, Laboratory Supervisor, Southeast Water Pollution Control Plant, September 5, 1997:
   City and County of San Francisco, Department of Public Works, Bureau of Water Pollution Control, Bayside Wet Weather Overflow Monitoring Program Data Summary, October 1994 - June 1995.
   City and County of San Francisco, Department of Public Works, Bureau of Water Pollution Control, Bayside Wet Weather Overflow Monitoring Program Data Summary, October 1995 - June 1996.
   City and County of San Francisco, Department of Public Works, Bureau of Water Pollution Control, Bayside Wet Weather Overflow Monitoring Program Data Summary, October 1996 - June 1997.

b. City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c.

c. The percentage change in load is assumed to be the same as the percentage change in volume. While the percentage change reflects the incremental change that would occur in each analysis scenario, there is a level of imprecision associated with the load calculations. Therefore, all load values have been rounded to two significant figures to reflect the statistical uncertainty of the calculations. The significance of each change was evaluated by determining whether the change falls within the range of uncertainty.

Source: EIP Associates.

TABLE J.4 ●
ESTIMATED ANNUAL POLLUTANT LOADING FROM DIRECT STORMWATER DISCHARGE TO THE BAY FROM PROJECT AREA/a/

	Bayside Base Case	Bayside Base Case + Project		Bayside Base Case + Mitigation A		Bayside Base case + Mitigation B	
Stormwater Volume to Bay from Bay Basin of Mission Bay (MG/yr) /b/	15.6	15.9		15.9		107.2	
Change in Volume from Existing (%)		0.4	(2.6%)	0.4	(2.6%)	91.6	(590%)
Change in Volume from Project (%)				0	(0%)	91.3	(570%)
Pollutant Load (lb/yr) /c/							
Total Suspended Solids	8,300	6,600		4,000		27,000	
Change in Mass from Existing (%)		-1,700	(21%)	-4,400	(-52%)	18,000	(220%)
Change in Mass from Project (%)				-2,600	(-40%)	20,000	(303%)
Cadmium	0.18	0.21		0.16		1.1	
Change in Mass from Existing (%)		0.03	(16%)	-0.022	(-12%)	0.92	(500%)
Change in Mass from Project (%)				-0.051	(24%)	0.89	(420%)
Total Chromium	1.5	2.2		1.6		11	
Change in Mass from Existing (%)		0.7	(48%)	0.12	(8.1%)	9.4	(640%)
Change in Mass from Project (%)				-0.59	(-27%)	8.7	(400%)
Copper	2.8	4.3		3.5		24	
Change in Mass from Existing (%)		1.5	(53%)	0.63	(22%)	21	(740%)
Change in Mass from Project (%)				-0.87	(-20%)	20	(450%)
Lead	6.6	10		8.9		64	
Change in Mass from Existing (%)		3.4	(58%)	2.4	(36%)	58	(870%)
Change in Mass from Project (%)				-1.5	(-14%)	54	(520%)
Nickel	3.1	4.8		2.3		16	
Change in Mass from Existing (%)		1.7	(55%)	-0.8	(-26%)	13	(410%)
Change in Mass from Project (%)				-2.5	(-52%)	11	(230%)
Zinc	24	27		17		120	
Change in Mass from Existing (%)		3	(13%)	-6.6	(-27%)	98	(410%)
Change in Mass from Project (%)				-9.8	(-36%)	94	(350%)

Notes:

MG= million gallons; lb = pound; ac = acre
in = inch; yr = year

a. While the percentage change reflects the incremental change that would occur in each analysis scenario, there is a level of imprecision associated with the load calculations. Therefore, all load values have been rounded to two significant figures to reflect the statistical uncertainty of the calculations. The significance of each change was evaluated by determining whether the change falls within the range of uncertainty.
b. Based on drainage basin area and runoff coefficient data provided by KCA Engineers, Inc. and Hawk Engineers.
c. Derived from unit load data found in Bay Area Stormwater Management Agencies Association, *San Francisco Bay Area Stormwater Runoff, Pollutant Monitoring Data Analysis, 1988 - 1995, Final Report*, prepared by Woodward-Clyde Consultants, October 15, 1996, Table 5-2.

Source: EIP Associates.

TABLE J.5 ●
ESTIMATED ANNUAL MASS COPPER LOADING TO NEAR-SHORE WATERS FROM OVERFLOWS AND STORMWATER DISCHARGES

	Bayside Base Case	Bayside Base Case + Project		Bayside Base Case + Mitigation A			Bayside Base Case + Mitigation B		
	Mass Load	Mass Load	Change from Base Case (%)	Mass Load	Change from Base Case (%)	Change from Base + Project (%)	Mass Load	Change from Base Case (%)	Change from Base + Project (%)
Near-Shore Discharges from Project Area Plus other Bayside CSOs /a/ (lb/yr) /b/	>300	>300	2.1 (0.72%)	>300	0.63 (0.21%)	-1.5 (-0.51%)	>310	10 (3.4%)	8.1 (2.7%)
Bayside Overflows (lb/yr)	300	300	0.65 (0.22%)	300	0 (0%)	-0.65 (-0.22%)	290	-11 (-3.6%)	-11 (-3.8%)
Project Area Stormwater Discharge (lb/yr) /c/	2.8	4.3	1.5 (53%)	3.5	0.63 (22%)	-0.87 (-20%)	24	21 (740%)	20 (450%)
Other Bayside Stormwater Discharges	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Notes:

lb/yr = pounds per year
N.A. = not available

a. Near-shore waters to the Project Area include China Basin Channel and the Bay waters adjacent to the Project Area.
b. Data are not available from which to derive volumes and quality of direct stormwater discharges from outside the Project Area. The total load contributed by Bayside CSOs plus direct discharges of stormwater along the Bayside understates the actual total load discharged to near-shore waters. Therefore, the percentage changes shown for the project and Mitigation Scenarios A and B overstate the load changes from Base Case and Base-Case-plus-Project conditions.
c. The copper load discharged under the Base Case, Project, and Mitigated Scenario A is much less than under Scenario B because under the first three, most of the Project Area stormwater would go to the combined sewer system.

Source: EIP Associates; City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c.

TABLE J.6 ●
ESTIMATED ANNUAL MASS ZINC LOADING TO NEAR-SHORE WATERS FROM OVERFLOWS AND STORMWATER DISCHARGES

	Bayside Base Case	Bayside Base Case + Project		Bayside Base Case + Mitigation A			Bayside Base Case + Mitigation B		
	Mass Load	Mass Load	Change from Base Case (%)	Mass Load	Change from Base Case (%)	Change from Base + Project (%)	Mass Load	Change from Base Case (%)	Change from Base + Project (%)
Near-Shore Discharges from Project Area Plus other Bayside CSOs /a/ (lb/yr) /b/	>2,400	>2,500	8.6 (0.35%)	>2,400	-6.6 (-0.27%)	-15 (-0.62%)	>2,500	10 (0.40%)	1.2 (0.049%)
Bayside Overflows (lb/yr)	2,400	2,400	5.3 (0.22%)	2,400	0 (0%)	-5.3 (-0.22%)	2,300	-88 (-3.6%)	-93 (-3.8%)
Project Area Stormwater Discharge (lb/yr) /c/	24	27	3.2 (13%)	17	-6.6 (-27%)	-9.8 (-36%)	122	98 (410%)	94 (350%)
Other Bayside Stormwater Discharges	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Notes:

lb/yr = pounds per year
N.A. = not available

a. Near-shore waters to the Project Area include China Basin Channel and the Bay waters adjacent to the Project Area.
b. Data are not available from which to derive volumes and quality of direct stormwater discharges from outside the Project Area. The total load contributed by Bayside CSOs plus direct discharges of stormwater along the Bayside understates the actual total load discharged to near-shore waters. Therefore, the percentage changes shown for the project and Mitigated Scenarios A and B overstate the load changes from Base Case and Base-Case-plus-Project conditions.
c. The zinc load discharged under the Base Case, Project, and Mitigated Scenario A is much less than under Scenario B because under the first three, most of the Project Area stormwater would go to the combined sewer system.

Source: EIP Associates; City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c.

TABLE J.7 ●
CUMULATIVE EFFLUENT, OVERFLOW, AND STORMWATER VOLUMES

	Existing Bayside Base Case	Cumulative Bayside Base Case with Project	Cumulative Bayside Base Case with Mitigation A	Cumulative Bayside Base Case with Mitigation B
Bayside Effluent (Deep Water) (MG/yr)	30,203	31,496	31,499	31,443
Near-Shore Discharges from Project Area Plus other Bayside CSOs /a/ (MG/yr)	>926	>1,024	>1,021	>1,077
Bayside Overflows (MG/yr)	910	1,008	1,005	970
Project Area Stormwater Discharge (MG/yr) /b/	15.6	15.9	15.9	107.2
Other Bayside Stormwater Discharge	N.A.	N.A.	N.A.	N.A.

Notes:

MG/yr = million gallons per year
N.A. = not available

a. Near-shore waters to the Project Area include China Basin Channel and the Bay waters adjacent to the Project Area. Data are not available from which to derive volumes and quality of direct stormwater discharges from outside the Project Area. The sum of Bayside CSOs plus direct discharges of stormwater along the Bayside understates the actual total near-shore discharge volume. Therefore, the percentage changes shown for the project and Mitigated Scenarios A and B overstate the volume changes from Base Case and Base-Case-plus-Project conditions.
b. The stormwater discharges under the Base Case, Project, and Mitigated Scenario A are much less than under Scenario B because under the first three, most of the Project Area stormwater would go to the combined sewer system.

Source: EIP Associates; City and County of San Francisco, Public Utilities Commission, Clean Water Program, *Draft Bayside Cumulative Impact Analysis*, March 1998, Table 5c.

K. CHINA BASIN CHANNEL VEGETATION AND WILDLIFE

This appendix includes two tables:

- Table K.1 China Basin Channel Benthic Invertebrate Species List
- Table K.2 Bird Species Observed in the Mission Bay Project Area

TABLE K.1
CHINA BASIN CHANNEL
BENTHIC INVERTEBRATE SPECIES LIST

Phylum Nemertea (ribbon worms)	
	Nemertea - unidentified
	Cerebratulus californiensis
Phylum Nematoda (roundworms)	
	Nematoda - unidentified
Phylum Sipuncula (peanut worms)	
	Golfingia species
Phylum Annelida (segmented worms)	
Class Oligochaeta (aquatic earthworms)	
	Oligochaeta - unidentified
Family Tubificidae	
	Tubificidae - unidentified
	Tubificoides species
Class Polychaeta (marine worms)	
Family Phyllodocidae (paddle worms)	
	Eteone lighti
Family Syllidae	
	Sphaerosyllis californiensis
Family Goniadidae	
	Glycinde polygnatha
Family Nephtydae	
	Nephtys cornuta franciscana
Family Orbiniidae	
	Lietoscoloplos elongatus
Family Spionidae	
	Spionidae - unidentified juvenile
	Polydora ligni
	Prionospio cirrifera
	Pseudopolydora kempi
	Pseudopolydora paucibranchiata
	Spiophanes berkeleyorum
	Spiophanes missioninsis
	Streblospio benedicti
Family Cerratulidae (hairy-gilled worm)	
	Aphelochaeta (=*Tharyx*) species
	Chaetozone spp.
	Cirriformia spirabrancha
Family Cossuridae (thread worm)	
	Cossura candida
Family Opheliidae	
	Armandia brevis

(Continued)

TABLE K.1 (Continued)

Phylum Annelida	
Class Polychaeta (continued)	
Family Capitellidae	
	Capitellidae - unidentified (head fragment)
	Capitella capitata ("pollution worm")
	Heteromastus filiformis
	Mediomastus species
Family Maldanidae (bamboo worms)	
	Sabaco elongatus
Family Pectinariidae (ice cream cone worms)	
	Pectinaria californiensis
Family Sabellidae (plumed worms)	
	Chone species
Phylum Arthropoda (jointed exoskeleton)	
Class Crustacea (beach hoppers, shrimp, crabs, etc.)	
Subclass Ostracoda (bean shrimp)	
	Eusarsiella zostericola
Subclass Copepoda	
Order Harpacticoida	
	Harpacticoida - unidentified
Subclass Malacostraca	
Order Cumacea	
	Eudorella pacifica
	Nippoleucon (=*Hemileucon*) *hinumensis*
Order Amphipoda (beach hoppers)	
	Ampelisca abdita
	Corophium heteroceratum
Phylum Mollusca	
Class Gastropoda (snails)	
Subclass Opistobranchia (sea slugs, sea hares)	
	Philine species
Class Bivalvia (clams)	
Subclasss Heterodonta	
	Macoma balthica
	Potamocorbula ameurensis
	Tellina modesta
	Theora lubrica
	Trachycardium quadragenarium
Phylum Echinodermata (sea stars)	
Class Ophiuroidea (brittle stars)	
	Ophiuroidea - unidentified

Source: Susan McCormick, Aquatic Biologist, and KDH Biological Consulting.

TABLE K.2
BIRD SPECIES OBSERVED IN THE MISSION BAY PROJECT AREA

Common Name[1]	Scientific Name[2]	Legal Status[3]	Seasonal Occurrence[4]	High Count	Primary Habitat: Upland	Primary Habitat: Channel[5]	Observed Activity in Channel[6]
Red-throated loon [a,b]	Gavia stellata		W	4		X	
Common loon [a,b]	Gavia immer		W	2		X	
Pied-billed grebe [a,b]	Podilymbus podiceps		R	2		X	
Horned grebe [a]	Podiceps auritus		W	4		X	
Eared grebe [d]	Podiceps nigricollis		W	2		X	
Western grebe [b]	Aechmophorus occidentalis		W	26		X	
Clark's grebe [a,b]	Aechmophorus clarkii		W	1		X	
California brown pelican [a,f]	Pelecanus occidentalis californicus	FE/CE	S	21		X	Foraging
Double-crested cormorant [a,b]	Phalacrocorax auritus		R	36		X	Perching, diving for fish
Brandt's cormorant [a]	Phalacrocorax penicillatus		R	6		X	
Pelagic cormorant [a]	Phalacrocorax pelagicus		R	2		X	
Great blue heron [a,b]	Ardea herodias		R	2		X	Resting
Great egret [a,b]	Casmerodius albus		R	3		X	Foraging, resting
Snowy egret [a]	Ergetta thula		R	2		X	Foraging
Green-backed heron [c]	Butorides striatus		R	N.A.		X	
Black-crowned night heron [a,b]	Nycticorax nycticorax		R	17		X	Foraging, resting
Muscovy duck	Carina moschata		E	1		X	Resting on bank
Mallard [b]	Anas platyrhynchos		R	N.A.		X	
Northern pintail [d]	Anas acuta		W	N.A.		X	

(Continued)

TABLE K.2 (Continued)

Common Name[1]	Scientific Name[2]	Legal Status[3]	Seasonal Occurrence[4]	High Count	Primary Habitat: Upland	Primary Habitat: Channel[5]	Observed Activity in Channel[6]
Cinnamon teal [d]	Anas cyanoptera		S	N.A.		X	
Northern shoveler [d]	Anas clypeata		W	N.A.		X	
American wigeon [d]	Anas americana		W	N.A.		X	
Canvasback [d]	Aythya valisineria		W	N.A.		X	
Greater scaup [a]	Aythya marila		W	50		X	
Lesser scaup [a]	Aythya affinis		W	7		X	
Surf scoter [a,b]	Melanitta perspicillata		W	1,240		X	
Common goldeneye [a]	Bucephala clangula		W	10		X	
Barrow's goldeneye [a]	Bucephala islandica		W	6		X	
Bufflehead [a]	Bucephala albeola		W	3		X	
Ruddy duck [a]	Oxyura jamaicensis		W	1		X	
American kestrel [d]	Falco sparverius		R	1	X		
American Peregrine falcon [d]	Falco peregrinus anatum	FE/CE	R	1	X		
American coot [b]	Fulica americana		R	N.A.		X	
Black-bellied plover [a]	Pluvialis squatarola		W	1		X	
Killdeer [a,b]	Charadrius vociferus		R	6	X		Foraging along bank and mudflats
Black-necked stilt [d]	Himantopus mexicanus		R	N.A.		X	
American avocet [d]	Recurvirostra americana		R	N.A.		X	
Greater yellowlegs [d]	Tringa melanoleuca		W	N.A.		X	
Willet	Catoptrophorus semipalmatus		R	N.A.		X	

(Continued)

TABLE K.2 (Continued)

Common Name[1]	Scientific Name[2]	Legal Status[3]	Seasonal Occurrence[4]	High Count	Primary Habitat: Upland	Primary Habitat: Channel[5]	Observed Activity in Channel[6]
Spotted sandpiper [a]	Actitis macularia		W	2		X	
Long-billed curlew [d]	Numenius americanus		R	N.A.		X	
Marbled godwit [d]	Limosa fedoa		W	N.A.		X	
Sanderling [a]	Calidris alba		W	150		X	
Western sandpiper [d]	Calidris mauri		W	N.A.		X	
Least sandpiper [a]	Calidris minutilla		W	23		X	
Dunlin [d]	Calidris alpina		W	N.A.		X	
Short-billed dowitcher [d]	Limnodromus griseus		R	N.A.		X	
Bonaparte's gull [a,b]	Larus philadelphia		W	1		X	
Heermann's gull [a,b]	Larus heermanni		S	3		X	
Mew gull [a,b]	Larus canus		W	1,375		X	
Ring-billed gull [a,b]	Larus delawarensis		R	4		X	
California gull [d]	Larus californicus		R	18		X	Resting, foraging, swimming
Herring gull [a]	Larus argentatus		W	2		X	
Thayer's gull [a]	Larus thayer		W	3		X	
Western gull [a,b]	Larus occidentalis		R	565		X	Feeding on carrion
Glaucous-winged gull [a,b]	Larus glaucescens		R	825		X	
Caspian tern [c]	Sterna caspia		S	1		X	Diving for fish
Forster's tern [a]	Sterna forsteri		R	2		X	Diving for fish
Rock dove (domestic pigeon) [a,b]	Columba livia		R	200	X		

(Continued)

TABLE K.2 (Continued)

Common Name[1]	Scientific Name[2]	Legal Status[3]	Seasonal Occurrence[4]	High Count	Primary Habitat		Observed Activity in Channel[6]
					Upland	Channel[5]	
Mourning dove [a,b]	Zenaida macroura		R	6	X		
Budgerigar (parakeet)	Melopsittacus undulatus		E	1	X		
Anna's hummingbird [c]	Calypte anna		R	N.A.	X		
Belted kingfisher [a,b]	Ceryle alcyon		R	3		X	
Black phoebe [a]	Sayornis nigricans		R	1	X		
Barn swallow [c]	Hirundo rustica		S	5	X		Foraging for insects
American crow [a]	Corvus brachyrhynchos		R	6	X		
Common raven [a]	Corvus corax		R	1	X		
Bushtit	Psaltriparus minimus		R	2	X		
American robin [c]	Turdus migratorius		R	1	X		
Northern mockingbird [a,b]	Mimus polyglottos		R	3	X		
European starling [a,b]	Sturnus vulgaris		R	370	X		
Yellow-rumped warbler [a]	Dendroica coronata		R	5	X		
Palm warbler [d]	Dendroica palmarum		W	2	X		
Song sparrow	Melospiza melodia		R		X		
Golden-crowned sparrow [a]	Zonotrichia atricapilla		W	1	X		
White-crowned sparrow [a]	Zonotrichia leucophrys		R	4	X		
Red-winged blackbird [c]	Agelaius phoeniceus		R	N.A.	X		
Western meadowlark [a]	Sturnella neglecta		R	2	X		
Brewer's blackbird [a,b]	Euphagus cyanocephalus		R	23	X		
Hooded Oriole [e]	Icterus cucullatus		S	1	X		

(Continued)

TABLE K.2 (Continued)

Common Name[1]	Scientific Name[2]	Legal Status[3]	Seasonal Occurrence[4]	High Count	Primary Habitat		Observed Activity in Channel[6]
					Upland	Channel[5]	
House finch [a,b]	Carpodacus mexicanus		R	17	X		
Pine siskin [a]	Carduelis pinus		R	1	X		
American goldfinch [a]	Carduelis tristis		R	1	X		
House sparrow [a,b]	Passer domesticus		R	35	X		
TOTAL:			**(R = 45, W = 31, S = 6, E = 2)**		**27**	**57**	

TOTAL SPECIES = 84

Notes:
N.A. = Not Available
1,2 Names presented in phylogenetic order according to the American Birding Association's checklist in *Birds of the United States and Canada*, Fourth Edition, Colorado Springs, Colorado, 1990.
3 California Natural Diversity Data Base, California Department of Fish and Game, Sacramento, CA, 1997.
4 McCaskie, De Benedictis, Erickson and Morgan 1979, Birds of Northern California, An Annotated Field List.
W = winter range S = summer range
R = resident E = exotic escape Note: Seasons vary widely among different species.
Species recorded during field surveys March 5-6; 26; April 25 - May 1; August 25 - September 2, 1992; January 4-11, 1993; and June 6, 13, 19, 1997.
5 L = Lower channel M = Middle channel U = Upper channel O = Open Water S = Shoreline
6 Biological Surveys conducted by EIP Associates, June and July 1997, or other reliable observers.

Unless otherwise noted, data from EIP Associates surveys
[a] Observed during Audubon bird counts conducted by Alan Hopkins, September 1987 to February 1988.
[b] Observed during on-site bird censuses conducted by Environmental Science Associates (ESA) on February 18 and 26, and March 14, 1986.
[c] Observed by Alan Hopkins subsequent to his census conducted for the Mission Creek Conservancy.
[d] Data from CH M_2Hill Engineers, 1983, Mission Bay Project EIR, prepared for Jefferson Associates.
[e] Observed off-site at nest in palm, north side of Channel between 3rd and 4th streets. As foraging in this area is limited due to paving, foraging for insects and fruits likely occurs in the Project Area.
[f] Reported by Scott Morrical, Golden Gate Audubon in *1990 Mission Bay FEIR*. High-flying birds that showed no apparent interest in the channel were not counted.

Sources: EIP Associates, Mission Creek Conservancy, 1990 Mission Bay FEIR, Environmental Science Associates.

L. COMMUNITY SERVICES AND UTILITIES

RECREATION AND PARKS

Plans and policies regarding the provision of open space in San Francisco are found in the *San Francisco General Plan* and in the Bay Conservation and Development Commission's *San Francisco Bay Plan* and *San Francisco Waterfront Special Area Plan*, as discussed below.

San Francisco General Plan

Recreation and Open Space Element

The Recreation and Open Space Element of the *San Francisco General Plan* sets forth plans and policies for San Francisco's recreation and open space system. Applicable objectives and policies of the Citywide, Neighborhood, Shoreline, and Regional sections are summarized below.

Citywide Objectives and Policies

Policy 1 of the Citywide System is to "provide an adequate total quantity and equitable distribution of public open spaces throughout the City."/1/ This policy states that there should be enough public open space to serve the City's population, and that this open space should be evenly distributed throughout the City. Policy 1 acknowledges that some areas of the City are deficient in open space, and that the City should work towards eliminating deficiencies and improving the distribution of open space./2/ The Mission Bay area is entirely outside of any service area shown on the map.

Policy 7 is to "acquire additional open space for public use."/3/ It states that additional public open space is needed in some areas, and should be acquired and/or developed. One such area, as shown on Map 4, page I.3.18 of the Recreation and Open Space Element, is the Mission Bay area.

Neighborhood Objectives and Policies

Objective 4 is to "provide opportunities for recreation and the enjoyment of open space in every San Francisco neighborhood."/4/ Relevant policies include the following: Policy 2, which is to maximize joint use of other properties and facilities; Policy 4, which gives priority to developing new open space in residential neighborhoods that are most deficient; Policy 5, which requires private usable outdoor open space in new residential development; Policy 6, which assures the provision of adequate public open space to serve new residential development; and Policy 7, which calls for providing open space to serve neighborhood commercial districts./5/

Shoreline Objectives and Policies

Objective 3 is to "provide continuous public open space along the shoreline unless public access clearly conflicts with maritime uses or other uses requiring a waterfront location."/6/ This objective includes policies to "assure that new development adjacent to the shoreline capitalizes on its unique waterfront location, considers shoreline land use provisions, improves visual and physical access to the water, conforms with urban design policies," to "maintain and improve the quality of existing shoreline open space," and to "provide new public open spaces along the shoreline."/7/ Policy 5 of Objective 3 includes the Eastern Shoreline, which includes China Basin Channel, and parts of Mission Bay. Shoreline provisions that are part of the *Mission Bay Plan* are discussed below under "Mission Bay Area."

Regional Open Space

Objective 1 is to "preserve large areas of open space sufficient to meet the long-range needs of the Bay Region."/8/ These open spaces should provide recreation based on the natural features of the region, and supplement the types of open space and recreation available within the City.

Mission Bay Area

Mission Bay is part of the eastern shoreline, and the Recreation and Open Space Element states that "redevelopment of the Eastern Shoreline should be balanced so that adequate space is planned for public open space..."/9/

Mission Bay Plan

The *Mission Bay Plan* presents objectives and policies for the development of open space in Mission Bay. These include Policies 5 and 6 of Objective 1, which call for open space throughout the plan area, and land uses that provide access to and use of the shoreline./10/ It calls for approximately 68 acres of open space throughout Mission Bay./11/ The *Mission Bay Plan* contains an Open Space section, which describes the location, scale, and distribution of open space./12/ In addition, Objective 14 is to provide adequate open space for the Mission Bay community, as well as to augment the City's open space network./13/

Central Waterfront Plan

Objective 9 under "Recreation and Open Space Access" in the *Central Waterfront Plan* is to "provide public access and recreational opportunities along the shoreline."/14/ It contains policies to improve the quality of existing shoreline recreation areas, which include the nearby Agua Vista Park, and to provide open spaces with convenient pedestrian access in areas of maritime activity. Under "Central Basin Subarea," Objective 17, Policy 2 is to improve and expand Agua Vista Park; and Policy 3 is to continue use of the public boat launch ramp south of Pier 50 or replace it with an equivalent along the eastern shoreline./15/

Bay Conservation and Development Commission

The Bay Conservation and Development Commission's *San Francisco Bay Plan* recommends maximum public access to the Bay shoreline through the development of new shoreline parks and recreation facilities./16/ The *San Francisco Waterfront Special Area Plan* contains policies related to public access and open space along the waterfront, particularly with regard to public access requirements for new development./17/ More up-to-date policies are presented in the *San Francisco Bay Area Seaport Plan*, which is discussed further in "Regional Agencies" in Section V.A, Plans, Policies, and Permits: Setting. BCDC jurisdiction within the Project Area includes a 100-foot-wide shoreline band around the edge of the China Basin Channel. Public access requirements of this BCDC designation are discussed further in "Regional Agencies" under Section V.A, Plans, Policies, and Permits: Setting.

SCHOOLS

The following procedure was used to estimate the approximate number of school-age children expected to reside in the Project Area at full build-out. A projected citywide total population of 795,800 for the year 2015 was used, along with the following ABAG-projected age groups and populations in each group:/18/

Age	Projected Population, 2015
5-9	44,100
10-14	45,900
15-19	44,900

To arrive at the number of children in age groups that correspond approximately to school grades, the following steps were taken: The total number of children in each age group was divided equally among all of the ages in that group. Then this number was divided by citywide population to determine the number of children of each age as a percentage of total population. Total projected Mission Bay population of approximately 10,900/19/ was multiplied by these percentages, to come up with a projected number of children of each age expected to live in the Project Area. Then each age was aligned with a school grade. The grades were then grouped by approximate school level to estimate the number of new students that would need to be accommodated at each school type. The results are shown in Table L.1.

SOLID WASTE

Solid Waste Estimates

The difference in the amount of solid waste estimated in the SEIR (19,000 tons/year, as shown in Table L.2) and in the 1990 FEIR (62,300 tons/year)/20/ can be attributed to the use of different waste generation factors, and slightly different land uses. The 1990 FEIR calculated waste generation by employment and residential populations. Although the SEIR uses population to calculate residential waste calculations, it uses gross floor area to calculate waste generation in retail and commercial industrial buildings.

The 1990 FEIR estimated approximately 34,600 tons of residential waste per year, while the SEIR estimates about 5.0 tons/year. The 1990 FEIR assumed 2.4 tons of solid waste per resident per year, or about 13 pounds per resident per day (lb/res/day). The SEIR uses a generation factor of 2.5 lb/res/day, which is approximately 0.46 ton per resident per year. The generation factor used in the SEIR comes from a 1985 report by the National Solid Wastes Management Association (NSWMA)/21/, and is very similar to the generation factor in San Francisco's 1992 Solid Waste Generation Study (2.4 lb/res/day)./22/ The difference in the amount of residential waste estimated to be generated in the two methods is approximately 29,000 tons per year.

The difference in solid waste generation estimates for the commercial sector is about 10,000 tons per year. The 1990 FEIR calculated commercial waste by using employee populations. The generation factor used in the 1990 FEIR (0.9 ton per person per year) was based on a San Francisco factor that estimated total commercial waste divided by total City employment. This SEIR uses waste generation factors obtained from the San Francisco Solid Waste Management Program, which are based on gross floor area by land use type. Calculation of commercial waste generation by land use is the more accurate method because it accounts for different waste generation rates from specific types of land use and, therefore, provides more accurate data.

TABLE L.1
CALCULATION OF APPROXIMATE NUMBER OF SCHOOL-AGE CHILDREN BY GRADE EXPECTED TO RESIDE IN THE PROJECT AREA AT FULL BUILD-OUT, 2015

Age	Total Projected Children Citywide Year 2015 /a/	Number of Children by Age	Percent of Total Population /b/	Approximate School Grade	Projected Number of Children in Project Area by Grade/c/	Projected Number of Children in Project Area by School Type /d/	School Type
5		8,820	1.1%	K	120		
6		8,820	1.1	1	120		
7	44,100	8,820	1.1	2	120	731	Elementary School
8		8,820	1.1	3	120		
9		8,820	1.1	4	120		
10		9,180	1.2	5	131		
11		9,180	1.2	6	131		
12	45,900	9,180	1.2	7	131	393	Middle School
13		9,180	1.2	8	131		
14		9,180	1.2	9	131		
15		8,980	1.1	10	120	491	High School
16		8,980	1.1	11	120		
17	44,900	8,980	1.1	12	120		
18		8,980					
19		8,980					
Total number of school-age children expected to reside in the Project Area at full build-out						**1,615**	

Notes:
Numbers are rounded to the nearest whole number; percents to the nearest tenth.
Dotted lines at left show age groupings used by ABAG.
Solid lines at right show age groupings by school type.

a. Association of Bay Area Governments, *Projections '96, Forecasts for the San Francisco Bay Area to the Year 2015*, December 1995, p. 216.
b This number arrived at by dividing the number of children at each age by the citywide projected population.
c. This number arrived at by multiplying percent of population for each age by total projected population in Project Area.
d. This assumes that an elementary school consists of grades K-5; a middle school, grades 6-8; and a high school, grades 9-12. The numbers of students in each grade were added to come up with a total number that would need to be accommodated at each type of school.

Source: EIP Associates.

TABLE L.2
MISSION BAY PROJECT SOLID WASTE GENERATION AT BUILD-OUT (2015)

Subarea	Land Use	Solid Waste Generation Factor/a,b/	Number of Units	Pounds per Day	Days per Year /d/	Pounds per Year	Tons per Year
North Subarea							
	Residential	2.5 lb/res/day	5,347 res	13,000	365	4,700,000	2,400
	Retail	2.0 lb/100 gsf/day	667,000 sf	13,000	365	4,700,000	2,400
	Subtotal			*26,000*			*4,800*
Central Subarea							
	Residential	2.5 lb/res/day	5,508 res	14,000	365	5,100,000	2,600
	Retail	2.0 lb/100 gsf/day	167,000 sf	3,300	365	1,200,000	600
	Hotel	2.0 lb/room/day	500 rooms	1,000	365	370,000	190
	Subtotal			*18,000*			*3,400*
East Subarea							
	Cmc. Industrial	1.0 lb/100 gsf/day	2,952,000 sf	30,000	260	7,800,000	3,900
	Retail	2.0 lb/100 gsf/day	340,000 sf	6,800	365	2,480,000	1,300
	Subtotal			*37,000*			*5,200*
West Subarea							
	Cmc. Industrial	1.0 lb/100 gsf/day	2,605,000 sf	26,000	260	6,800,000	3,400
	Retail	2.0 lb/100 gsf/day	333,000 sf	6,700	365	2,400,000	1,200
	Subtotal			*33,000*			*4,600*
UCSF Subarea	UCSF /e/	---	---	10,400	260	2,700,000	1,350
	Elem. School	0.5 lb/stu/day	500 stu/c/	250	217	54,000	27
	Subtotal			*11,000*			*1,380*
Total Yearly Solid Waste Generation /f//g/				**124,000**			**19,000**
1996 Citywide Solid Waste Generation							**1,115,673**
% of Citywide Generation							**1.7%**

(Continued)

TABLE L.2 (continued)

Notes:

lb = pounds	res = resident(s)
du = dwelling unit	Cmc. Industrial = Commercial Industrial
gsf = square feet	stu = student(s)
1 ton = 2,000 pounds	Elem. School = Elementary School

a. Source for Residential solid waste generation factors: City and County of San Francisco, *Solid Waste Generation Study*, October 1992, pp. 4-12.

b. Source for Retail, Student, Commercial Industrial, and Hotel waste generation factors: NSWMA, Basic Data: Solid Waste Amounts, Composition, and Management, Technical Bulletin #85-6, October 1, 1985.

c. Based on estimated school student capacity of 500 students.

d. Days for schools based on 5 days/week and 10 months/year. Days for R&D/Office operations based on 52 five-day weeks per year.

e. Waste generation for UCSF facility based on: University of California San Francisco, *UCSF Long Range Development Plan Final Environmental Impact Report*, State Clearinghouse No. 95123032, January 1997, Volume Two, p. 455.

f. Solid waste generated by police and fire fighting services is not included because accurate staff numbers are not available. The absence of this information is not expected to cause a large impact on the total annual solid waste generation for the project.

g. Numbers may not add exactly due to rounding.

Source: EIP Associates.

The 1990 FEIR used a modified regression intercept to estimate the difference between the actual amount of solid waste generated in the Project Area in 1985 and the amount estimated by the population and employment projections./23/ This regression produced a calibration factor of 5,210 tons per year. This SEIR did not need a calibration factor because the actual amount of solid waste generated in the Project Area was not obtained; existing waste generation was estimated based on land use types.

The differences in methods explained above account for a discrepancy of approximately 45,000 tons of solid waste per year between the 1990 FEIR and SEIR estimates (29,000 tons/year for population, 11,000 tons/year for employment, and about 5,000 tons/year for the calibration factor).

WATER SUPPLY

Estimates of Existing Water Demand

No change in land use that would cause a substantial change in water demand has occurred in Mission Bay since the 1990 FEIR, except for the addition of the Mission Bay Golf Center (a golf driving range) in December 1992. The SEIR estimate also assumes that there has been no large-scale replacement or upgrade of existing plumbing fixtures with more water-conserving ones. The current (1996) water estimate was calculated by adding the current water demand for Mission Bay from the 1990 FEIR (80,000 gallons per day, or gpd)/24/, to the estimated water demand from the Mission Bay Golf Center (17,000 gpd)./25/ Therefore, the current (1996) water demand for Mission Bay is estimated to be about 97,000 gpd.

Estimates of Future Water Demand

The Mission Bay water demand estimate in the 1990 FEIR was 1,895,000 gpd, while this SEIR estimates the project's water demand to be 2,900,000 gpd. This represents an increase of about 1,000,000 gpd for the SEIR proposed development program. This difference is a result of more conservative estimates in commercial industrial water use, an increase in retail gross square footage, and a higher water demand for the irrigated open space.

In estimating the water demand for Commercial Industrial, all of the use was assumed to be R&D, which has a water use approximately three times greater than office water demand. This SEIR assumes 50% R&D and 50% office use for most of the analyses; therefore, the assumption of 100% R&D for water demand is very conservative. Alternative A from the 1990 FEIR estimated that 3.6 million gross sq. ft. of R&D and 4.1 million gross sq. ft. of office space would use approximately 690,000 gpd./26/ The SEIR estimates that 5.56 million gross sq. ft. of Commercial Industrial space and the 2.65 million gross sq. ft. UCSF site would use approximately 1.3 million gallons per day (see Table L.3). Additionally, retail space has increased from 250,000 gross sq. ft. analyzed in the 1990

TABLE L.3
MISSION BAY PROJECT TOTAL DAILY WATER DEMAND AND WASTEWATER GENERATION AT BUILD-OUT (2015), MISSION BAY NORTH AND SOUTH

Land Use	Building Floor Area (gsf)	Water Demand Factor /a/	Daily Water Demand (gal)	Daily Wastewater Generation (gal) /b/
Commercial Industrial	5,557,000	150 gal/1,000 gsf	830,000	750,000
UCSF /c/	2,650,000	N/A	510,000	460,000
Neighborhood-serving Retail	257,000	95 gal/1,000 gsf	24,000	22,000
Moderate Scale Retail	805,000	95 gal/1,000 gsf	76,000	68,000
Commercial Entertainment	445,000	150 gal/1,000 gsf	67,000	60,000
Community Facilities /d/	171,000	150 gal/1,000 gsf	26,000	23,000
	[du]			
Hotel, rooms	500	170 gal/du	85,000	77,000
Residential	6,090	187.5 gal/du	1,142,000	1,028,000
	[acre]			
Irrigated Open Space /e,f/	47	2,300 gal/acre	100,000	
Total Daily Demand (gal/day) /g/			**2,900,000**	**2,500,000**
Total Daily Demand (mgd) /h/			**2.9**	**2.5**
Existing Citywide Daily Consumption (mgd) /I/			**90**	**84**
% of Citywide Consumption (mgd)			**3.2%**	**3.0%**

Notes:
du = dwelling units
gsf = gross square feet
gal = gallons
mgd = million gallons per day
N/A = not available

a. Factors based on information provided by Fred DeJarlais, Vice President, KCA Engineers, memorandum to EIP Associates, August 7, 1997. Water demand factors include water to be used for potentially non-potable uses (i.e., toilet flushing, cooling systems, and landscaping).
b. Wastewater generation assumed to be 90% of water consumption.
c. University of California San Francisco, *UCSF Long Range Development Plan Final Environmental Impact Report*, State Clearinghouse No. 95123032, January 1997, p. 464.
d. Fire/police station, and school, assumes 75% coverage of site.
e. City and County of San Francisco, San Francisco Public Utilities Commission, *Recycled Water Master Plan,* Table 3-1. Irrigation water demand factor is an annual average demand; water demand would be higher in the summer and lower in the winter.
f. Water used for irrigation is assumed to seep into the soil, and, therefore, does not contribute to wastewater production.
g. Numbers may not add exactly due to rounding.
h. "Total Daily Demand" includes both potable and non-potable water demand.
i. City and County of San Francisco, Planning Department, *San Francisco Kaiser Medical Center Geary Campus Development Project, Final Environmental Impact Report*, 95.102E, Volume I, April 10, 1997, pp. 215, 216.

Source: EIP Associates.

FEIR to 1,507,000 gross sq. ft. for the project, which represents an increase in water demand, from 23,750 gpd to about 170,000 gpd. The two differences described above account for an increased demand of approximately 900,000 gpd.

The water demand factor used in this SEIR for irrigating open space was 2,300 gallons per day per acre (gpd/acre), a yearly average./27/ The 1990 FEIR used a water demand factor of 300 gpd/acre./28/ The SEIR has slightly more open space than Alternative A in the 1990 FEIR. These differences are reflected in the increased water demand for irrigation in the SEIR (100,000 gpd) from that in the 1990 FEIR (12,990 gpd).

The 900,000 gpd variance due to the differences in Commercial Industrial uses and the increase in retail use, combined with the approximately 100,000 gpd difference for irrigation, account for a total increase over the 1990 FEIR of approximately 1,000,000 gpd.

Reclaimed Water

The daily demand for reclaimed water at build-out in Mission Bay North and Mission Bay South is shown in Table L.4.

TABLE L.4 ●
MISSION BAY PROJECT DAILY RECLAIMED WATER DEMAND AT BUILD-OUT (2015)
MISSION BAY NORTH AND SOUTH

Non-Irrigation Water Demand

Land Use	Building Floor Area (gsf)	Water Demand Factor /a/ Toilet Flushing	Water Demand Factor /a/ Cooling Systems /b/	Total Daily Demand (gal)
Commercial Industrial	5,557,000	17 gal/1,000 gsf	6 gal/100 gsf	430,000
UCSF /c/	2,650,000	N/A	N/A	0
Neighborhood-serving Retail	257,000	17 gal/1,000 gsf	6 gal/100 gsf	20,000
Moderate Scale Retail	805,000	17 gal/1,000 gsf	6 gal/100 gsf	62,000
Commercial Entertainment	445,000	17 gal/1,000 gsf	6 gal/100 gsf	34,000
Community Facilities /d/	171,000	17 gal/1,000 gsf	6 gal/100 gsf	13,000
Hotel /e/	480,000	N/A	6 gal/100 gsf	29,000
Hotel /f/	500 (rooms)	4.8 gal/room	N/A	2,400
Subtotal-Non-Irrigation				*590,000*

Irrigation Water Demand

	Area (acres)	Water Demand Factor /g/	Total Daily Demand (gal)
Irrigated Open Space/h/	47	2,300 gal/acre	100,000
Landscaping /i/		N/A	290,000
Subtotal-Irrigation			*390,000*

Total Non-Potable Water Demand (gal/day)/j/	**980,000**
Total Non-Potable Water Demand (mgd)	**0.98**
Total Potable Water Demand (mgd)	**1.9**
Project Citywide Potable Water Consumption (mgd) /k/	**80.4**
% of Citywide Potable Water Consumption (mgd)	**2.4%**

Notes:
du = dwelling units
gal = gallons
gsf = gross square feet
N/A = not available

a. Dennis Gellermon, Principal Engineer, Montgomery Watson, facsimile to EIP Associates, August 20, 1997. Montgomery Watson prepared the *Recycled Water Master Plan* for the City and County of San Francisco.
b. All buildings are assumed to have central cooling systems.
c. UCSF projected non-potable water demand is not included in the total Daily Non-Potable Water Demand because UCSF indicates that it is not subject to San Francisco 390-91 and 391-91.

(Continued)

TABLE L.4 ● (continued)

Notes (continued):

d. Assumes 75% coverage of site.
e. Hotel water demand is divided due to different generation factors. Cooling system use if calculated by square footage, while toilet flushings are calculated by number of rooms.
f. Based on 3 flushes/room/day on a 1.6 gal/flush toilet.
g. City and County of San Francisco, San Francisco Department of Public Works and San Francisco Water Department, *Draft Recycled Water Master Plan,* July 1996, Table 3-1. Irrigation water demand factor is an average annual demand; water demand would be higher in the summer and lower in the winter.
h. Irrigation value is a daily value averaged throughout the year. Water consumption may be higher in the summer and lower in the winter.
i. Based on 10% of the total water demand. This is the amount of water that was eliminated from the wastewater generation total because it was assumed to be used for landscaping.
j. The Total Non-Potable Water Demand estimate is a conservatively large value for the proposed project. All commercial buildings are assumed to have dual-piping; but some buildings may be smaller than 40,000 square feet, thus not requiring dual-piping. Additionally, Catellus engineers believe the cooling system water demand factor (6 gal/100 gsf) is relatively high.
k. City and County of San Francisco, Planning Department, *San Francisco Recycled Water Master Plan and Groundwater Master Plan Final Environmental Impact Report*, 92.371E, November 1, 1996, p. 455.

Source: EIP Associates.

NOTES: Appendix L, Community Services and Utilities

1. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.7.*

2. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, pp. I.3.7, I.3.11.*

3. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.17.*

4. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.41.*

5. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, pp. I.3.41-I.3.50.*

6. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.25.*

7. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, pp. I.3.25-I.3.40.*

8. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.3.*

9. San Francisco Planning Department, *San Francisco General Plan*, Recreation and Open Space Element, p. I.3.37.*

10. San Francisco Planning Department, *San Francisco General Plan*, *Mission Bay Plan*, p. 3-1.*

11. San Francisco Planning Department, *San Francisco General Plan*, *Mission Bay Plan*, p. 3-3.*

12. San Francisco Planning Department, *San Francisco General Plan*, *Mission Bay Plan*, p. 3-37.*

13. San Francisco Planning Department, *San Francisco General Plan*, *Mission Bay Plan*, p. 3-37.*

14. San Francisco Planning Department, *San Francisco General Plan*, *Central Waterfront Plan*, p. II.8.11.*

15. San Francisco Planning Department, *San Francisco General Plan*, *Central Waterfront Plan*, p. II.8.15 - II.8.16.*

16. San Francisco Bay Conservation and Development Commission, *San Francisco Bay Plan*, January 1969 as amended, and with amendments since December 1988, p. 3.*

17. San Francisco Bay Conservation and Development Commission, *San Francisco Waterfront Special Area Plan*, April 1975 as amended.*

18. Association of Bay Area Governments, *Projections '96, Forecasts for the San Francisco Bay Area to the Year 2015*, December 1995, p. 216.

19. Hausrath Economics Group, Employment and Population Estimates for the Proposed Project and the Alternatives and Cumulative Growth Scenario for San Francisco and the Rest of the Region, 1995 - 2015, Memorandum to EIP Associates, August 7, 1997.

20. San Francisco Planning Department, *Mission Bay Final Environmental Impact Report*, Planning Department File No. 86.505E, State Clearinghouse No. 86070113, certified August 23, 1990, Volume Three, p. XIV.D.42.*

21. National Solid Wastes Management Association, Basic Data: Solid Waste Amounts, Composition and Management, *Technical Bulletin #85-6*, October 1, 1985.

22. City and County of San Francisco, *Solid Waste Generation Study*, prepared by Brown, Vence & Associates, October 1992, pp. 4-12.

23. 1990 FEIR, Volume Three, p. XIV.D.41.*

24. 1990 FEIR, Volume Two, p. VI.D.22.*

25. City and County of San Francisco, San Francisco Department of Public Works, *Recycled Water Master Plan*, Revised Draft, July 1996, Table 3-1.

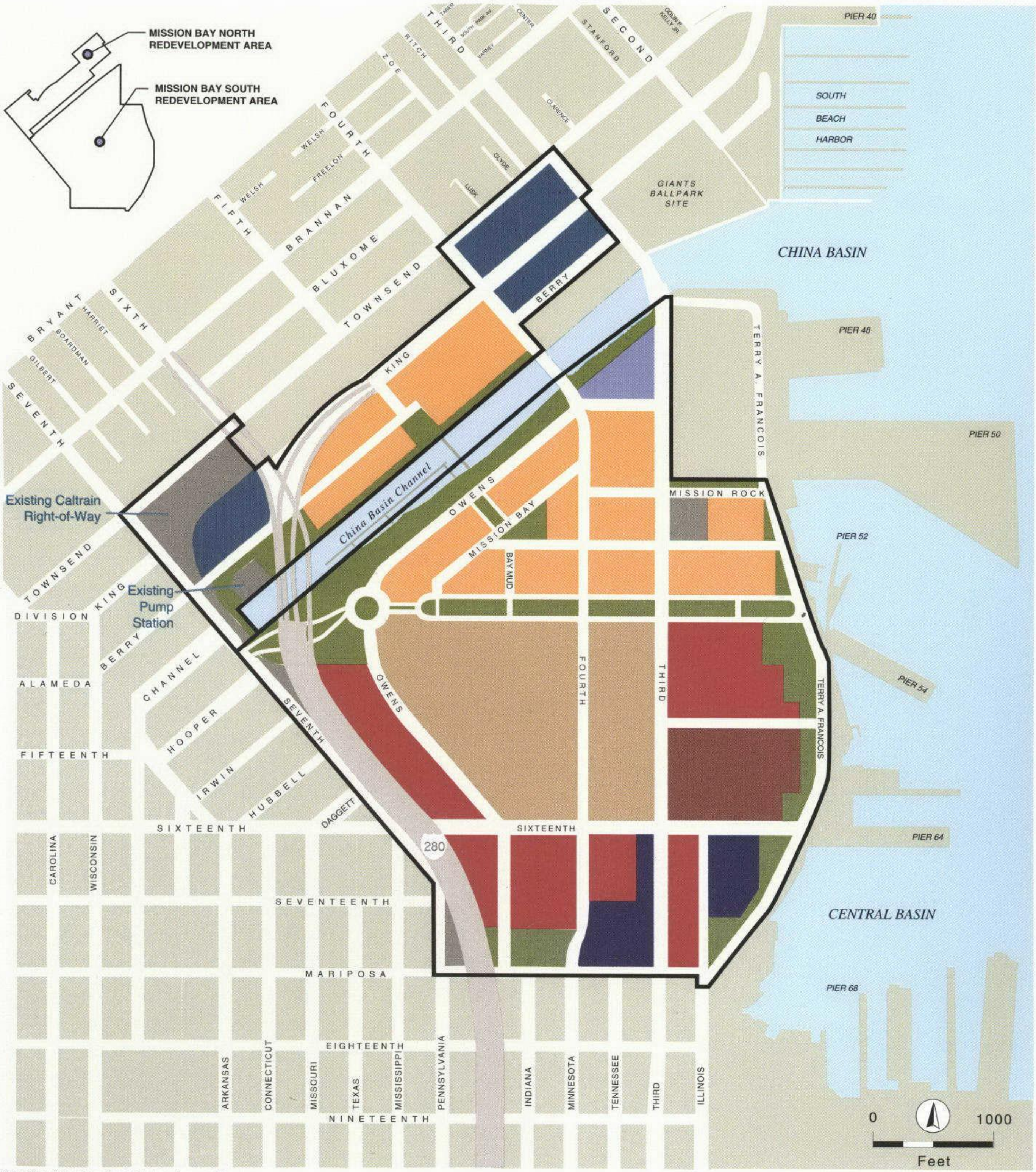
26. 1990 FEIR, Volume Two, p. XIV.D.39.*

27. City and County of San Francisco, San Francisco Department of Public Works, *Recycled Water Master Plan*, Revised Draft, July 1996, Table 3-1.

28. 1990 FEIR, Volume Three, p. XIV.D.39.*

* A copy of this report is on file for public review at the Office of Environmental Review, Planning Department, 1660 Mission Street, San Francisco.

EIP
ASSOCIATES



SOURCE: San Francisco Redevelopment Agency

- COMMERCIAL INDUSTRIAL
- COMMERCIAL INDUSTRIAL / RETAIL
- MISSION BAY NORTH RETAIL
- MISSION BAY SOUTH RETAIL
- MISSION BAY RESIDENTIAL
- HOTEL
- MISSION BAY OPEN SPACE
- UCSF (includes City school site)
- MISSION BAY PUBLIC FACILITIES
- PROPOSED BOUNDARIES OF MISSION BAY REDEVELOPMENT AREAS

NOTE: See Table III.A.2 for types and amounts of uses.

LAND USE PROGRAM ANALYZED AS THE PROJECT IN THE DRAFT EIR

SEE INSIDE FRONT COVER FOR THE COMBINATION OF PROJECT FEATURES AND VARIANTS AS ADOPTED