NATIONAL SEMICONDUCTOR CORPORATION
SANTA CLARA, SANTA CLARA COUNTY, CALIFORNIA
CERCLIS NO. CAD041472986
JUNE 23, 1993

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

PUBLIC HEALTH ASSESSMENT

NATIONAL SEMICONDUCTOR CORPORATION

SANTA CLARA, SANTA CLARA COUNTY, CALIFORNIA

CERCLIS NO. CAD041472986

Prepared by
California Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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SUMMARY

The California Department of Health Services (CDHS) has prepared this public health assessment under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). The CDHS/ATSDR Public Health Assessment is a mechanism to provide the community with information on the public health implications of specific hazardous waste sites and identify those populations for which further health actions or studies are indicated. The public health assessment of National Semiconductor Corporation is based on a review of the Remedial Investigation (RI)(1) and Baseline Public Health Evaluation (2), in conjunction with a site visit and consultation with staff from the California Regional Water Quality Control Board (RWQCB). The report serves to update the ATSDR Preliminary Public Health Assessment for National Semiconductor Corporation (3), completed by ATSDR in December 1988.

The National Semiconductor Corporation site, located in Santa Clara, Santa Clara County, California, was placed on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA) on July 21, 1987. The RWQCB is the lead governmental agency for the cleanup at the NSC site. Several underground acid waste and solvent sumps and tanks, leaks in chemical piping, and aboveground chemical storage areas apparently leaked volatile organic compounds (VOCs), semi-volatile compounds, and metals into the subsurface soils and groundwater (1). Some of these underground tanks and some but not all of the surrounding contaminated soil have been excavated and removed from the site (1). Various organic and inorganic pollutants have been detected in on-site and off-site groundwater at levels of human concern (1). However the contaminated groundwater is not a source of drinking water (1). On-site groundwater extraction and treatment systems have been in operation since 1985; and an off-site system since 1988 (1).

Based on information reviewed, CDHS has concluded that the NSC/former UTC site is an indeterminate public health hazard. Off-site resident and worker exposure is predicted by an indoor air-model but the exposure is at a level below that of health concern. On-site worker exposure from the inhalation of vapor arising from the contaminated soil and groundwater may potentially be occurring.

In the future (and perhaps currently and in the past), residents may be exposed to the contaminated groundwater by drilling and using private wells as a drinking water source. Significant exposure to groundwater contaminants is unlikely if 1) the groundwater treatment system reduces contaminants to below levels of health concern and 2) future drinking water wells are not placed in areas of known contamination.

The potentially exposed population living within a mile north of the site consists of 5,780 persons. Approximately 75-110 people attended a community meeting that was set up by RWQCB to discuss issues of remediation in May, 1991. Several attendees questioned the safety of the water: were there municipal wells around the site that were being impacted and if so was the contaminated water from the site being mixed with the water from other clean sources. The issue of chemicals volatizing up from the contaminated water through the soil and accumulating in homes is an issue that had been raised at other sites in Santa Clara

Valley. As had happened in relation to other sites, this group raised the question about whether there would be indoor air monitoring in people's homes. Someone also addressed the issue of workers' health in view of the old buildings on-site.

CDHS and ATSDR recommend the following:

In the areas of known groundwater contamination, implement institutional controls to prevent future use of contaminated aquifers for drinking water supplies until remediation has reduced contaminant concentrations to below levels of health concern.

Continue monitoring the active wells in the area of NSC: Pepsico, Hilton, and the City of Santa Clara well. If contaminants are measured at levels of health concern in either the Pepsico or the City of Santa Clara well then the water should not be used for drinking water purposes.

If the area to the north of AMD/Arques but south of U.S. Highway 101 is ever rezoned to be residential, review the inhalation exposure of volatilized compounds from contaminated groundwater for those proposed residences.

Conduct indoor air monitoring in the buildings on-site (Buildings A, C, 2, 3, 19) to ascertain the impact from compounds that potentially could be migrating from the contaminated soil.

Conduct a detailed well inventory to clearly identify the status of the wells known to have previously been drilled in the area.

Notify well-owners in the site area for which the well information cannot confirm proper abandonment to inform them of the potential chemical hazard of drawing water from their wells.

The data and information developed in the National Semiconductor Corporation public health assessment have been evaluated by the ATSDR Health Activities Recommendation Panel (HARP) for follow-up health activities. The available evidence does not indicate that humans are or have been exposed to site related contaminants at levels which could cause illness or disease. Therefore, if a follow-up site area well inventory identifies well owners who have not properly abandoned their wells, then these owners will be notified and informed that the water from those wells may pose a health hazard if used for domestic purposes. If additional data become available, ATSDR and the California Department of Health Services will reevaluate this site for any indicated follow-up health activities.

BACKGROUND

A. SITE DESCRIPTION AND HISTORY

The National Semiconductor Corporation (NSC) facility covers approximately 60 acres at 2900 Semiconductor Drive in Santa Clara, California (Figure 1). For the purposes of the soil and groundwater cleanup, the NSC site also includes the former United Technologies Corporation (UTC) facility of about 10 acres located approximately 200 feet northwest of the NSC facility and the area downgradient of the NSC facility boundary to Arques Avenue (Figure 1). Groundwater pollution (Operable Unit 1) from NSC, UTC, and a nearby Advanced Micro Devices facility (AMD Arques) has moved off of the facilities properties, merged, and has moved downgradient beyond the AMD Arques facility to the north beyond U.S. Highway 101 (Figure 1).

Located near the middle of the Santa Clara Valley, the NSC/UTC facility is 14 miles north of the Santa Cruz Mountains and 6 miles south of the San Francisco Bay. The cities of San Jose and San Francisco are approximately 6 miles southeast and 40 miles northwest, respectively, of the site. Prior to 1960, land use was agricultural. In 1960, two small semiconductor research/manufacturing facilities were built on the east end of the property. These operations ceased after several years. Then in 1967, NSC started semiconductor manufacturing. In addition, Nortech conducted similar operations on property now leased by NSC from 1968 to 1977. The NSC facility continues to be used for semiconductor manufacturing, and research and development. Dyna-Craft, Inc., a subsidiary of NSC, currently occupies Buildings 1, 2, and 9 on the NSC site (Figure 2).

The UTC property was the site of research, development, and small-scale testing of rocket propellants from 1960 to 1982. Two buildings were present on the site but Hewlett Packard (HP) bought the property from UTC between 1982 and 1983 and removed the UTC buildings and auxiliary facilities. HP subsequently constructed a park, conference facility, and parking facilities on the site.

The major sources of the contamination at the NSC site are due to leakage from numerous underground tanks, sumps, and pipes and drum storage areas (1). The potential sources of contamination have been associated with 24 underground acid-waste sumps, 17 underground waste solvent tanks, and associated underground piping, 11 above ground drum storage areas, and 3 solvent dump stations (1). NSC under the direction of the RWQCB found contaminated soil near some of these possible source areas. To date, NSC has removed many of those leaking underground sumps and tanks, discontinued using others, and secondarily contained others. Some contaminated soil still remains. The proposed soil cleanup includes further soil excavation followed by off-site disposal, excavation followed by on-site aeration and on-site disposal, and soil vacuum extraction (4). Additionally, the groundwater beneath NSC and UTC is contaminated with many of the same compounds that contaminate the soil.

Figure 1. National Semiconductor Site

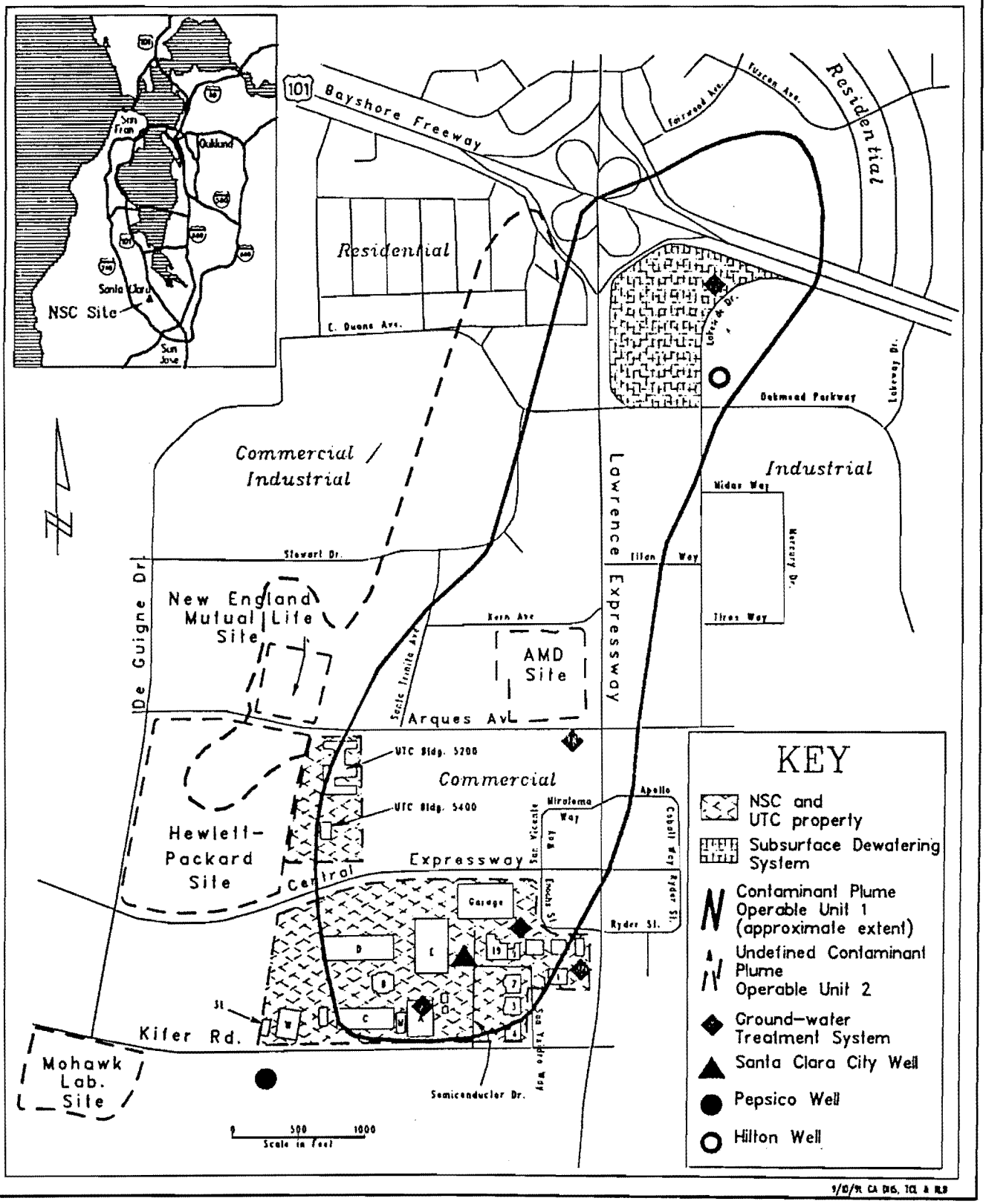
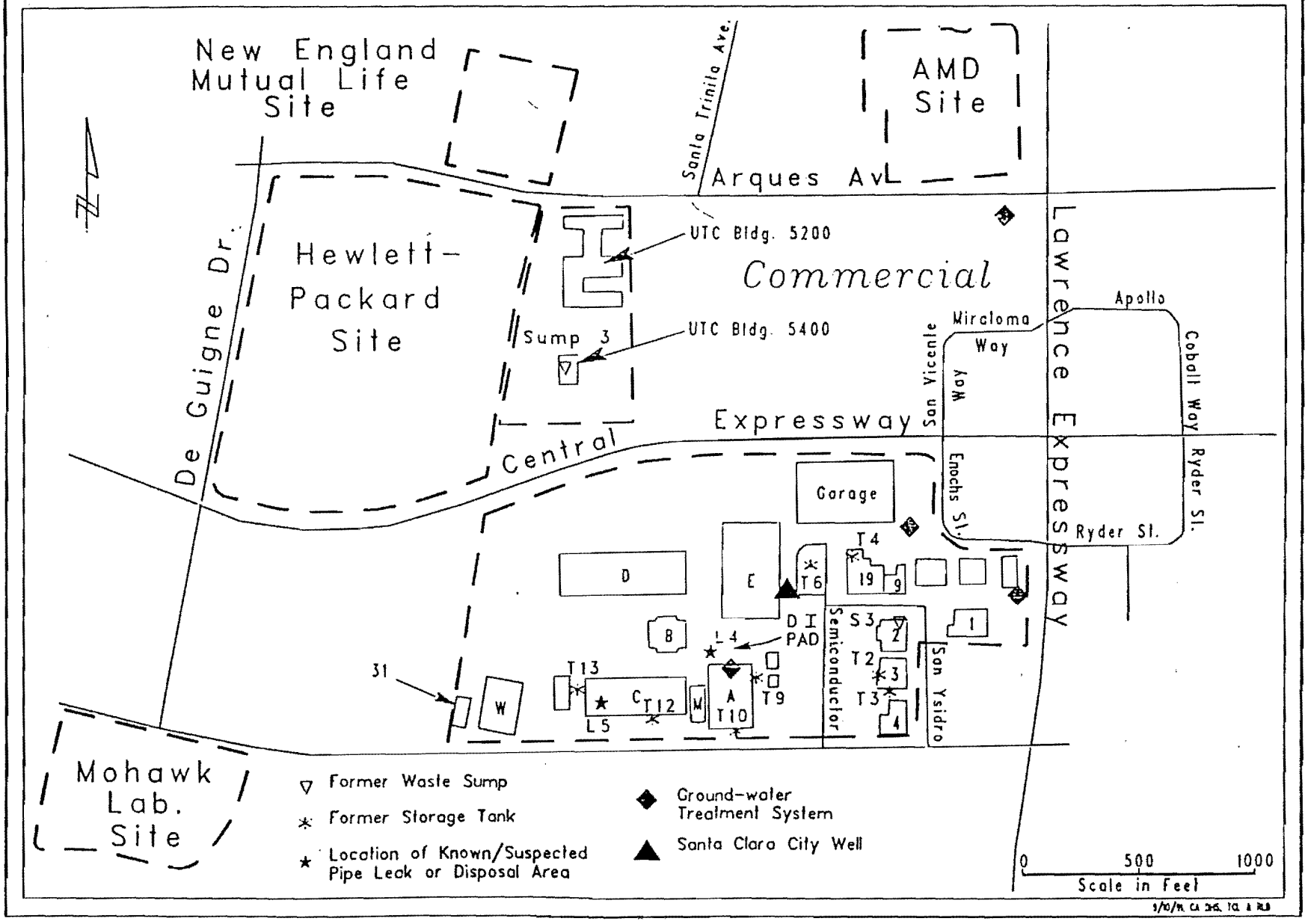


Figure 2. National Semiconductor Contamination Sources



In addition to the sources of contamination that have been identified on the NSC site (collectively referring to the NSC and UTC property), RWQCB has identified other sources within close proximity to the NSC site that have contributed to the downgradient plume that is part of Operable Unit 1 (Figure 1). A property owned by Advanced Micro Devices (AMD Arques), formerly Monolithic Memories, Inc. (MMI), is located downgradient from the NSC site and is also an NPL site. AMD Arques is investigating the extent of contamination, has already removed several leaking underground tanks and associated contaminated soil, and has installed and is operating an on-site groundwater extraction and treatment system.

Groundwater contamination from the NSC, UTC, and AMD Arques facilities has moved off of the facilities' property, merged, and has moved downgradient (north to northeast) beyond the AMD Arques facility and beyond U.S. Highway 101 (1). NSC has installed and is operating both on-site and off-site groundwater treatment systems.

Hewlett-Packard, Mohawk Laboratories, KTI Chemicals, and MACOM/New England Life are also suspected to have contributed to the groundwater pollution (Figure 1). Because some of these site investigations are not yet complete, the western edge of the groundwater contamination has not yet been identified, and thus that part of the plume will be considered as a separate unit (Operable Unit 2). This public health assessment will only evaluate the impact of Operable Unit 1, the contamination on the NSC and former UTC properties and the off-site plume north to northeast of these two sites.

B. SITE VISIT

The CDHS/ATSDR staff visited the NSC site on May 29, 1991. The Groundwater Program Manager for NSC assisted us in observing the NSC property layout. The NSC property is tightly controlled. Buildings A, M, C, D, and E are fenced together so entry into the interior space must be gained through the secured entrances of Building A or C or several different security-controlled fence-gate entrances. The solvent pad, which is outside this enclosed area, is surrounded by a chain-link fence. The buildings now occupied by Dyna-Craft are more accessible but tanks and drum storage areas are all surrounded by chain-link fencing. Department of Transportation chemical warning signs were evident on the fences surrounding the chemical-storage area.

Buildings and asphalt cover the majority of the site. There is a beautifully landscaped area to the west of Building B, the employee cafeteria. Additionally, there is grass covering the ground in front and to the sides of Buildings 2 and 3. To the west of Building C is the drum storage area, where we observed considerable oil waste that had accumulated on the cement surface. Otherwise the asphalt surfaces were unremarkable.

We observed a number of employees both within and outside the buildings. The NSC representative said that approximately 1200 people currently work at NSC. Numerous delivery trucks and vans gain access to the NSC property through a gate between Buildings

A and E and load and unload in the DI area behind Building A. Similarly, trucks unload and load behind Buildings 19, 9, 2, and 3.

The air strippers located behind Buildings 9 and 1 are situated in corners of parking lots and are not surrounded by any fences. The air stripper located behind a gas station on the corner of Arques Avenue and the Lawrence Expressway is surrounded by a chain-link fence.

The former UTC property, now occupied by HP, is covered with grass, a few tennis courts, a basketball court, a parking lot, and one building which is used as a conference facility. Several office buildings, a gas station, and an unkept empty lot overgrown with weeds occupy the area to the east of the former UTC property, to the north of the NSC property, and to the south of Arques Avenue.

C. DEMOGRAPHICS, LAND USE, AND NATURAL RESOURCE FEATURES

Demographics

According to 1990 census information, 5,780 people live in 1,814 housing units within a mile north of the National Semiconductor site. Seventy-four percent (74%) of this population is 18 years of age or older. The current census information does not give any further breakdown of housing units or age-specific information. The census data show the ethnic/racial breakdown as follows: 38% white (not Hispanic), 36% Asian/Pacific Islander (not Hispanic), 22% Hispanic, 3% black (not Hispanic).

Land Use

National Semiconductor is located in a large industrial park area. The Planning Department of the City of Sunnyvale estimates 17,450 employees work in the industrial park area surrounding the National Semiconductor property. The nearest residences downgradient of the site are located to the west of the northwestern edge of the plume and to the north of U.S. Highway 101, approximately 1 mile (Figure 1).

Natural Resource Features

Groundwater

Three major water-bearing zones (aquifers)-defined as the A-, B- and C-aquifer zones-exist at the site (1). The A-aquifer is the shallowest and the C-aquifer is the deepest of these three zones. The B-aquifer is further defined into the B1 to B3 zones. The approximate depths (below ground level) at which these zones occur at the NSC site are as follows: A: 5-25 ft; B1: 30-45 ft; B2: 50-65 ft; and B3: 70-90 ft. Deeper aquifers (B4 and B5) are reported to be present below the B3-aquifer in the study area. A regional aquitard, the B-C aquitard, is reportedly located at a depth range from 100-150 ft below ground level. The C-aquifer,

which supplies most of the municipal water in the region, is located below the regional aquitard.

A well survey of the site area indicates the presence of 38 wells not associated with the remediation, although only 20 wells are located within the current contaminated plume (15). Of the 38 total wells, 17 have been destroyed. Many of the wells are now located under parking lots or buildings even if they were not first destroyed. A few of them are located on residential property and their status is unknown.

Three of the wells located within the contaminant plume are deep (>100 feet, C-aquifer), production wells (15): a City of Santa Clara production well, the Hilton well, and the Pepsico well (Figure 1).

The shallow aquifers encountered beneath and downgradient of the NSC site vary in thickness and consist of relatively moderate to high permeability sands and gravels (1). The aquifers are separated by relatively low permeability clay and silt aquitards (groundwater barriers) of varying lateral continuity (1). For instance, in some areas (Lawrence Highway and Highway 101 intersection) the A/B1 aquitard is not present, resulting in a combined A/B1 aquifer (1).

In general, the groundwater flows from the south-southwest to north-northeast (1). The A-aquifer is currently not completely saturated due to the regional drought and local pumping associated with groundwater remediation, whereas the B-aquifers are currently saturated. There is hydraulic interconnection between the A- and B1-aquifers and the B1- and B2-aquifers (1). The predominant flow trend is downward, although upward flow appears to occur in some area, particularly those in which the A-aquifer has been extensively dewatered (1).

Surface water

No natural surface drainage features traverse the area of investigation (1). Surface runoff in the area is channeled to storm sewers, and subsequently to Calabazas Creek, a tributary to San Francisco Bay (1). Several ornamental ponds are present on the NSC site; they are filled with city well water. An artificial lake, which is filled with deep well water, is present at the Hilton Hotel near Lawrence Expressway and U.S. Highway 101.

Calabazas Creek, the creek closest to the site, is approximately 4,000 feet east of the site and flows north to Guadalope Slough and South San Francisco Bay (1). The creek typically discharges 90% of its annual flow during the five winter months and is nearly dry during the rest of the year (1). Water is derived from natural surface runoff and point source discharges into the creek under National Pollutant Discharge Elimination System (NPDES) permits. Depending on local and seasonal water table fluctuations, the creek may receive water from or contribute to the uppermost aquifer (A-aquifer).

D. HEALTH OUTCOME DATA

There are two CDHS health outcome registries currently operating in the area of NSC. The state's cancer reporting system (CDHS California Tumor Registry) began collecting data for the region that includes the former NSC site and surrounding area in 1988. The CDHS Birth Defects Monitoring Program began collecting data for Santa Clara County in 1983.

COMMUNITY HEALTH CONCERNS

The community relations staff from CDHS/ATSDR spoke with city officials from Santa Clara, officials from the Santa Clara Health Department, two Santa Clara County Board of Supervisors staff persons, and the community relations staff from the EPA and the CDHS Toxic Substances Control Program. None of the individuals contacted were aware of any recent community health concerns regarding the National Semiconductor site.

Following the discovery of the contamination at the Fairchild and IBM facilities in South San Jose in the early 1980s, the community became concerned about groundwater contamination in Santa Clara County. In November, 1982, a group of environmental, labor and other organizations upset about groundwater contamination formed the Silicon Valley Toxics Coalition. The Coalition organized residents around some of the hazardous waste sites with the result that residents in the South Bay became generally more knowledgeable about the issue of groundwater contamination.

In January 1990, the RWQCB released their Community Relations Plan for the City of Santa Clara incorporating the plans for five Superfund sites including National Semiconductor into a single plan. (5). This plan identified the primary historical concerns in Santa Clara area as being: concern about the quality of drinking water; whether the extent of the problem had been discovered; what would happen if the contamination spread; what was being done to cleanup the soil and groundwater; what happened to contaminated groundwater that was pumped out; what the schedule for clean-up is; and how the property values would be affected?

In April 1990, RWQCB released Fact Sheet 1 describing the pollution problem, the investigation and cleanup and the projected schedule for the development and selection of alternatives for final cleanup of the site (6). The second NSC fact sheet from RWQCB became available in June, 1991. (7). The purpose of this fact sheet was to present the proposed soil and groundwater cleanup. It stated that it would take 100 years to reduce VOC concentration in all groundwater to cleanup standards which would protect human health and the environment (7). The fact sheet also announced the public comment period and the Community Meeting on June 27, 1991.

Approximately 75-100 people attended the Community Meeting, June 27, 1991. The format was similar to other community meetings in that the RWQCB Project Manager gave a

description of the site and cleanup alternatives. In an attempt to describe why the western edge of ground-water contamination had not been defined, RWQCB presented the concept of Operable Units. Operable Unit 1 was the area where cleanup would begin and Operable Unit 2 might be delayed for up to a year in order to define the western edge of the plume.

The issues of concern that were raised at the meeting are the following:

1. Are the Courtyard Condominiums on Evelyn Terrace affected by the hazardous waste site?

2. Is it possible that the plumes from AMD901/902/Signetics/TRW and NSC have commingled?

3. What will be the future extraction plan?

4. Will vapor monitoring occur and where?

5. What is the risk from the hazardous waste site to workers in the 20-year old buildings at the site?

6. Is the water safe to drink?

7. Are Proposition 65 warnings appropriate?

8. Is the contaminated soil at the site still contaminating the groundwater?

9. Can vapors from the shallow aquifer follow the sewer system back up into houses?

10. Is it possible to increase the capacity and treat more water so that it can be cleaned up faster?

11. Can there be residential toxic vapor monitoring?

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

The tables in this section list the contaminants of concern. We evaluate these contaminants in the subsequent sections of the Public Health Assessment and determine whether exposure to them has public health significance. ATSDR selects and discusses these contaminants based upon the following factors (8):

1. Concentrations of contaminants on and off the site.

2. Field data quality, laboratory data quality, and sample design.

3. Comparison of on-site and off-site concentrations with background concentrations, if available.

4. Comparison of on-site and off-site concentrations with public health assessment comparison values for (1) noncarcinogenic endpoints and (2) carcinogenic endpoints.

5. Community health concerns.

In the following sections dealing with On-site Contamination and the Off-site Contamination, the listing of a contaminant does not mean that it will cause adverse health effects from exposures. Instead, the list indicates which contaminants will be evaluated further in the Public Health Assessment. When selected as a contaminant of concern in one medium, that contaminant will be reported in all media.

The data tables include the following acronyms:

EMEG	=	ATSDR Environmental Media Evaluation Guide
CREG	=	ATSDR Cancer Risk Evaluation Guide
NREG	=	ATSDR Noncancer Risk Evaluation Guide
EPA MCLG	=	Federal Maximum Contaminant Level Goal
EPA MCL	=	Federal Maximum Contaminant Level
CA MCL	=	California Maximum Contaminant Level
CA AL	=	California Action Level
ppm	=	parts per million (equivalent to milligram per kilogram, mg/kg)
ppb	=	parts per billion (equivalent to microgram per liter, μg/L)

Comparison values for the public health assessment are contaminant concentrations in specific media that are used to select contaminants for further evaluation. EMEGS are media-specific values developed by ATSDR to serve as an aid in selecting environmental contaminants that need to be further evaluated for potential health impacts. EMEGs are based on noncarcinogenic health endpoints and do not consider carcinogenic effects. CREGs are media-specific values developed by ATSDR to serve as an aid in selecting contaminants for follow-up that are potential carcinogens. CREGs are based on EPA cancer slope factors which give an indication of the relative carcinogenic potency of a particular chemical. NREGs are similar to EMEGs, in that they are evaluating the noncarcinogenic effects of a particular chemical. NREGs are derived using the EPA Reference Dose (RfD). The RfD is

an estimate of a daily exposure to a particular compound that is unlikely to cause adverse, noncarcinogenic health effects.

EPA's Maximum Contaminant Level Goal (MCLG) is a drinking water health goal, that represents the concentration that no known or anticipated adverse effect on the health of persons should occur, including an adequate margin of safety. Maximum Contaminant Levels (MCLs) represent contaminant concentrations that EPA or CDHS deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters water per day. California's Action Levels (CA AL) are health-based concentration levels designed to limit exposure to substances not yet regulated by formal standards. While MCLs are regulatory concentrations, EMEGs, CREGs, NREGs, MCLGs, and CA ALs are not.

Toxic Chemical Release Inventory

Ongoing facility and/or surrounding facilities emissions may be contributing an additional environmental burden to the nearby population. Therefore, the CDHS staff searched the Toxic Chemical Release Inventory (TRI) for the years 1987, 1988, and 1989 (the years for which TRI data is currently available). The TRI contains information on estimated annual releases (emission rates) of toxic chemicals to the environment (via air, water, soil, or underground injection) whether these releases are routine releases, spills and other accidental releases, or occasional releases from normal operation. Toxic chemical release information is submitted to the EPA by certain industries as mandated under the Emergency Planning and Community Right-to Know Act of 1986.

As provided in TRI, NSC reported in 1987 that NSC facilities released into the air 94,300 pounds of 15 different chemicals including Freon 113, phenol, xylene, methanol, 1,2,4-trichlorobenzene, acetone, and copper (9). NSC reportedly released 500 pounds of methanol and 250 pounds of ammonia into surface water (9). Six facilities in the one zip code area surrounding the NSC facility reported the release of 352,690 pounds of chemicals, primarily VOCs and acids, into the air in 1987 (9). In 1987, these facilities reportedly released 11,700 pounds of 1,1,1-trichloroethane, 70,388 pounds of acetone, 120,100 pounds of Freon 113, 23,010 pounds of xylenes, 500 pounds of 1,2,4-trichlorobenzene, and 2,650 pounds of phenol (9).

As provided in TRI, NSC reported in 1988 that NSC facilities released into the air 70,622 pounds of 11 different chemicals including Freon 113, xylene, methanol, 1,2,4-trichlorobenzene, and acetone (10). Seven facilities in the one zip code area surrounding the NSC facility reported the release of 766,144 pounds of chemicals, primarily VOCs and acids, into the air in 1988 (10). In 1988, these facilities reportedly released 14,725 pounds of 1,1,1-trichloroethane, 18,710 pounds of acetone, 133,720 pounds of Freon 113, 6,354 pounds of xylenes, and 11,974 pounds of 1,2,4-trichlorobenzene (10).

As provided in TRI, NSC reported in 1989 that NSC facilities released into the air 100,070 pounds of 11 different chemicals including Freon 113, xylene, methanol, 1,2,4-trichlorobenzene, and acetone (11). NSC reportedly released 379 pounds of sulfuric acid, nitric acid, phosphoric acid, and hydrogen fluoride into surface water (11). Eight facilities in the one zip code area surrounding the NSC facility reported the release of 438,711 pounds of chemicals, primarily VOCs and acids, into the air in 1989 (11). These facilities reportedly released 20,378 pound of 1,1,1-trichloroethane, 91,830 pounds of acetone, 149,914 pounds of Freon 113, 19,544 pounds of xylenes and 7,630 pounds of 1,2,4-trichlorobenzene (11).

These releases are from typical operations occurring at the plant and are not as a result of the underground tank/spillage problem.

A. ON-SITE CONTAMINATION

Subsurface Soil

In 1982, NSC began soil sampling to investigate possible point sources of contamination (1). Volatile organic compounds (VOCs) were analyzed for and found at several locations. Subsequently, several underground solvent tanks were excavated and removed from the site, abandoned in place, or secondarily contained. Unfortunately, there is little documentation of these excavations.

Sporadic soil analyses were conducted every year from 1984-1991 (1). Eventually NSC had sampled the subsurface soils around approximately 32 underground sources, such as buried pipes, tanks, and sumps. NSC also sampled soils within several above ground drum or oil storage areas and around a couple of solvent dump stations. The soil samples were generally analyzed for aliphatic and aromatic VOCs and for metals (Table I), but often times the metal analyses were conducted in different years of soil sampling and at different depths than were the VOC analyses. Some soil samples were also analyzed for semi-volatile compounds such as phenol-derivatives, oil and gasoline constituents, etc. These soil investigations led to further excavations of leaking underground tanks and contaminated soil.

The maximum concentrations of acetone, 1,2-dichlorobenzene, trans-1,2-dichloroethylene, ethylbenzene, naphthalene, tetrachloroethylene, 1,2,4-trichlorobenzene, trichloroethylene, and xylenes remaining in the on-site subsurface soil exceed their corresponding comparison values and therefore are the contaminants of concern remaining in the soil (Table I). Comparison values for oil and grease, copper, and lead do not yet exist; therefore, these compounds are considered compounds of concern in the remaining contaminated subsurface soil (Table I). Ethyl benzene and xylenes are the most often detected and most concentrated of the contaminants found in the subsurface soil samples.

Chloroform, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,1-dichloroethylene, cis-1,2-dichloroethylene, Freon 113, phenol, toluene, and 1,1,1-trichloroethane have been detected

in a few subsurface soil samples, but the concentrations are low and do not exceed their comparison values.

Concentrations of arsenic, boron, copper, lead, nickel, and tin in some of the subsurface soil samples exceed the concentrations typically found in regional soil (Table I). The concentrations of arsenic, boron, nickel, and tin in the subsurface soil samples do not exceed their comparison values. In the absence of comparison values reference criteria for copper and lead, these compounds are considered contaminants of concern in the subsurface soil.

Groundwater-Monitoring wells

Since 1982, NSC has installed 51 on-site monitoring wells to characterize the vertical and horizontal extent of contamination (1). The most contaminated wells are located near or downgradient of Buildings 2 and 3, Building A, and the DI Pad. Additionally, UTC had installed 19 monitoring wells on its property prior to NSC taking over clean-up responsibilities.

The largest concentrations of organic chemicals are found in the A- and B1-aquifers, although organic chemicals have been detected in the B2-aquifer (Table II). There are no on-site wells monitoring the B3-aquifer.

The shallowest aquifer (A) is or has been contaminated with acetone, benzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,1-dichlorethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, ethyl benzene, Freon 113, pentachlorophenol, phenol, tetrachloroethylene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, trichloroethylene, vinyl chloride, xylenes, arsenic, lead, and nickel at concentrations exceeding their comparison values (EMEG, CREG, NREG, EPA MCLG, CA AL, EPA or CA MCL)(Table II)(12-14).

The B1-aquifer is or has been contaminated with 1,4-dichlorobenzene, 1,1-dichlorethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, tetrachloroethylene, trichloroethylene, and vinyl chloride at concentrations exceeding their comparison values (EMEG, CREG, NREG, EPA MCLG, CA AL, EPA or CA MCL)(Table II)(12-14).

The B2-aquifer is or has been contaminated with cis-1,2-dichloroethylene, tetrachloroethylene, and trichloroethylene at concentrations exceeding their comparison values (EMEG, CREG, NREG, EPA MCLG, CA AL, EPA or CA MCL)(Table II)(12-14).

Extraction wells

Since 1985, NSC has installed 21 extraction wells on-site: 11 draw from the A-aquifer, 8 draw from both the A- and B1-aquifers, and two draw from the B1-aquifer (1). Seven

TABLE I. POLLUTANTS IN ON-SITE SOIL AT THE NATIONAL SEMICONDUCTOR CORPORATION SITE.

Contaminant	Sample depth (feet)	Maximum concentration (ppm)	Detection Ratio (#Detect/ Analyses)	Comparison Value (ppm); Source*	*Contaminant of Concern
Acetone	9-9.5 14.5-15	40 1,400	11/85	200; NREG	Yes
Benzene	--	nd	0/169	24; CREG	
Chloroform	9-12	0.001 or 0.002	2/103	115; CREG 1,000;EMEG	
1,2-Dichlorobenzene	10-10.5 15.5	210 110	17/148	180 NREG	Yes
1,4-Dichlorobenzene	10-10.5 15.5	70 20	13/148	29; CREG	
1,1-Dichloroethane	10-10.5 15-15.5	0.060 0.220	6/102	200; NREG	
1,1-Dichloroethylene	10-10.5 15-15.5	0.500 0.050	5/138	1.2; CREG 400; EMEG	
cis-1,2- Dichloroethylene	10-11.5 15.5-16	0.024 0.099	17/127	20; NREG	
trans-1,2- Dichloroethylene	3.5-5.0	86	2/139	40; NREG	Yes
Ethylbenzene	5.5-6.5 10.5-11 15.5-16	10 220 3,900	32/164	200; NREG	Yes
Freon 113	10-10.5 16-16.5	0.180 1.5	12/114	6000; NREG	
Oil and grease (total)	0.5-1	120	1/1		Yes
Naphthalene	10.5-11 15.5-16	41 0.360	3/35	8; NREG	Yes
Pentachlorophenol	--	nd	0/35	5.8; CREG	
Phenol	4.5 7-7.5	1.2 3	5/38	1,200; NREG	
Tetrachloroethylene	3.5-5.0 11.5-12 17.5-18	31 1 2	41/170	20; NREG	Yes

Contaminant	Sample depth (feet)	Maximum concentration (ppm)	Detection Ratio (#Detect/ Analyses)	Comparison Value (ppm); Source*	Contaminant of Concern
Toluene	3.5-5.0 10.5-11 17.5-18	5 0.097 2.2	40/178	400; NREG	
1,2,4- Trichlorobenzene	10.5-11 15.5-16	2,200 12	15/38	2.6; NREG	Yes
1,1,1-Trichloroethane	10-10.5 17.5-18	50 3.2	34/140	180; NREG	
Trichloroethylene	3.5-5.0 10-10.5 15.5-16	67 0.810 1.4	50/570	64; CREG	Yes
Vinyl chloride	–	nd	0/103	0.4; CREG 50;EMEG(c)	
Xylenes	3.0-5.5 10.5-11 15.5-16	53 1,000 9,400	52/164	4,000; NREG	Yes
Arsenic	5-5.5 10-10.5 15-15.5	22.1 15.3 12.9	41/71	50;EMEG(c) 6-8; regional background	
Boron	10-10.5	54	7/10	180; NREG <20; regional background	
Copper	5-5.6 10.5-11 15.5-16	244 44.7 39.6	33/89	30; regional background	Yes
Lead	4.5-5 10-10.5 15-15.5	676 9.4 5.8	60/84	30; regional background	Yes
Nickel	5-5.5 10.5-11 15.5-16	45.4 80 82.3	58/84	1,000;EMEG(c) 30; regional background	
Tin	5-6.5 11-11.5	91 2.6	10/81	1200; NREG 2-10; regional background	

nd = not detected above detection limits

*See introduction to the Environmental Contamination section for explanation of the comparison value.

TABLE II.
ON-SITE GROUNDWATER CONTAMINATION IN MONITORING WELLS LOCATED AT THE NATIONAL SEMICONDUCTOR SITE

Contaminant	Aquifer	Maximum Historical Concentration (ppb)	Current Maximum Concentration (ppb)	Comparison Value (ppb): Source	Contaminant of Concern in On-site Groundwater
Acetone	A B1 B2	340,000 10 48	na	1,000; NREG	Yes
Benzene	A B1 B2	14 nd nd	nd	1.2; CREG	Yes
Chloroform	A B1 B2	820 1 3	nd nd 1.3	200; EMEG 5.7; CREG	Yes
1,2-Dichlorobenzene	A B1 B2	820 1 3	nd nd 1.3	130; CA AL 600; EPA MCL	Yes
1,4-Dichlorobenzene	A B1 B2	7,300 17 nd	15 nd nd	1.5; CREG	Yes
1,1-Dichloroethane	A B1 B2	18,000 320 120	1300 15 nd	1,000; NREG	Yes
1,1-Dichloroethylene	A B1 B2	6,400 170 nd	1400 nd nd	90; EMEG 0.06; CREG	Yes
cis-1,2-Dichloroethylene	A B1 B2	20,260 6,800 5,256	3400 970 2.5	100; NREG	Yes
trans-1,2-Dichloroethylene	A B1 B2	13,000 16,000 21	nd nd nd	200; NREG	Yes
Ethylbenzene	A B1 B2	38,000 24 32	11,000	1,000; NREG	Yes
Freon 113	A B1 B2	4,652 978 99	3,300 530 31	1,200; CA MCL	Yes
Naphthalene	A B1 B2	31 nd nd	na	40; NREG	
Oil and Grease (total)	all	na	na		

Contaminant	Aquifer	Maximum Historical Concentration (ppb)	Current Maximum Concentration (ppb)	Comparison Value (ppb): Source	Contaminant of Concern in On-site Groundwater
Pentachlorophenol	A B1 B2	87 nd nd	nd nd	0.3; CREG	Yes
Phenol	A B1 B2	320 nd nd	nd nd	6,000; NREG	
Tetrachloroethylene	A B1 B2	880 70 3	400 11 nd	0.7; CREG	Yes
Toluene	A B1 B2	810 nd 100	nd	2,000; NREG	
1,2,4-Trichorobenzene	A B1 B2	710 nd nd	na	13; NREG	Yes
1,1,1-Trichloroethane	A B1 B2	76,000 55 72	1,200 14 nd	900; NREG	Yes
Trichloroethylene	A B1 B2	23,960 8,000 1,938	4,300 400 2.5	3; CREG	Yes
Vinyl chloride	A B1 B2	120,000 36 nd	1,300 nd nd	10; EMEG 0.015; CREG	Yes
Xylenes	A B1 B2	175,000 40 140	35,000	20,000; NREG	Yes
Arsenic	A	167	8.4	10; EMEG	Yes
Copper	A	540	nd	1,300; EPA MCLG	
Lead	A	177	nd	50; CA MCL 5; proposed EPA MCL	Yes
Nickel	A	2,200	378	200; EMEG	Yes

nd = not detected above detection limits
na = not analyzed

A-aquifer extraction wells and one B1-aquifer well are currently not operating due to the low water table (13). The water drawn from these extraction wells is treated by either the two air-strippers or an acid fume scrubber (on top of Building A) on the NSC property (1). The treated groundwater is discharged by NPDES permit into a storm sewer tributary to Calabazas Creek (1).

Municipal wells

A city well was installed in October 1980 on NSC property (Figure 1). The well draws from eight places across aquifers that range from 265 to 639 feet below ground surface. The monthly well water analyses performed by the City of Santa Clara show that trans-1,2-dichloroethylene has been detected at concentrations ranging from 0.5 to 0.7 ppb from May, 1986 to June, 1989 (4). These concentrations are well below the comparison value (CA MCL= 10 ppb). NSC believes that due to the geohydraulics, it is unlikely that the trans-1,2-dichloroethylene is a result of the shallow groundwater contamination associated with the NSC hazardous waste site (4).

B. OFF-SITE CONTAMINATION

Soil-gas emission

In response to requests from RWQCB, AMD and NSC hired a consultant to conduct soil gas flux measurements off-site. On July 17, 1991, soil gas flux emission using the isolated flux chamber was measured at five locations in the vicinity of Kern Avenue and Lawrence Expressway (17). All collected samples were analyzed for 1,1-dichloroethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, tetrachloroethylene, trichloroethylene, and vinyl chloride. None of these compounds were detected in any of the samples at detection levels of 0.1 ppb.

Groundwater-Monitoring wells

NSC has installed 56 monitoring wells to investigate the horizontal and vertical extent of off-site groundwater contamination (1). Additionally, UTC installed 24 monitoring wells off-site of its property prior to NSC taking over the investigation (1). At this time only VOCs have migrated off-site. The largest concentrations of VOCs are found in the A- and B1-aquifers, although organic chemicals have been detected in the B2-aquifer (Table III)(12-14).

1,1-Dichloroethylene, cis-1,2-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, and Freon 113 are used as indicators for the contaminant plume (Figure 1) because they are detected in a large number of monitoring wells at very elevated concentrations (12-14). At this time the contaminant plume extends north above U.S. Highway 101 almost to Tuscon Avenue.

The shallowest aquifer (A) is or has been contaminated with chloroform, 1,1-dichlorethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride at concentrations exceeding their comparison values, (EMEG, NREG, CREG, CA AL, EPA MCLG, EPA or CA MCL) (Table III) (12-14). The B1-aquifer is or has been contaminated with chloroform, 1,1-dichlorethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, Freon 113, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride at concentrations exceeding their comparison values (EMEG, NREG, CREG, EPA MCLG, CA AL, EPA or CA MCL) (Table III)(12-14).

The B2-aquifer is or has been contaminated with 1,1-dichloroethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, tetrachloroethylene, and trichloroethylene at concentrations exceeding their comparison values (EMEG, NREG, CREG, EPA MCLG, CA AL, EPA or CA MCL)(Table III)(12-14).

There are three off-site wells monitoring the B3-aquifer. The B3-aquifer seems to be uncontaminated except for a single detection of 1,1,1-trichloroethane (0.7 ppb, May, 1990), and this concentration is well below a level of health concern, (NREG=900 ppb).

Since 1989, NSC periodically analyzes the groundwater from two off-site A-aquifer monitoring wells for arsenic and no arsenic has been detected (Table III)(12-14).

Extraction wells

Since 1988, NSC has installed 15 extraction wells off-site: 3 draw from the A-aquifer, 9 draw from both the A- and B1-aquifers, and three draw from the B1-aquifer (1). One each of the A-, A-/B1-, and B1-aquifer wells is currently not operating due to the low water table (13). The majority of the off-site extraction wells are located along Arques Avenue from the Lawrence Expressway to the edge of the former UTC property (1). The water drawn from the active extraction wells is treated by an air-stripper located on the corner of Arques Avenue and the Lawrence Expressway (1). The treated groundwater is discharged by NPDES permit into a storm sewer tributary to Calabazas Creek (1).

Private wells

A deep production well, the Hilton well, was installed March, 1976 on the Sunnyvale Hilton Inn located on Lakeside Drive, near Highway 101 (4). It provides water to an artificial lake adjacent to the Hilton Inn and operates infrequently. The well is 260 feet deep and draws from several aquifers between 115 and 260 feet deep. Low levels of VOCs have been detected in the well in the past, but not in recent monitoring. In 1988, the water in the artificial lake was analyzed for VOCs and none were detected (14).

A well, located at the Pepsico bottling plant at 960 Kifer Road and upgradient from the NSC contamination plume, is at least 429 feet deep and screened at several intervals between 125

and 429 feet (4). NSC samples the water from this well on a yearly basis and no VOCs have been detected in such sampling (4).

C. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

ATSDR presumes that site investigation protocols and analytical data have been reviewed and accepted by the agencies for which the work is being performed. The data used in the preparation of this Public Health Assessment have been reviewed and qualified appropriately. The completeness and reliability of relevant reference information determines the validity of the conclusions drawn in this Public Health Assessment.

D. PHYSICAL AND OTHER HAZARDS

No physical hazards appear to be present at the site.

PATHWAYS ANALYSES

A. ENVIRONMENTAL PATHWAYS (FATE AND TRANSPORT)

Surface soil

NSC claims the nature of their chemical handling procedures and the available soil chemical data indicate chemicals that could pose a direct soil contact risk are only present several feet below ground level. There is sufficient evidence showing that subsurface soil is contaminated. On the other hand, almost no data address the question of surface contamination. Thus while ATSDR/CDHS does not support the NSC claim concerning the lack of surface soil contamination, we do recognize that a risk associated with skin contact or fugitive dust generation is probably minimal or non-existing, because the soils are paved and landscaped.

TABLE III.
GROUNDWATER CONTAMINATION OFF-SITE OF THE NATIONAL SEMI-CONDUCTOR CORPORATION SITE

Contaminant	Aquifer	Maximum Historical Concentration (ppb)	Current Maximum Concentration (ppb)	Comparison Value (ppb); Source	Contaminant of Concern in Off-site Groundwater
Acetone	A B1 B2 B3	na na na na	na na na na	1,000; NREG	
Benzene	A B1 B2 B3	nd nd nd na	na na na na	1.2; CREG	
Chloroform	A B1 B2 B3	9 50 0.9 nd	4.3 nd nd nd	200; EMEG 5.7; CREG	Yes
1,2-Dichlorobenzene	A B1 B2 B3	nd 7.9 nd nd	nd nd nd nd	130; CA AL 600; EPA MCL	
1,4-Dichlorobenzene	A B1 B2 B3	0.7 nd nd nd	nd nd nd nd	1.5; CREG	
1,1-Dichloroethane	A B1 B2 B3	300 39 nd nd	nd 4.3 nd nd	1,000; NREG	Yes
1,1-Dichloroethylene	A B1 B2 B3	180 210 2 nd	1 4.1 nd nd	90; EMEG 0.06; CREG	Yes
cis-1,2-Dichloroethylene	A B1 B2 B3	3,400 3,600 160 nd	280 900 33 nd	100; NREG	Yes

Contaminant	Aquifer	Maximum Historical Concentration (ppb)	Current Maximum Concentration (ppb)	Comparison Value (ppb); Source	Contaminant of Concern in Off-site Groundwater
trans-1,2-Dichloroethylene	A B1 B2 B3	4,500 11,000 300 nd	nd nd nd nd	200; NREG	Yes
Ethylbenzene	A B1 B2 B3	15 nd nd na	na na na na	1,000; NREG	
Freon 113 (1,1,2-trichloro-1,2,2-trifluroethane)	A B1 B2 B3	880 2,500 77 nd	13 75 3.9 nd	1,200; CA MCL	Yes
Napthalene "paint thinner"	A B1 B2 B3	nd nd nd na	na na na na	40; NREG	
Oil and Grease (total)	all	na	na		
Pentachlorophenol	A B1 B2 B3	nd nd nd na	na nd na na	0.3; CREG	
Phenol	A B1 B2 B3	nd nd nd na	na nd na na	6,000; NREG	
Tetrachloroethylene	A B1 B2 B3	320 6.1 20 nd	nd nd nd nd	0.7; CREG	Yes
Toluene	A B1 B2 B3	1.3 nd nd na	na na na na	2,000; NREG	Yes
1,2,4-Trichorobenzene	A B1 B2 B3	nd nd nd na	na na na na	13; NREG	

Contaminant	Aquifer	Maximum Historical Concentration (ppb)	Current Maximum Concentration (ppb)	Comparison Value (ppb); Source	Contaminant of Concern in Off-site Groundwater
1,1,1-Trichloroethane	A B1 B2 B3	740 1,400 32 0.7	7.8 3.6 nd nd	900; NREG	Yes
Trichloroethylene	A B1 B2 B3	7,800 2,800 300 nd	700 1,100 8.5 nd	3; CREG	Yes
Vinyl chloride	A B1 B2 B3	11 59 nd nd	nd 1.7 nd nd	0.015; CREG 10; EMEG	Yes
Xylenes	A B1 B2 B3	25 5 nd na	na na na na	20,000; NREG	
Arsenic	A	nd	nd	10; EMEG	
Copper	A	nd	na	1,300; EPA MCLG	
Lead	A	nd	na	50; CA MCL 5; proposed EPA MCL	
Nickel	A	nd	na	200; EMEG	

nd = not detected above detection limits
nt = not analyzed for

Subsurface soil

Eleven areas on the NSC facility property and one area on the former UTC facility property have been identified for subsurface soil remediation (Table IV) because these contaminants may continue to migrate from the soil to the underlying groundwater. The RWQCB has suggested a general cleanup level of 1 ppm for total VOCs in soil in order to be protective of groundwater in the Santa Clara Valley. The proposed subsurface soil remediation techniques include excavation and on-site soil aeration and on-site and off-site Class III landfill disposal, excavation and disposal off-site at a Class I landfill, and soil vacuum extraction with off-gas treated by catalytic incinerator or carbon adsorption (4). Near-surface soil (<5 feet below ground surface) is to be excavated; whereas, VOC-bearing soils at depths greater than 5 feet would be treated in place by soil vapor extraction (4). Soil cleanup is expected to be complete within 5 years (4).

There is the possibility for human exposure, to remedial workers, to occur or to have occurred during contaminated soil remediation such as the excavation, transport, and disposal of the contaminated soils. Additionally, there is a concern for any workers that may be doing invasive soil activity as a part of a construction project, for instance.

Groundwater

The current extraction system does not capture the entire plume (4). Groundwater modeling shows that four additional A-aquifer wells and three additional B1-aquifer wells are required to capture the northern portion of the plume (near Lakeside Drive). Some of the monitoring wells located in the Lakeside Drive area are to be converted to extraction wells (4). This model assumed that the companies responsible for the contamination in Operable Unit 2 would install extraction systems to address the western edges of contamination (4). This model predicts that 91% of the A-aquifer chemical contamination and 97% of the B1-aquifer chemical contamination would be extracted after 50 years (4).

In early July 1990, a subsurface drain system was installed at the parcel bordered by U.S. Highway 101, Lawrence Expressway, and Lakeside Drive (Figure 1)(1). The drains were installed as a permanent dewatering system for a new condominium complex. A total of 9 south-north and 2 east-west drain pipes were installed to a depth of approximately 20 feet below the ground surface. The drains flow to a collection sump in the northwest corner of the parcel. Groundwater collected in the sump is pumped out continuously and discharged under a temporary permit to the sanitary sewer. In the future, the discharge from the subsurface drain system and the water drawn by one or more existing nearby A-aquifer wells are to be piped to a proposed groundwater treatment system (ozone oxidation system) to be located near Lakeside Drive (4). On a quarterly basis, a sample of the drainage water is collected at the point that it discharges into the sanitary sewer and analyzed by NSC for contaminants (4).

A well survey of the site area indicates the presence of 38 wells not associated with the remediation, although only 20 wells are located within the current contaminated plume (15). Of the 38 total wells, 17 have been destroyed. Many of the wells are now located under parking lots or buildings even if they were not first destroyed. A few of them are located on residential property and their status is unknown.

Three of the wells located within the contaminant plume are deep (>100 feet, C-aquifer), production wells (15): a City of Santa Clara production well, the Hilton well, and the Pepsico well (Figure 1). Site-associated contamination is believed to be confined to the first three aquifers (A, B1, and B2), i.e., to a depth of approximately 65 feet.

The monthly well water analyses performed by the City of Santa Clara show that trans-1,2-dichloroethylene has been detected at concentrations ranging from 0.5 to 0.7 ppb from May, 1986 to June, 1989 (4) in the well located on the NSC property. These concentrations are well below the drinking water standard for trans-1,2-dichloroethylene (10 ppb). During the work week (Monday through Friday), the City well supplies water to NSC's deionized water system and on weekends is available to supplement the City's municipal water system (4). The City uses 10-20% of the water to blend with other water in its distribution system. Apparently 20 other wells are used by the City on a full-time or part-time basis, therefore the dilution factor is large.

Low levels of VOCs have been detected in the deep well that supplies water to the artificial lake at the Hilton Inn on Lakeside Drive. Recently the well monitoring revealed no contamination. In 1988, NSC analyzed the water in the artificial lake and no VOCs were detected.

No contaminants have been detected in the Pepsico deep well which is sampled on a yearly basis. The water from the Pepsico well is used for bottling.

TABLE IV.
POINTS SOURCES OF SOIL CONTAMINATION NEEDING REMEDIATION (4)

AREA	POTENTIAL POINT SOURCE	STATUS	INFORMATION SOIL REMOVAL	CONTAMINATION STATUS
Bldg. A	Waste solvent tank T9	Removed (3/84)	180 cu. yd. soil removed	Contamination not documented
Bldg. A	Waste solvent tank T10	Removed (1982)	15 cu. yd. soil removed, 1984	Tetrachloroethylene, 1,2-dichlorobenzene, toluene, and xylenes
Bldg. C	Waste solvent tank T12	Removed (1982)	No soil removed	Contamination unknown
Bldg. C	Waste solvent tank T13	Removed (1982)	30 cu. yds. soil removed	Up to 1 foot: oil and grease At 9 feet: xylenes, ethylbenzene, acetone, and 1,2-dichlorobenzene
Bldg. C	Leak in waste collection trench L5	Repaired	No information	1,2-Dichlorobenzene, 1,4-dichlorobenzene, trichlorobenzene, acetone, xylenes, phenol
Bldg. 2	Acid waste sump S3	Removed	No information	Trichloroethylene, xylenes, ethylbenzene, and Freon 113
Bldg. 3	Waste solvent tank T2	Removed	100 cu. yds. soil removed	1,1,1-Trichloroethane, ethylbenzene, xylenes
Bldg. 3	Waste solvent tank T3	Removed	No information	Tetrachloroethylene, ethylbenzene, xylenes, dichlorobenzene, cis-1,2-dichloroethylene
Bldg. 19	Waste solvent tank T4	Tank replaced in 1990 appeared to be in tack	Tank is secondarily contained	Acetone, xylene, ethylbenzene
DI Pad	Former solvent dump station L4	No information	35 cu. yds. soil removed, 1989	Trichloroethylene, trans-1,2-dichloroethylene, xylenes, toluene, tetrachloroethylene
Solvent Pad	Waste solvent tank T6	T6 filled with concrete	No soil removed	Xylenes, ethylbenzene, Freon 113
UTC 5400	Acid neutralization sump 3	Removed 1983	No information	Trichloroethylene, 1,1,1-Trichloroethane. More chemicals found in soil gas.

Surface water

Contamination of any surface water such as Calabazas Creek via soil erosion and overland runoff is unlikely to occur since the contaminated soils are covered by asphalt and the creek is located 1000 feet to the east of the northern tip of the contaminant plume. Additionally, the groundwater plume is moving in a direction that parallels the flow of the creek, toward the San Francisco Bay, therefore the contamination from the groundwater should not impact the creek.

The water extracted from the contaminated groundwater plume is treated by either an air-stripper or an acid-fume scrubber that will remove the majority of VOCs but will not remove semi-volatile organics or metals. Therefore, pentachlorophenol, phenol, 1,2,4-trichlorobenzene, arsenic, lead, or nickel present in the groundwater will not be removed before it is discharged to the sewer system which eventually empties into Calabazas Creek. Recent analyses of the treated water leaving the air-strippers indicates the concentrations of metals being discharged to the sewer system are not elevated (16).

Consumable Biota

There are no current, or indicated future, pathways in which consumable biota could be exposed to site-related contaminants. Furthermore, the contaminants detected in the groundwater and subsurface soils are not expected to significantly bioaccumulate in plant or animal tissues.

Air

VOCs in the subsurface soil may diffuse upward through the subsurface and surface soils, ultimately being released to the ambient air or creeping into confined spaces such NSC buildings.

VOCs transported off-site by groundwater may volatilize and diffuse through the subsurface and surface soils, ultimately being released to the ambient air or creeping into confined spaces such as homes or other buildings. Soil-gas flux chamber sampling was recently performed off-site from NSC and within the contaminant plume to address this exposure (17). No VOCs were found to be emitted from the soil.

The Bay Area Air Quality Management District (BAAQMD) permits the use of two air-strippers and an acid-fume scrubber for the on-site ground-water extraction systems. NSC estimates that in 1989 (the last year for which data are available) the two on-site air strippers released a combined 199 pounds of trichloroethylene, 17.8 pounds of 1,1,1-trichloroethane, and 7.6 pounds of Freon 113 per year to the air (18). The off-site air stripper is permitted by BAAQMD to release no greater than 2.9 pounds per day (or 1060 pounds per year) of chlorinated compounds to the air (19).

Some of the proposed soil remediation and the future Lakeside Drive extraction system will also be regulated by the BAAQMD.

B. HUMAN EXPOSURE PATHWAYS

Human exposure pathways that may have potentially occurred or that may be occurring at the NSC site:

*Inhalation of organic compounds volatilizing from off-site groundwater

Human exposure is likely, as a result of organic compounds volatilizing off-site from the contaminated groundwater and accumulating within buildings (residences and off-site businesses). This route can only be proposed, since no indoor air sampling has occurred.

A theoretical indoor-air model was used to estimate the air concentrations within single-family residences located within the contaminated plume around U.S. Highway 101 (2). Air concentrations were modeled from nearby groundwater concentrations (2). This model uses various parameters including: 1) area of infiltration (crawlspace or crack around perimeter of home), 2) the fraction of air that infiltrates from the crawlspace, 3) the air exchange rate of the home, and 4) the air-filled porosity of the soil.

According to the theoretical indoor air model, concentrations of trichloroethylene in off-site residences north of U.S. Highway 101 (2.8 $\mu g/m^3$) or south of U.S. Highway 101 (1.7 $\mu g/m^3$) are below the air quality guidance value (California Department of Health Services Applied Action Levels, AALs) of 7 $\mu g/m^3$. Besides trichloroethylene, the predicted concentrations of 1,1-dichloroethane, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, Freon 113, or 1,1,1-trichloroethane were also calculated.

Soil-gas flux sampling off-site did not detect VOCs arising from the soil (i.e., the groundwater)(17). The relevancy of these data to indoor air accumulation is still in question (20); therefore, these data can not necessarily be used to support the conclusions of the indoor air modelling.

*Inhalation of organic compounds volatilizing from on-site contaminated groundwater and soil

It is likely that migration of organic chemical compounds from on-site contaminated groundwater and contaminated soil may be occurring within buildings on the NSC property, especially within Buildings C and 3 where both soil and groundwater contamination currently exists.

A completed exposure pathway that may occur in the future:

*Ingestion of contaminated groundwater and inhalation of volatilized organic compounds from groundwater during showering or other usage of the contaminated groundwater

The concentrations of site-related contaminants in groundwater (as shown in Tables II and III) are at levels that would be of potential public health concern if domestic use of the contaminated groundwater occurred (2).

One municipal well currently exists on NSC property, but there is no NSC-related contamination in the deep aquifers from which it draws. Additionally, at this time, sufficient water for municipal use is available from aquifers having higher quality water and water yield.

A well study has identified a number of wells that had previously been operational in the area of the groundwater contamination. It has been the conclusion of NSC that almost all of these are not actively used anymore. One active private well is used for drinking water purposes. It draws from a deep aquifer and has not been contaminated.
The Santa Clara Valley Water District does not permit the drilling of any future wells that would be screened at depths shallower than 50 feet. However, there is contamination of aquifers as deep as 65 feet, thus any water drawn from these deeper contaminated aquifers would not be suitable for drinking water.

PUBLIC HEALTH IMPLICATIONS

A. TOXICOLOGICAL EVALUATION

A quantitative risk assessment for the inhalation of volatilizing VOCs from the groundwater for current residents living north and south of U.S. Highway 101 was completed (2). The concentrations of organic contaminants accumulating in a house as developed by the indoor air model were used in this assessment (2). The "plausible maximum" exposure was assumed to be 24 hours per day, 365 days per year for 30 years of residence (2). The "average" exposure was assumed to be 16 hours per day, 365 days per year for 9 years of residence (2). Possible carcinogenic and noncarcinogenic adverse health impacts were evaluated for the contaminants of concern. The discussion of those possible health endpoints follows.

Carcinogenic Health Effects

Trichloroethylene, currently under review by EPA for carcinogenic effects, was the only possible carcinogen detected in the groundwater samples from the monitoring wells around U.S. Highway 101 used for this scenario. Thus all carcinogenic risks for this pathway are due to the potential exposure to trichloroethylene.

Lifetime excess cancer risk for the residents living north of U.S. Highway 101 ranged from 3.0×10^{-7} ("no increased risk") for the least conservative estimate and 5.0×10^{-6} ("no increased risk") for upperbound worst-case conditions (2). Lifetime excess cancer risk for the residents living south of U.S. Highway 101 ranged from 4.0×10^{-7} ("no increased risk") for the least conservative estimate and 3.0×10^{-6} ("no increased risk") for upperbound worst-case conditions (2). For comparison, EPA considers an excess cancer risk of 1 in 10,000 (1×10^{-4}) to 1 in 1,000,000 (1×10^{-6}) as appropriate clean-up goals.

Potential risks for residents south of U.S. Highway 101 and within the contaminated groundwater plume were assessed for the noncarcinogenic effects of 1,1-dichloroethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, and 1,1,1-trichloroethane (2). These compounds and Freon 113 were considered for noncarcinogenic risks to residents living north of U.S. Highway 101. The analyses indicated that the inhalation of organic contaminants from off-site groundwater would not result in adverse noncarcinogenic effects (2).

A theoretical indoor-air model, similar to that described above, needs to be developed for the potential exposure of on-site workers to compounds volatilizing from the contaminated groundwater and soil and accumulating within the NSC buildings. As an alternative, CDHS adapted the risk of inhaling VOCs from the contaminated groundwater by future residents living on the NSC property that had been developed in the Baseline Public Health Evaluation (2). While this model is not exactly the same as a model for on-site worker exposure, it is helpful. The exposure parameters were identical to those described above, i.e. they are greater than those for worker exposure which is typically 8 hours per day, 260 days per year for 10 or 30 years.

The lifetime excess cancer risk caused by the inhalation of volatilizing organic contaminants from the shallow groundwater was estimated from the addition of the individual risks to the seven potential carcinogens found in on-site monitoring wells: benzene, vinyl chloride, chloroform, tetrachloroethylene, trichloroethylene, 1,1-dichlorethylene, and chloromethane (2).

Lifetime excess cancer risk from inhalation of chemicals volatilizing from shallow groundwater for future on-site residents ranged from 5.0×10^{-5} ("no apparent increased risk") for the least conservative estimate and 4.0×10^{-4} ("low increased risk") for upperbound worst-case conditions (2). Therefore, taking into account the smaller exposure parameters, the risk for current on-site workers is approximately 1.8×10^{-5} ("no apparent increased risk") to 9.4×10^{-5} ("no apparent increased risk").

Noncarciogenic Health Effects

Potential risks were also assessed for future on-site residents exposure to the noncarcinogenic effects of certain compounds found in on-site monitoring wells (1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, ethyl benzene, Freon 113, 1,1,1-trichloroethane, and xylenes)(2). The analyses indicated that the inhalation of organic contaminants from on-site groundwater by future on-site residents would not result in adverse noncarcinogenic effects (2). Therefore it follows that on-site workers, with less exposure than residents, would not be expected to experience any noncarcinogenic effects.

In the model, the volatilization of compounds from the contaminated groundwater but not the contaminated soil was evaluated. Since there is a considerable amount of contaminated soil remaining beneath some buildings, the volatilization of compounds from the soil into the on-site buildings could potentially pose an additional health concern.

Although the concentrations of site-related contaminants in groundwater are at levels that would be of potential public health concern if domestic use of the contaminated groundwater occurred, supposedly there are no private wells that are affected at levels of health concern. Additionally, the municipal water that is drawn from the deep aquifers has shown low levels of VOCs, levels not associated with adverse health effects, and the water is diluted before it is delivered to the city water customers.

B. HEALTH OUTCOME DATA EVALUATION

There have been no epidemiological studies (i.e., evaluations of disease patterns with respect to chemical exposure patterns) conducted to determine whether releases of hazardous substances from the NSC site have resulted in increased disease rates in populations exposed to the contaminant of concern.

The CDHS California Tumor Registry recently released a preliminary report on 1988 data for the entire state including Santa Clara County (21). This cancer incidence information may ultimately be useful in a future cancer investigation study, but by itself it should be viewed carefully since historical background cancer rates for the region are unavailable, and data collection during the first year of cancer registries' operation usually results in underreporting (22). Additionally, due to the presumed biological lag time (usually up to 10 years or more) from exposure to cancer development, the cancer incidence for 1988 would probably not reflect effects of exposure that occurred in previous years at the NSC hazardous waste site.

The CDHS Birth Defects Monitoring Program has been collecting data for Santa Clara County since 1983 but the low level of chemical exposure that might arise from this site's contamination does not warrant the utilization of such data (23).

NSC is part of the local industry group, Semiconductor Industry Association (SIA). SIA has contracted with scientists at the University of California at Davis, Department of Occupational Medicine to conduct a series of epidemiological studies on the workers in fifteen SIA-member semiconductor manufacturing facilities (one of which is NSC). A prospective study will attempt to measure rates of conception, spontaneous abortion, and other pregnancy characteristics by following female employees working in the semiconductor manufacturing rooms (fabrication rooms) and in the non-manufacturing areas. The second is a retrospective study of spontaneous abortions among female employees working in fabrication rooms. The last is a cross-sectional study of both male and female fabrication workers to determine general health effects and infertility among males. In conjunction with these studies, SIA has contracted with University of Massachusetts researchers to conduct an industrial hygiene study to characterize the work environment through assessment of chemical and physical agents and ergonomic stressors. The study report is due to be released to SIA in December, 1992. When this information is available it will provide some insight into the reproductive and other health effects of working at places such as NSC but may not provide much insight into the effects of working at the NSC hazardous waste site. On the other hand, since the compounds that the workers are exposed to are the same compounds that are in the soil and groundwater these studies may provide a better understanding of the health effects that might result from such low level exposures as arise in "clean rooms" where semiconductors are produced.

C. COMMUNITY HEALTH CONCERNS EVALUATION

We have addressed each of the community concerns about health as follows:

1. How fast does the plume move?

   The plume in its natural state without any pumping is estimated to move between 50 and 100 feet per year.

2. Are the Courtyard Condominiums on Evelyn Terrace affected by the hazardous waste site?

   The groundwater flow in the area is in a north/northeast direction toward U.S. Highway 101. Since the condominium complex is south of the NSC site, the groundwater at the complex would not be affected.

3. Are the A- and B-aquifers the same for the AMD 901/902/Signetics/TRW site and NSC?

   The aquifers were formed at the same time so they have the same geologic names. However, they are not connected hydrologically which means that they are not physically connected and that chemicals would not get from AMD 901/902/TRW to the NSC site.

4. Is it possible that the plumes from AMD901/902/Signetics/TRW and NSC have commingled?

   The groundwater from NSC flows north/northeast so it would not be expected that it would go in a direction to commingle with the AMD/Signetics/TRW plume.

5. What will be the future water extraction plan?

   Near U.S. Highway 101 and Lakeside Drive there is a dewatering system which consists of a series of drains that flow to a sump where groundwater is collected and pumped into the sanitary sewer. The dewatering system discharges into the sanitary sewer under a temporary permit from the City of Sunnyvale Public Works Department. This water has not been treated but the concentration of contaminants is low.

   The additional extraction wells are going to be located just south of U.S. Highway 101 along Lakeside Drive. There will also be an air stripper treatment unit placed in that neighborhood. It is possible that the water from the dewatering system will also be treated at this air stripper unit.

6. Will vapor monitoring occur and where?

   Soil-gas (vapor) monitoring was conducted in July 1991 at locations near Kern Avenue and Lawrence Expressway. No VOCs were detected arising from the soil.

7. When did the site become a Superfund site and how many Superfund sites are in the South Bay?

   The site became a Superfund site in July, 1987. There are 28 Superfund sites in Santa Clara County.

8. What is the risk to employees working in the 20-year old buildings on the NSC property from the hazardous waste site?

   A CDHS representative said that under CERCLA, exposures to on-site workers not associated with the remediation is not required in the Baseline Public Health Evaluation. However, health risks to on-site workers are considered in the ATSDR Public Health Assessment and a request might be made to the companies to look at worker health from the perspective of exposure from working on-site at an NPL site. The request was made of AMD because of contaminated soil under one of their semiconductor manufacturing buildings (AMD 901). They did indoor air monitoring in that building and the data showed that the level of exposure to workers was in an acceptable range for worker health and safety.

9. Is the drinking water safe?

   Most of the water from the city well located on the NSC site is used by NSC in their process streams. Some is blended into the drinking water. The chemical that has been detected periodically in the well water is trans-1,2-dichloroethylene which is not a carcinogen. The drinking water standard (California MCL) for this compound is 10 ppb (parts per billion) and the concentrations in the well have been between 0.5 and 0.7 ppb.

   There was another question about the proximity of drinking water wells to the site. Except for the one previously mentioned, the representative of the City of Santa Clara Department of Water and Sewers said that there are no other drinking water wells within 1,000 meters of the boundaries of NSC.

10. Are Proposition 65 warnings appropriate?

    Proposition 65 requires that companies with more that 10 employees cannot expose anyone to chemicals listed by the state as being capable of causing cancer or reproductive defects without giving a clear and reasonable warning. Therefore, in this situation, it would be NCS's responsibility to warn their workers about possible exposure to a number of site-associated chemicals.

11. Is the contaminated soil at the site still contaminating the groundwater?

    At the time of the removal of leaking tanks several years ago, the most highly contaminated soils were also removed. The remaining soils are not contaminated with the same chemicals that have migrated with the plume. They are heavier compounds and don't move very far. More soil remediation is planned. Additionally, the on-site extraction system is trapping any contaminated groundwater before it moves off-site.

12. Is it possible to increase the capacity and treat more water so that it can be cleaned up faster?

    Just increasing the flow rate will not necessarily get rid of all the contaminants any faster. The contaminants are attached to the soil and in order to clean up the contaminants the soil must be flushed by continually moving water through it. Increasing the pumping rate will work to dewater the aquifer so that it is dry and this would not maintain a flushing system.

13. Can vapors from the shallow aquifer follow the sewer system back up into houses?

    Yes, one route of entry for vapors into a house is through the space around utility pipes such as sewer pipes where they penetrate the foundation.

14. Can there be residential toxic vapor monitoring?

    At this time residential vapor monitoring is not indicated, but if it is needed, it can be done.

CONCLUSIONS

Based on information reviewed, CDHS has concluded that the NSC/former UTC site is an indeterminate public health hazard. The available data do not indicate that humans are being or have been exposed to levels of contamination that would be expected to cause adverse health effects However, data are not available for all environmental media to which humans may be exposed. As noted in the human exposure pathways section above, off-site resident and worker exposure is predicted by an indoor air-model but the exposure is at a level below that of health concern. On-site worker exposure from the inhalation of contaminated vapor arising from contaminated soil and groundwater may potentially be occurring. In the future (and perhaps currently and in the past) residents may be exposed to the contaminated groundwater by drilling and using private wells for drinking water purposes. Future significant exposure to groundwater contaminants is unlikely if 1) the groundwater treatment system reduces contaminants to below levels of health concern and 2) future drinking water wells are not placed in areas of known residual contamination.

RECOMMENDATIONS

Cease/Reduce Exposure Recommendations

In the areas of known groundwater contamination, implement institutional controls to prevent future use of contaminated aquifers for drinking water supplies until remediation has reduced contaminant concentrations to below levels of health concern.

Continue monitoring the active wells in the area of NSC: Pepsico, Hilton, and the City of Santa Clara wells. If contaminants are measured at levels of health concern in either the Pepsico or the City of Santa Clara well then the water should not be used for drinking water purposes.

If the area to the north of AMD/Arques but south of U.S. Highway 101 is ever rezoned to be residential, review the inhalation exposure of volatilized compounds from contaminated groundwater for those proposed residences.

Notify well-owners in the site area for which the well information cannot confirm proper abandonment, informing them of the potential chemical hazard of drawing water from their wells.

Site Characterization Recommendations

Conduct indoor air monitoring in the buildings on-site (Buildings A, C, 2, 3, 19) to ascertain the impact from compounds that potentially could be migrating from the contaminated soil.

Conduct a detailed well inventory to clearly identify the status of the wells known to have previously been drilled in the area.

Health Activities Follow-up Recommendations

The data and information developed in the National Semiconductor Corporation public health assessment have been evaluated by the ATSDR Health Activities Recommendation Panel (HARP) for follow-up health activities. The available evidence does not indicate that humans are or have been exposed to site related contaminants at levels which could cause illness or disease. If a follow-up site area well inventory identifies well owners who have not properly abandoned their wells, then these owners will be notified and informed that the water from those wells may pose a health hazard if used for domestic purposes. If additional data become available, ATSDR and the California Department of Health Services will reevaluate this site for any indicated follow-up health activities.

PUBLIC HEALTH ACTION

Based on the recommendations of the HARP, ATSDR is not planning any follow-up health activities at this time.

RWQCB has indicated that they or NSC has taken or will take the following actions related to the recommendations in the public health assessment:

NSC and the other sites near NSC that have confirmed releases resulting in groundwater impacts have already implemented deed restrictions, which prohibit the use of contaminated aquifers as drinking water supplies. Those sites include Hewlett Packard, United Technologies Corporation, and Advanced Micro Devices-Arques.

RWQCB has attempted to minimize the use of contaminated groundwater in the area of NSC by promoting awareness of the situation in public meetings and by working with the neighborhood action groups.

Exposure to shallow groundwater is currently limited in the area due to a Santa Clara Valley District ordinance, which allows no wells of less than 50 feet to be drilled.

NSC continues to monitor the Pepsico, Hilton, and City of Santa Clara wells on a regular basis. RWQCB agrees that should contaminants be measured above levels of health concern, the water should not be used for drinking water purposes. However, consideration should be given as to the degree of mixing (dilution) of such contaminated water with noncontaminated water form other sources.

RWQCB agrees with the recommendation that a review of inhalation exposure data should be conducted should the off-site area under the groundwater plume be rezoned as residential.

RWQCB has not required indoor air monitoring at the NSC site to ascertain the impact from compounds that may potentially migrate from the subsurface. However, NSC has indicated to RWQCB staff that it is willing to implement an indoor air monitoring program. NSC is currently preparing an air monitoring workplan for staff review.

RWQCB acknowledges that the well survey around NSC did not identify the status of certain public and private wells because the location of the older wells could not be determined. Thus, it is still possible that some of those wells are still in use. RWQCB has attempted to determine if and where such private wells exist through public meetings and working with neighborhood action groups; however, no property owners have notified RWQCB staff of wells on their property.

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CERTIFICATION

This National Semiconductor Corporation Public Health Assessment has been prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated.

Technical Project Officer, SPS, RPB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

Director, DHAC, ATSDR

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APPENDIX A

Summary of Response During Public Comment Period

The mayor of the City of Sunnyvale submitted a letter during the public comment period (July 2 to July 31).

The City of Sunnyvale had the following comments:

a. They concur with the report's overall findings that there appears to be no current significant public health risks associated with off-site contamination, assuming that clean-up activities and restrictions are implemented as planned.

b. They are concerned about the continuance of ongoing monitoring of groundwater quality

c. They endorse institutional controls regarding the use of contaminated aquifers.

d. They strongly encourage NSC and appropriate state and federal agencies to assess the risk that the site poses to on-site workers and to take any remedial steps as necessary to reduce potential risk to employees.

e. They agree that although there appears to be no serious risk from the volatilizing of chemicals from the contaminated aquifers, this should be periodically monitored and reviewed.