

**California Regional Water Quality Control Board  
San Francisco Bay Region**

**Third Five-Year Review**

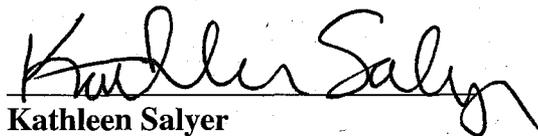
**National Semiconductor Corporation  
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Santa Clara, Santa Clara County, California**

**September 2008**

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9/30/08  
Date

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## List of Acronyms

AMD	Advanced Micro Devices
BGS	Below Ground Surface
BPHE	Baseline Public Health Evaluation
COC	Chemicals of Concern
DCE	Dichloroethene
ESL	Environmental Screening Level
GWE&T	Groundwater Extraction and Treatment
MCL	Maximum Contaminant Level
NSC	National Semiconductor Corporation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
SVE&T	Soil Vapor Extraction and Treatment
O & M	Operation and Maintenance
OS	Ozone Sparging
OU	Operating Unit
PCE	Tetrachloroethene, perchloroethene
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SCR	Site Cleanup Requirement
SU	Subunit
SVET	Soil Vapor Extraction and Treatment
TCA	1,1,1-trichloroethane
TCE	Trichloroethene
U.S. EPA	United States Environmental Protection Agency
UTC	United Technologies Corporation
VOC	Volatile Organic Compound

## Executive Summary

The remedy for groundwater contamination at the National Semiconductor Corporation (NSC) Superfund site in Santa Clara, California, includes soil vapor extraction and treatment, groundwater extraction and treatment, groundwater monitoring, and institutional controls. This is the third five-year review for the NSC site, and it covers remedial activities conducted between September 2003 and September 2008.

Remedial actions conducted at the site are functioning as designed. NSC has continued to conduct soil vapor extraction, ozone sparging and groundwater extraction and treatment during the past seven years. The groundwater pollution plume has remained stable and concentrations of volatile organic compounds have declined across the plume. The volatile organic compounds (VOC) mass removed during this review period by soil vapor extraction and treatment system (SVE&T) and groundwater extraction and treatment (GWE&T) system are 4,060 pounds and 1,370 pounds, respectively.

However, contaminant concentrations remain elevated above cleanup standards throughout the plume. NSC is implementing in-situ chemical oxidation pilot study at Building C Leak 5 Area, bioremediation at Building E area and ozone sparging at the former Buildings 2, 3, and 4 source areas.

The remedy is considered to be protective of human health and the environment because 1) the remedy is functioning as intended and being evaluated to enhance effectiveness of current remedies, 2) exposure pathways that could result in unacceptable risks are being controlled, and 3) institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater.

### Five-Year Review Summary Form

SITE IDENTIFICATION		
<b>Site name (from WasteLAN):</b> National Semiconductor Corporation		
<b>EPA ID (from WasteLAN):</b> CAD041472986		
<b>Region:</b> 9	<b>State:</b> CA	<b>City/County:</b> Santa Clara/Santa Clara
SITE STATUS		
<b>NPL status:</b> <input checked="" type="checkbox"/> Final <input type="checkbox"/> Deleted <input type="checkbox"/> Other (specify)		
<b>Remediation status</b> (choose all that apply): <input type="checkbox"/> Under Construction <input checked="" type="checkbox"/> Operating <input type="checkbox"/> Complete		
<b>Multiple OUs?*</b> <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	<b>Construction completion date:</b> 8/19/1992	
<b>Has site been put into reuse?</b> <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO NSC has operated the facility continuously since 1967		
REVIEW STATUS		
<b>Lead agency:</b> <input type="checkbox"/> EPA <input checked="" type="checkbox"/> State <input type="checkbox"/> Tribe <input type="checkbox"/> Other Federal Agency		
<b>Author name:</b> Max Shahbazian		
<b>Author title:</b> Engineering Geologist	<b>Author affiliation:</b> California Regional Water Quality Control Board, San Francisco Bay Region	
<b>Review period:**</b> February 2008 to September 2008		
<b>Date(s) of site inspection:</b> 3/21/2008		
<b>Type of review:</b> <input type="checkbox"/> Post-SARA <input type="checkbox"/> Pre-SARA <input type="checkbox"/> NPL-Removal only <input type="checkbox"/> Non-NPL Remedial Action Site <input checked="" type="checkbox"/> NPL State/Tribe-lead <input type="checkbox"/> Regional Discretion		
<b>Review number:</b> <input type="checkbox"/> 1 (first) <input type="checkbox"/> 2 (second) <input checked="" type="checkbox"/> 3 (third) <input type="checkbox"/> Other (specify)		
<b>Triggering action:</b> <input type="checkbox"/> Actual RA Onsite Construction at OU # _____ <input type="checkbox"/> Actual RA Start at OU# _____ <input type="checkbox"/> Construction Completion <input checked="" type="checkbox"/> Previous Five-Year Review Report <input type="checkbox"/> Other (specify)		
<b>Triggering action date (from WasteLAN):</b> 9/30/2003		
<b>Due date (five years after triggering action date):</b> 9/30/2008		

\* ["OU" refers to operable unit.]

\*\* [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

## Five-Year Review Summary Form, cont'd.

### Issues:

Three issues identified during the review are 1) declining effectiveness of groundwater extraction and treatment over time, 2) declining effectiveness of soil vapor extraction and treatment over time, and 3) the existing deed restriction is not consistent with the California Civil Code section 1471, which establishes the framework for environmental covenants in California.

### Recommendations and Follow-up Actions:

The combination of GWET, SVET and OS/SVET continued to remove significant VOC mass from soil and groundwater, and VOC concentrations have declined across the plume. The efficiency of VOC removal through groundwater extraction had declined considerably since the previous five-year review period, however. NSC will continue to evaluate alternate groundwater cleanup technologies, such as chemical oxidation and biodegradation, to determine whether other methods could achieve cleanup standards more quickly than the methods currently employed.

To address the declining effectiveness of groundwater extraction, NSC is currently evaluating and will continue to evaluate and implement alternate remedial technologies such as chemical oxidation at the Building C Leak L5 area, bioremediation at the Building E area and ozone sparging at the former Buildings 2, 3, and 4 source areas.

To address the declining effectiveness of soil vapor extraction in removing semi-volatile compounds (SVOC) such as dichlorobenzenes and trichlorobenzenes found in soil at Building C Leak L5 area, NSC will continue to evaluate and implement alternative remedial technologies such as chemical oxidation.

To address the issue regarding the deed restriction, which was recorded prior to passage of California Civil Code section 1471, a new restrictive covenant must be recorded that is consistent with current California law.

### Protectiveness Statement(s):

The remedy is considered to be protective of human health and the environment because 1) the remedy is functioning as intended and is being evaluated to enhance the effectiveness of the existing remedies, 2) exposure pathways that could result in unacceptable risks are being controlled, and 3) institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater.

**California Regional Water Quality Control Board  
San Francisco Bay Region**

**Third Five-Year Review**

**National Semiconductor Corporation  
2900 Semiconductor Drive  
Santa Clara, California**

**I. Introduction**

The purpose of the five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

*If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

*If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The California Regional Water Quality Control Board, San Francisco Bay Region, conducted the five-year review of the remedy implemented at the NSC Superfund Site in Santa Clara, Santa Clara County, California. This is the third five-year review for the NSC Site. The triggering action for this statutory review is the completion of the second five-year review on September 30, 2003. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

## II. Site Chronology

NSC begins manufacturing semiconductors at the site	1967
Soil and groundwater contamination discovered at the site	1982
Removal of 22 underground solvent storage tanks and acid waste sumps and associated piping; Excavation of 400 cubic yards of contaminated soils	1982 - 1991
Groundwater extraction and treatment begins. NPDES permit issued for discharge of treated effluent.	1984
NSC accepts responsibility for groundwater contamination from adjacent UTC facility	1987
NSC site and AMD site (1165 East Arques Avenue) added to NPL	July 1987
Baseline Public Health Evaluation completed for NSC site	July 1990
Water Board and U.S. EPA approve NSC's Final RI/FS work plan	Sept 1991
Water Board adopts Orders No. 91-137, 91-139, and 91-140, the Final Site Cleanup Requirements for Subunits 1, 2, and 3 of OU 1.	Sept 1991
U.S. EPA issues Record of Decision (ROD) for NSC and AMD sites	Sept 1991
NSC submits first (State-required) Five-Year Review Report to Water Board.	Sept 1996
Water Board submits first EPA-required Five-Year Review Report to EPA, Region 9	Sept 1998
Low levels of perchlorate detected at former UTC facility	2000
Ozone sparging/soil vapor extraction system installed at a former source area	2001
NSC submits second (State-required) Five-Year Review Report to Water Board	Aug 2001
Water Board submits second EPA-required Five-Year Review Report to EPA, Region 9	Sept 2003
Focused Risk Assessment Report, Potential Vapor Intrusion	July 2004
SVE Systems shut down	Feb and Mar 2005
NSC submits third Five-Year Review Report to Water Board	Nov 2006
Pilot Study Work Plan for Vegetable Oil Injection to Accelerate Remediation of Chlorinated Volatile Organic Compounds at Building E	Nov 2006
Field Sampling Report in Support of Remedial Alternatives Evaluation, Building C: Tank T13/Leak L5 Areas	Nov 2006
Injected Vegetable Oil at Building C	Jan 2007
Remedial Action Plan for Building C: Tank T13 and Leak 5 Areas	Nov 2007
Work Plan for In-Situ Chemical Oxidation (ISCO) Pilot Study at Building C: Leak 5 Area	Feb 2008
Implemented ISCO pilot study at Building C: Leak 5 Area	March & July 2008
Water Board submits third EPA-required Five-Year Review Report to EPA, Region 9	Aug 2008

### **III. Background**

#### Physical Characteristics

The NSC Site is approximately 60 acres in size and is located between Kifer Road, Central Expressway, and Lawrence Expressway in the city of Santa Clara, California. A groundwater contaminant plume extends down-gradient from the NSC property beneath an off-property commercial area. Contaminants from other source areas, including one other Superfund site, commingle with the NSC plume in the off-property area. The groundwater plume from the NSC facility and adjacent sites is managed by the Water Board as Operable Unit 1 (OU 1). OU 1 has been subdivided into Subunits 1, 2, and 3, as shown on the attached map. Subunit 1 lies within the cities of Santa Clara and Sunnyvale and consists of the NSC campus, the down-gradient area to East Arques Avenue and the adjacent former United Technologies Corporation (UTC) facility at 1050 East Arques Avenue. Subunit 2 consists of another Superfund site, the former Advanced Micro Devices, also known as Monolithic Memories (AMD/MMI) site at 1165 East Arques Avenue in Sunnyvale. Subunit 3 consists of the commingled solvent plume down-gradient of the NSC, UTC, and AMD/MMI facilities and lies entirely within the city of Sunnyvale. Santa Clara and Sunnyvale each have populations of approximately 100,000, and are part of the San Francisco Bay Metropolitan Region, which has a total population of about six million. OU 1 is located in a light industrial and commercial area dominated by the electronics industry that is known as the Silicon Valley. Most buildings in the area are low-rise developments containing office space and research and development facilities. NSC has occupied the facility continuously since 1967. Semiconductors were manufactured at the facility between 1967 and 1999. The facility is now used for offices, laboratories, and support services.

This five-year review covers remedial activities conducted by NSC in Subunits 1 and 3 only. Because the AMD/MMI site at 1165 East Arques Avenue is a separate U.S. EPA Superfund site, remedial activities performed by AMD in Subunit 2 will be addressed in a separate five-year review report.

#### Hydrogeology

Groundwater flows to the north-northeast towards San Francisco Bay. The Site is located in the Santa Clara Valley, a structural basin filled with marine and alluvial sediments. The coarser deposits are probably the result of deposition in or near stream channels that drain the highlands that surround the basin. Finer-grained deposits result from a variety of conditions with the eventual result of a heterogeneous sequence of inter-bedded sands, silts, and clays. Municipal water supply wells tap an extensive deep regional confined aquifer that lies generally greater than 200 to 300 feet below ground surface (bgs). A thick, relatively impermeable aquitard separates this deep confined aquifer from a complex series of laterally discontinuous aquifers and aquitards that can extend up to within a few feet of the ground surface. Four distinct water-bearing zones in the upper 100 feet bgs have been characterized at this site. These coarse-grained, transmissive units are generally composed of sand or sandy gravel. The first encountered water-bearing zone, called the A-zone, is found from 5 to 30 feet bgs. The next encountered water-bearing zone is

called the B1-zone and is found from about 30 to 45 feet bgs. The B2-zone is typically found between 45 and 60 feet bgs, and the B3-zone typically occurs between 70 and 90 feet bgs. The aquifer zones are separated by variable thicknesses composed of clay to silty sand. There is some degree of hydraulic connection between the zones due to the discontinuous nature of the sediment types. The highest concentrations of contaminants exist in the A-zone and B1 zone, and in some locations within the plume, monitoring and extraction wells have been screened across both units. Low levels of VOCs have been detected in the B2-zone, while contaminants have only rarely been detected in the B3-zone. Groundwater flows from south to north in all zones. The groundwater contaminant plume in the A- and B1-zones is approximately 5000 feet long and 2100 feet wide, and extends to Highway 101. The shallow water bearing zones are not currently used as a source of drinking water. The City of Santa Clara supplies drinking water within the city limits.

### History of Contamination

Site investigations, which began in 1982, identified VOCs in soil and groundwater. Fourteen separate sources of contamination have been identified at the NSC Site. The main chemicals of concern are trichloroethene (TCE), 1,1,1-trichloroethane (TCA), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene, and Freon 113. Relatively low concentrations of other chemicals, including the inorganic salt perchlorate, are also present within the plume in Subunit 1. The perchlorate was released from the former UTC facility, which operated at 1050 East Arques Avenue between 1960 and 1982. NSC assumed responsibility for contamination from the former UTC facility in 1987. VOCs in groundwater are limited to water-bearing units in the upper 60 feet and have not impacted deeper aquifers used for public water supply.

TWC Storage, LLC, purchased the former AMD/MMI site for redevelopment in 2005. On July 15, 2005, during site redevelopment activities, an electrical transformer was damaged in an equipment area located in the northwest corner of the property. Approximately 250 gallons of PCE were released from the damaged transformer. Although interim remedial activities have been conducted to address the release of PCE, the extent of any remaining PCE-impacted soil or impacts to shallow groundwater are not fully known at this time.

NSC and AMD reached a settlement concerning the groundwater cleanup in OU1. Beginning on January 31, 2002, NSC took the lead on groundwater remediation in all of OU1 (including SU1, SU2, and SU3). Remedial systems operation, monitoring, and reporting in OU1 are now integrated. National has obtained the required NPDES permits. The common objective of both parties is to optimize the cleanup without regard to property boundaries. This will, for example, allow a reconfiguration of remedial systems to eliminate redundant pumping. AMD will remain the responsible party for all purposes under the Water Board's orders and will retain certain specific responsibilities, including any soil remediation required in SU2 and any environmental studies or remediation required in connection with redevelopment activities in SU2.

## Initial Response

Remedial action at the NSC facility began in 1982 with the removal of underground acid waste sumps and solvent storage tanks. Over 400 cubic yards of contaminated soils have been excavated and disposed. Groundwater extraction and treatment (GWE&T) began in 1984.

## Summary of Basis for Taking Action

The site overlies the Santa Clara Valley groundwater basin. Groundwater from this basin provides up to 50% of the municipal drinking water for over 1.4 million residents of the Santa Clara Valley. The NSC site was made a Superfund site primarily because of the past chemical releases' potential threat to this valuable resource.

## **IV. Remedial Actions**

### Remedy Selection

A Baseline Public Health Evaluation (BPHE) was submitted July 3, 1990. The Remedial Investigation/Feasibility Study (RI/FS) was approved by U.S. EPA and the Water Board in September 1991. These documents form the basis of the remedial action plan. The Water Board adopted Final Site Cleanup Requirements (SCRs), Order No. 91-137, 91-139, and 91-140 for Subunits 1, 2, and 3 of OU 1 in September 1991. Also, the U.S. EPA issued a Record of Decision (ROD) in September 1991. The Final SCRs and the ROD contain the approved remedy for cleanup at the site. The remedy selected in the SCRs and ROD for final site cleanup consisted of the following elements:

- 1) soil vapor extraction and treatment
- 2) groundwater extraction
- 3) treatment of extracted groundwater by air stripping
- 4) discharge of treated water under NPDES permit
- 5) deed restriction prohibiting the use of shallow groundwater for drinking water.
- 6) long-term groundwater monitoring

The SCRs set cleanup standards at California proposed or adopted Maximum Contaminant Levels (MCLs), EPA MCLs, California Action Levels, or levels based on a risk assessment. These cleanup standards are as follows:

### Groundwater Cleanup Standards

Chemical	Cleanup Standard (micrograms/Liter)
Benzene	1
Chloroform	5
Chloromethane	5
4-Chloro-3methylphenol	7
1,2-Dichlorobenzne	60
1,4-Dichlorobenzne	5
1,1-dichloroethane (1,1-DCA)	5
1,1-dichloroethene (1,1-DCE)	6
cis-1,2-dichloroethene (cis-1,2-DCE)	6
trans-1,2-dichloroethene (trans-1,2-DCE)	10
2,4-dimethylphenol	46
2,4-Dinitrophenol	5
Ethylbenzene	68
Freon 113	1,200
2-Methyl-4,6-dinitrophenol	1
Pentachlorophenol	1
Phenol	5
Tetrachloroethene (PCE)	5
1,1,1-Trichloroethane (1,1,1-TCA)	200
Trichloroethene (TCE)	5
Vinyl Chloride	0.5
Xylene (total)	175

## Remedy Implementation

### Groundwater:

Groundwater extraction and treatment has been conducted continuously since 1984. NSC added additional groundwater extraction capabilities in 1986, 1988, 1990, and 1992. During the seven-year period covered by this review (2001 to 2008), NSC operated three separate groundwater extraction systems within the plume (on the NSC campus, along East Arques Avenue, and AMD E-1, which was shut down in April 2005) and a dewatering/extraction system at the down-gradient end of the plume (at Lakeside Drive near Highway 101). NSC operated 38 extraction wells and the Lakeside dewatering system from 2001 to 2005. In February 2005, extraction from 20 wells was suspended with Water Board approval. These wells were shutdown because they had low VOC mass removal, low pumping rates, or both. Effluent from the treatment systems is treated by air stripping and ozone technologies and then discharged to Calabazas Creek under NPDES Permit No. CAG 912003.

NSC installed an ozone sparging (OS) system with soil vapor extraction and treatment (SVE&T) in September 2001 to address lingering high VOC concentrations in groundwater at a source area near former Buildings 2, 3, and 4.

NSC implemented a vegetable oil injection pilot study at the Building E area in January 2007 to accelerate biological dechlorination of VOC-impacted groundwater.

NSC implemented an in-situ chemical oxidation pilot study at the Building C Leak 5 Area in March and July 2008 to evaluate the effectiveness of this technology in breaking down VOCs and SVOCs in shallow groundwater.

### Soil:

Soil vapor extraction and treatment (SVE&T) was initiated in 1992 and has been conducted in 12 former source areas on the NSC site.

In February 2005, SVE&T was concluded in eleven of these source areas, upon receiving confirmation from the Water Board that soil cleanup standards were met. The SVE&T system at Building C Leak 5 Area was shut down in March 2005. Due to high concentrations of SVOCs at the Building C Leak 5 Area, NSC is implementing an in-situ chemical oxidation pilot study to treat the unsaturated soil immediately above the water table.

Future soil excavation is the recommended alternative for cleanup of the unsaturated zone soil beneath Building C if/when Building C is demolished.

Deed Restrictions:

In May 1993, National Semiconductor recorded a covenant for the NSC property, as required by the ROD.

AMD/MMI site:

As indicated in Section III above, because the AMD/MMI site in Subunit 2 of the OU1 is a separate U.S. EPA Superfund site, remedial activities performed by AMD and TWC Storage, LLC, in Subunit 2 will be addressed in a separate five-year review report, due September 30, 2009.

Systems Operation/O&M

NSC submits annual groundwater monitoring and soil vapor extraction reports and quarterly NPDES reports.

The GWE&T, OS and SVE&T systems operated as designed during the five-year period covered by this report.

The main costs associated with the operation and maintenance of the GWET and OS/SVET systems are sampling, analytical laboratory fees, electricity, parts, and consulting fees.

**Table 2: System Operations/O&M Costs**

From	To	Total Cost
September 2001	August 2006	\$3,514,000
September 1996	August 2001	\$3,935,000

**V. Progress Since Last Review**

NSC was required to re-evaluate human health risk associated with vapor intrusion of TCE. The results of this evaluation are presented in the Focused Risk Assessment Report, Potential Vapor Intrusion July 2004. Indoor air sampling results indicate that indoor air concentrations were below environmental screening levels (ESLs) and the remedy is protective of human health and the environment as it relates to vapor intrusion into indoor air.

NSC also implemented a vegetable oil injection pilot study at the Building E area in January 2007 to accelerate biological dechlorination of VOC-impacted groundwater.

NSC implemented an in-situ chemical oxidation pilot study at the Building C Leak 5 Area in March and July 2008 to evaluate the effectiveness of this technology in breaking down VOCs and SVOCs in shallow groundwater.

**Table 3: Actions Taken Since the Last Five-Year Review**

Issues from Previous Review	Recommendations Follow-up Actions	Action Taken and Outcome
Effectiveness of GWE&T system	Evaluate alternative technologies	Operated three GWE&T and one OS systems and removed VOCs. Injected vegetable oil at Bldg. E in January 2007, and chemical oxidants at Leak L5 area at Bldg. C in March and July 2008
Concern over vapor intrusion into indoor air	Re-assess potential VOC indoor air intrusion risks	Indoor air sampling conducted. VOCs in indoor air are below ESLs

**VI. Five-Year Review Process**

Community Notification

The Water Board published a public notice in the local newspaper regarding this third five-year review of cleanup actions undertaken at the NSC site. A copy of the notice, published on July 9 2008 in the Sunnyvale Sun, is attached.

Document Review

This five-year review consisted of a review of relevant documents including NSC’s Fifteen-Year status report (submitted to the Water Board on November 16, 2006), annual groundwater monitoring reports, annual soil vapor extraction reports, a risk assessment report and a field sampling report. Applicable groundwater cleanup standards contained in the Final Site Cleanup Requirements were reviewed. There have been no changes in the cleanup standards contained in the Site Cleanup Requirements.

Data Review

The data presented in the above mentioned reports were reviewed and are summarized below.

Groundwater Data:

Groundwater monitoring data collected from 2001 to 2007 were reviewed to evaluate progress in remediating the groundwater pollutant plume. The data review shows that the VOC concentrations in groundwater in the former source areas and across the plume continue to decline. VOC concentrations in monitoring wells located along the down-gradient and perimeter edges of the off-property area have remained stable at low to non-detectable concentrations, demonstrating that hydraulic control of the VOC plume has been achieved.

**Table 4: TCE Concentrations in ug/L in Off-property Down-gradient and Perimeter Wells**

Well No.	2001	2002	2003	2004	2005	2006	2007
62A	4.8	18	23	40	29	25	16
97A/B1	<0.5	<0.5	NS	NS	<0.5	<0.5	<0.5
128A	6.2	14	8.9	10	NS	NS	NS
139A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
MM33A	7.1	30	15	6.1	7.7	8.3	6.7
MM34A	61	71	67	54	42	79	39
MM40A	110	150	130	74	83	110	39
83B1	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5
124B1	<5	<2.5	1.0	1.2	1.6	1.5	1.5
125B1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
126B1	120	94	92	98	110	95	110
127B1	11	10	7.0	11	11	15	10

**Table 5: TCE Concentrations in ug/L in Source Area Wells**

Well No.	2001	2002	2003	2004	2005	2006	2007
11A	12	7.1	<0.5	4	2.7	2.6	3.1
30A	NS	NS	160	160	110	130	120
89A	3.6	ND	43	49	38	29	28
46A	ND	ND	870	720	810	610	740
15B1	ND	ND	97	120	90	120	130
112A/B1	ND	2.9	80	76	130	130	75
113A	1.9	1.5	46	47	47	50	53
114A/B1	5.6	5.4	62	60	63	89	77
45A/B1	8.9	11	80	130	98	150	170
14B1	ND	5.1	130	17	43	49	57
111A/B1	4.4	ND	60	53	62	49	46
39A	NS	<50	<10	<25	33	17	36
141A	<200	<10	<10	6.9	3.8	20	16
142A	130	130	700	130	100	130	110
143A	<200	<200	28	<250	<50	<5.0	<5.0
144A	540	4,900	140	800	1,900	830	180

Notes:

ND = Not detected

NS = Not sampled

Between October 2001 and June 2008, approximately 513 million gallons (MG) of groundwater were extracted, from which 1,370 pounds of VOCs were removed. In comparison, almost 1,420 pounds of VOCs were removed from 463 MG of groundwater during the previous five-year period. The amount of VOCs removed during the last five years has thus declined by 29% from the previous five-year period. Mass removal efficiency during the last five years compared with the previous five-year period has declined from about 3.1 pounds of VOCs per MG of water

extracted to 2.7 pounds of VOCs per MG of water extracted. Between 1991 and June 2008, an estimated 5,250 pounds of VOCs were removed by the groundwater extraction system.

The combination of OS/SVET and GWE&T has been successful in controlling migration of the plume, in removing VOC mass from saturated soils, and reducing concentrations of VOCs in groundwater. After almost 25 years of groundwater extraction, however, the amount of VOC mass being removed has declined considerably and VOC concentrations in groundwater may be stabilizing. This observation of an initial significant reduction in VOC concentrations followed by a leveling off of the reduction in VOC concentrations has been found to occur at many other sites in the area and around the country.

Remedial efforts have reduced VOC concentrations in groundwater in source areas and across the plume. Maximum VOC concentrations in on-site source areas have been reduced from over 100,000 ug/L to less than 1,000 ug/L. However, several VOCs such as TCE, PCE, cis-1,2-DCE, ethylbenzene, xylenes, and chlorobenzene in groundwater remain above cleanup standards due to the complexity of site hydrogeology, recalcitrance of the chlorinated solvents, and limitations in current cleanup technology (see Table 5 for TCE). In 2007, TCE and cis-1,2-DCE were the predominant VOCs detected in groundwater at a maximum concentration of 740 ug/L and 580 ug/L, respectively.

No potentially toxic or mobile transformation products have been identified during sampling that was not already present at the time of the Record of Decision.

#### Soil Data:

Soil vapor monitoring data collected from 2001 to 2006 were reviewed to evaluate progress in remediating VOC and SVOC in unsaturated soil beneath the site. The data review shows that VOC and SVOC concentrations in unsaturated soil at 11 of the 12 former source areas have declined and soil cleanup standards have been achieved.

A total of 4060 pounds of VOCs were removed from the soil during this five-year review period. To date, SVE&T systems have removed a total of 26,261 pounds of VOCs. The majority of VOC mass (23,400 pounds) was removed from the Tank 13 and Leak L5 source areas at Building C. VOC and SVOC soil cleanup standards for the Leak L5 source area have not been achieved.

Analytical results of the confirmation soil samples obtained during well installation at the former UTC property (1050 East Arques Avenue) indicated chlorinated VOCs were the only COCs. The VOC soil cleanup standard of 1.0 mg/kg for the former UTC property has been achieved.

#### Soil Vapor and Indoor Air Data:

In 2004, NSC collected soil vapor and indoor air samples to evaluate the indoor air vapor intrusion pathway. The laboratory results for the soil vapor samples collected on May 6, 2004, underneath five buildings and the solvent pad indicated that TCE, PCE, and 1,1,1-TCA were the

most prevalent VOCs detected, with maximum concentrations of TCE 12,000 ug/m<sup>3</sup>, PCE 680 ug/m<sup>3</sup> and 1,1,1-TCA 3,900 ug/m<sup>3</sup>. TCE concentrations exceed the commercial ESL (4,100 ug/m<sup>3</sup>) for evaluation of potential vapor intrusion concerns.

The laboratory results for the indoor air and outside ambient air samples collected on May 6, 2004, in five buildings indicate that of the few chemicals detected in indoor air, most were detected at concentrations similar to that of outside ambient air and were not detected in soil gas. The exception was detection of 1,1,1-TCA at 11 ug/m<sup>3</sup> in the indoor air sample from Building A. 1,1,1-TCA in the soil gas sample from beneath Building A was 140 ug/m<sup>3</sup>. This concentration is not significant enough to cause indoor air intrusion. The lack of indoor detection of other VOCs detected in soil gas indicates that 1,1,1-TCA may not be from the subsurface but rather from a non-groundwater source. Common sources of 1,1,1-TCA include carpet glues, spot cleaners, and other cleaners. VOC concentrations in indoor air for each of the buildings did not exceed the target excess cancer risk set at 10<sup>-6</sup> for carcinogenic effects, and the target hazard quotient set at 0.2 for non-carcinogenic effects.

**Table 6: TCE Concentrations in ug/m<sup>3</sup> in Indoor Air and Soil Gas Samples Collected on May, 6, 2004**

Sample	Bldg. E	Bldg. A	Bldg. B	Bldg. 19/9	Bldg. 39
Indoor air (ESL = 2.0)	<1 U	<0.93 U	<0.98 U	<0.9 U	<0.93 U
Soil gas (ESL = 4,100)	2,400	1,700	1,600	12,000	7,800

Notes:

U = TCE was not detected above the reporting limits of 0.9 ug/m<sup>3</sup> to 1.0 ug/m<sup>3</sup>

Site Inspection

A site inspection was conducted on March 21, 2008, by Water Board Staff. No activities that could interfere with cleanup of the site were observed. The institutional controls that are in place include prohibitions on the use of groundwater until cleanup levels are achieved. No activities were observed that would have violated the institutional controls. VOC contamination is confined to soil and groundwater. Title search results showing the recorded deed restrictions on the site are included as Attachment B.

**VII. Technical Assessment**

Question A: Is the remedy functioning as intended by the decision documents?

The remedy is functioning as intended, although groundwater extraction efficiency is decreasing. The current groundwater monitoring program is sufficient to track the plume and detect any migration beyond the current plume boundaries, as well as track the effectiveness of remedial actions. Down-gradient monitoring wells have remained at non-detect or below the cleanup

level. Thus, the plume has not expanded in size and has not migrated vertically. Contamination remains confined to the shallow groundwater bearing zones.

The combination of GWET, SVET and OS/SVET continued to remove significant VOC mass from soil and groundwater, and VOC concentrations have declined across the plume. The efficiency of VOC removal through groundwater extraction had declined considerably since the previous five-year review period, however. NSC is evaluating alternate groundwater cleanup technologies such as chemical oxidation and biodegradation to determine whether other methods could achieve cleanup standards more quickly than the methods currently employed. NSC is implementing an in-situ chemical oxidation pilot study at the Building C Leak 5 Area, and is required to submit a report by November 2008 documenting completion of the in-situ chemical oxidation work.

The institutional controls in place include prohibitions on the use of groundwater until cleanup levels are achieved. No activities were observed that would have violated the institutional controls. However, in 1995, California passed California Civil Code Section 1471, which creates a framework for environmental restriction covenants and specifies how they are to be recorded and made applicable to successors. A new covenant or covenants must be recorded to be consistent with state law.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

There have been no changes to the physical conditions of the site that would affect the protectiveness of the remedy. The use of the site and the down-gradient area under which the groundwater plume has migrated remains commercial, light industrial, and office space.

There have been no changes to Applicable, Relevant, and Appropriate Requirements (ARARs) for the site and no new standards that would affect the protectiveness of the remedy. TCE and cis-1,2-DCE are the primary chemicals whose concentrations still routinely exceed the cleanup standards. Groundwater cleanup standards for these chemicals have not changed since the ROD was issued. Perchlorate was detected within the plume in 2004 and 2005 at concentrations that exceeded the California action level. However, no perchlorate was detected in groundwater monitoring wells during the past two years.

The exposure assumptions used to develop the Human Health Risk Assessment were for potential future exposure if untreated groundwater were to be used for drinking water and if residential uses were to occur on the site. These assumptions are considered to be conservative in evaluating risk and developing risk-based cleanup levels. Institutional controls prohibit the use of groundwater and groundwater is not currently used at the site. The land use of the site is primarily commercial/industrial.

The toxicity of TCE has been reassessed since completion of the Baseline Public Health Evaluations (BPHE) in 1991. The findings indicate that toxicity values for TCE are currently more stringent than in 1994. In 2008, EPA consolidated all EPA Regional Screening Levels into

one table, the Regional Screening Level (RSL) table. The RSL table was developed using the latest toxicity values, default exposure assumptions and physical and chemical properties and is consistent with the OSWER chemical toxicity hierarchy. For TCE, the RSL table uses the current Cal EPA derived toxicity value.

In addition, EPA released the draft "TCE Health Risk Assessment" in 2001. According to the draft TCE Health Risk Assessment, for those who have increased susceptibility and/or higher background exposures, TCE could pose a higher risk through inhalation than considered here. The draft TCE Health Risk Assessment has been peer reviewed by the Science Advisory Board, a team of outside experts convened by U.S. EPA, in 2002 and the National Academy of Sciences in 2006. EPA has not yet finalized this evaluation and therefore only the current Cal EPA derived toxicity value was used.

Although the toxicity values have changed for TCE since 1991, these changes do not affect the protectiveness because there is no exposure to untreated groundwater at the Site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary

According to the data reviewed and the site inspection, the remedy is functioning as intended by the Record of Decision. There have been no changes in the physical condition or land use of the site that would effect the protectiveness of the remedy. Indoor air sampling results indicate that the remedy is protective of human health and the environment as it relates to vapor intrusion into indoor air. There is no other information that calls into question the protectiveness of the remedy.

**VIII. Issues**

Three issues, as summarized in Table 5 below, were identified during the review: 1) declining effectiveness of groundwater extraction and treatment over time, and 2) declining effectiveness of soil vapor extraction and treatment over time, 3) the existing deed restriction is not consistent with state law, because it was recorded prior to the passage of California Civil Code section 1471, which establishes the framework for environmental covenants in California.

**IX. Recommendations and Follow-up Actions**

To address the declining effectiveness of groundwater extraction, NSC is currently evaluating and implementing other alternate remedial technologies such as chemical oxidation at the Building C Leak L5 area, bioremediation at the Building E area and ozone sparging at the former Buildings 2, 3, and 4 source areas.

To address the declining effectiveness of soil vapor extraction in removing semi-volatile compounds (SVOC) such as dichlorobenzenes and trichlorobenzenes found in soil at Building C Leak L5 area, NSC is currently evaluating and implementing alternative remedial technologies such as chemical oxidation. NSC also recommends future soil excavation for remediating the unsaturated zone soil beneath Building C if/when Building C is demolished.

To address the deed restriction issue, a new restrictive covenant must be recorded for the NSC property that is consistent with current California law.

**Table 6: Issues/Recommendations and Milestones Dates**

Issue	Recommendations and Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Declining effectiveness of groundwater extraction and treatment over time	Evaluate and implement alternate remedial technologies such as chemical oxidation at the Building C Leak L5 area, bioremediation at the Building E area and ozone sparging at the former Buildings 2, 3, and 4 source areas.	PRP	SF Bay RWQCB	9/30/2013	N	N
Declining effectiveness of soil vapor extraction and treatment over time	Evaluate and implementing alternative remedial technologies such as chemical oxidation.	PRP	SF Bay RWQCB	9/30/2013	N	N
Existing deed restriction is not consistent with state law, because it was recorded prior to the passage of California Civil Code section 1471	A new restrictive covenant must be recorded for the NSC property that is consistent with current California law.	PRP, USEPA, and RWQCB	USEPA	9/30/2010	N	N

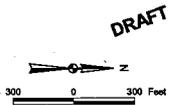
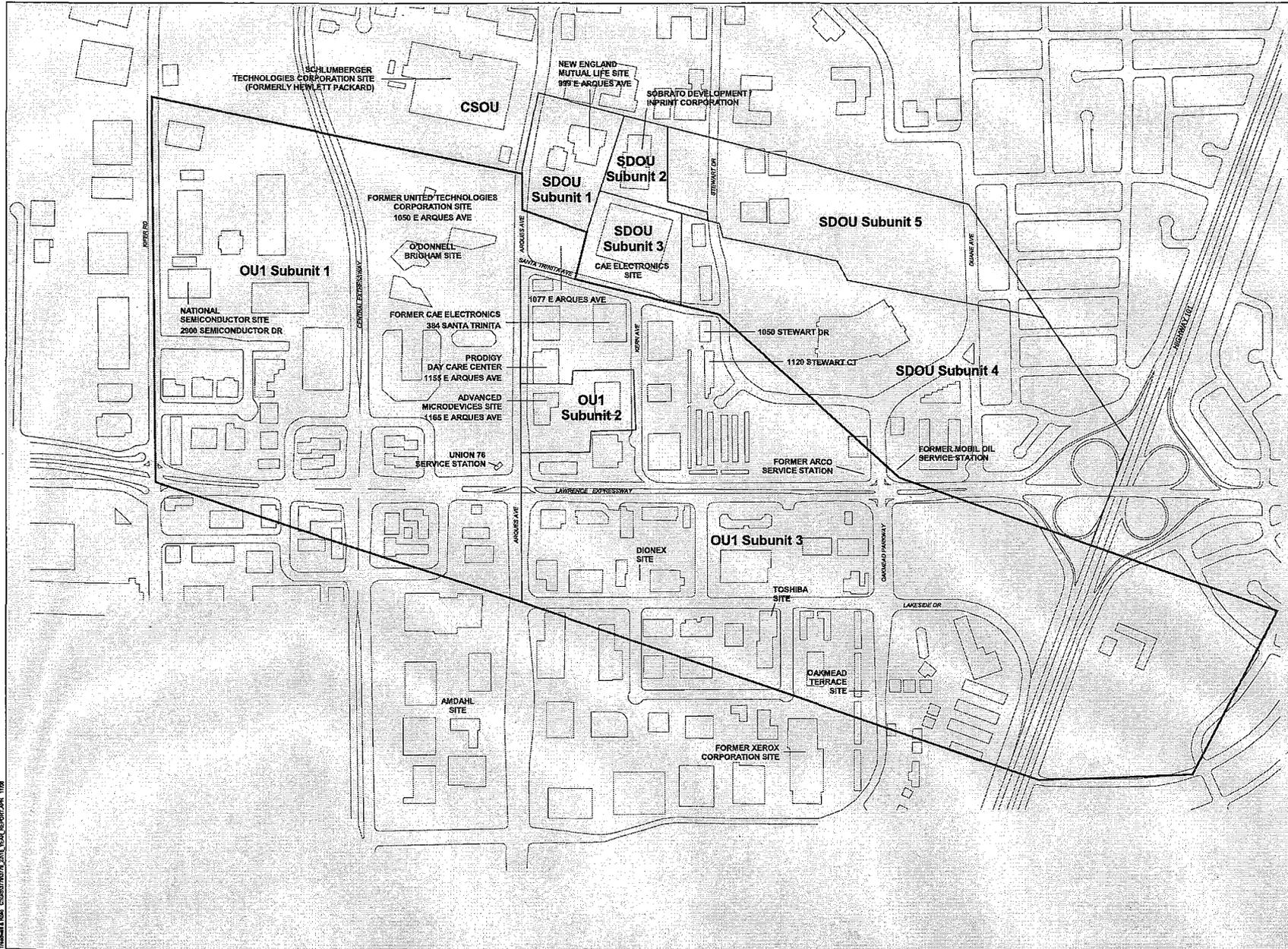
## **X. Protectiveness Statement**

The remedy is considered to be protective of human health and the environment because 1) the remedy is functioning as intended, 2) exposure pathways that could result in unacceptable risks are being controlled, and 3) institutional controls are preventing exposure to, or the ingestion of contaminated groundwater.

## **XI. Next Review**

The next five-year review for this site is required by September 30, 2013. NSC will submit its next Five-Year Review Report by December 31, 2012.

**ATTACHMENT A**



- LEGEND**
- OU1 Operable Unit 1
  - SDOU Stewart Drive Operable Unit
  - CSOU Commercial Street Operable Unit
  - OU1 Boundary
  - Subunit Boundaries
  - Basemap

National Semiconductor Corporation  
Santa Clara, California

**Location Map**

Date 11/7/06 Project No. 3779.23 Figure 1

**Treadwell & Rollo**

Treadwell & Rollo CONSULTANTS 2011 YEAR REPORT PAGE 1108

## **ATTACHMENT B**



July 30, 2008

Mr. Max Shahbazian  
California Regional Water Quality Control Board  
1515 Clay Street, Suite 1400  
Oakland, CA 94612

RE: Deed Restrictions

Dear Mr. Shahbazian:

Enclosed are the Preliminary Title Reports for properties that make up National Semiconductor's Santa Clara facility within Operable Unit 1, Subunit 1 of the National Semiconductor and Advanced Micro Devices Joint Superfund Sites. The facility has a nominal address of 2900 Semiconductor Drive and consists of the following properties in Santa Clara, California:

- 3885 Kifer Road                      Main campus (Buildings A, B, C, D, F, M, W  
Parking Garage, associated parking & open space)
- 2970 San Ysidro Way                Building G (Ex-Buildings 2, 3, 4)
- 3697 Tahoe Way                      Buildings 9 & 19
- 2900 Semiconductor Drive        Building E & associated parking
- 2990 Semiconductor Drive        Ex-City of Santa Clara water production well site at  
northwest corner of Semiconductor Drive & Tahoe  
Way
- 2919 San Ysidro Way                Parking lot (Ex-Building 11)
- 2999 San Ysidro Way                Building 39 (National First Credit Union)

Please refer to enclosed Santa Clara Site Plan and Operable Unit 1 Map from the September 1991 ROD.

In 1993, deed restrictions were placed on properties within Subunit 1 belonging to National Semiconductor. They include 3885 Kifer Road, 2970 San Ysidro Way and 3707 Tahoe Way, now part of 3697 Tahoe Way. The remaining properties, 2900 Semiconductor Drive, 2990 Semiconductor Drive, 2919 San Ysidro Way, and 2999 San Ysidro Way were purchased by or deeded to National Semiconductor after 1993 and have not had deed restrictions placed on them.

Sincerely,

A handwritten signature in black ink, appearing to read "Richard R. Banks". The signature is written in a cursive style with a large, prominent initial "R".

Richard R. Banks  
Corporate Environmental Manager  
National Semiconductor

Enclosures

## **ATTACHMENT C**

**PUBLIC NOTICE**  
**WATER BOARD BEGINS THIRD FIVE-YEAR REVIEW OF CLEANUP AT THE**  
**NATIONAL SEMICONDUCTOR CORPORATION SUPERFUND SITE**  
2900 Semiconductor Drive  
Santa Clara, California

The California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) and the U.S. Environmental Protection Agency have begun the third five-year review of cleanup actions undertaken at the National Semiconductor Corporation (NSC) Superfund Site (Site), in Santa Clara, California. The review will evaluate whether the cleanup actions for the Site remain protective of human health and the environment.

**FIVE-YEAR REVIEW PROCESS**

When the cleanup remedies leave some waste in place or the remedy will take longer than five years to complete, the Superfund law requires an evaluation of the protectiveness of remedial systems every five years, until the Site has been cleaned up sufficiently to allow unrestricted access. The purpose of the five-year review is to understand how the constructed remedy is operating and to measure the progress towards achieving the Site's cleanup standards.

The Water Board will look at the movement and/or breakdown of the Site's remaining contaminants, the operation of soil and groundwater treatment systems, the application and monitoring of the deed restriction, changes in scientific knowledge about site contaminants and exposure pathways. The Water Board project manager will talk with the on-site manager, other regulatory authorities and interested members of the public. The review will be completed by September 30, 2008.

**CLEANUP PLAN**

To achieve Site cleanup, NSC was required to implement the following remedies:

- 1) soil vapor extraction and treatment
- 2) groundwater extraction
- 3) treatment of extracted groundwater by air stripping
- 4) in-place treatment of groundwater and soil by ozone oxidation
- 5) discharge of treated water under NPDES permit
- 6) deed restriction prohibiting the use of shallow groundwater for drinking water
- 7) long-term groundwater monitoring

**COMMUNITY INVOLVEMENT**

The Water Board is always interested in hearing from the public. If you have any issues or concerns about the NSC cleanup plan, and particularly if you have direct knowledge regarding the operation or implementation of the remedy, the Water Board would like to talk with you. Please contact the project manager at the number below. If you would like to be included in our mailing list and receive future fact sheets, please contact the Water Board.

**FOR MORE INFORMATION**

For a copy of the report and other Site documents, please visit the Water Board's website at:

<http://geotracker.waterboards.ca.gov/search/casseseearch.htm>

Enter the unique Case/Global ID number for this Site, which is 43S0084. Then click on the "Report", then on the "Geo Report/Site Documents" link under the Electronic Submittals heading. You may also review the report and other Site documents at the Water Board offices at:  
1515 Clay Street, Suite 1400, Oakland, CA 94612 - phone (510) 622-2300.

**CONTACT INFORMATION:**

For additional information, contact Water Board project manager Max Shahbazian at  
(510) 622-4824, or [mshahbazian@waterboards.ca.gov](mailto:mshahbazian@waterboards.ca.gov)