CERTIFICATION

I certify that the information contained in or accompanying this submittal is true, accurate, and complete. As to those portions of this submittal for which I cannot personally verify the accuracy, I certify that this submittal and all attachments were prepared at my direction in accordance with procedures designed to assure that qualified personnel properly gathered and evaluated the information submitted. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: William E. Collins

Name: William E. Collins

Document Title: Final Removal Action Closeout Report
IR Site 9, Area 3
Naval Air Station North Island
Delivery Order 139, Project 779680

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Final Removal Action Closeout Report

Non-Time-Critical Removal Action for Volatile Organic Compounds at Installation Restoration Site 9, Area 3
Naval Air Station North Island,
Coronado, California

SWDIV RAC Contract No. N68711-93-D-1459, Delivery Order No. 0139
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OHM Remediation Services Corp.

1230 Columbia Street, Suite 1200
San Diego, California 92101

Reviewed by:

Merry A. Coons, P.E.
Technical Leader

Reviewed by:

Dan B. McCullar, R.G
Technical Manager

REGISTERED GEOLOGIST
DAN B. McCULLAR
No 1862
CERTIFIED ENGINEERING GEOLOGIST
Exp. 6/30/01
STATE OF CALIFORNIA

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Abbreviations and Acronyms

APCD	Air Pollution Control District
ARAR	applicable or relevant and appropriate requirement
AS	air sparging
Bechtel	Bechtel National, Inc.
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
COPC	contaminant of potential concern
CWDA	Chemical Waste Disposal Area
DCE	dichloroethene
DCN	Document Control Number
DHS	Department of Health Services
DO	Delivery Order
DON	U.S. Department of the Navy
DTSC	California Department of Toxic Substances Control
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
FID	flame-ionization detector
FS	Feasibility Study
HHRA	human health risk assessment
HLA	Harding Lawson Associates
IAS	initial assessment study
ILCR	incremental lifetime cancer risk
IR	installation restoration
IWTP	Industrial Waste Treatment Plant
Jacobs	Jacobs Engineering Group Inc.
LNAPL	light non-aqueous phase liquid
MDL	method detection limit
mg/kg	milligrams per kilogram
MLLW	mean lower low water
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NTCRA	non-time-critical removal action
NWC	Naval Weapons Center
OHM	OHM Remediation Services Corp.
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
ppm	parts per million
ppmv	parts per million by volume
PRG	preliminary remediation goal
PRL	project reporting limit

Acronyms and Abbreviations (Cont.)

PWC	Navy Public Works Center
RAB	Restoration Advisory Board
RAC	Remedial Action Contract
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RWQCB	California Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWDIV	Southwest Division Naval Facilities Engineering Command
SWMU	solid waste management unit
TCE	trichloroethene
TEPH	total extractable petroleum hydrocarbons
VOC	volatile organic compound
VPAC	vapor-phase activated carbon
µg/kg	micrograms per kilogram
95% UCL	95 percent upper confidence limit

Executive Summary

This removal action closeout report presents the results of a non-time-critical removal action (NTCRA) conducted by OHM Remediation Services (OHM) to remove volatile soil contamination at Installation Restoration (IR) Site 9, Area 3, Naval Air Station (NAS) North Island, Coronado, California. The NTCRA was performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for the U.S. Department of the Navy, under Southwest Division Naval Facilities Engineering Command (SWDIV) Remedial Action Contract (RAC) No. N68711-93-D-1459, Delivery Order (DO) No. 0036. The NTCRA was conducted in cooperation with the California Department of Toxic Substances Control (DTSC), the lead State agency for the removal action, and in compliance with interim measures corrective action requirements of the Resource Conservation and Recovery Act (RCRA) Hazardous Waste Facility Permit for NAS North Island. Removal action closeout activities relevant to the NTCRA at Site 9, Area 3, are being conducted under DO No. 0139.

Site 9 is located in the southwestern portion of NAS North Island and is the location of the Chemical Waste Disposal Area (CWDA), which was formerly used for the disposal of liquid chemical waste starting in the 1940s. Area 3 at IR Site 9 was used intermittently for liquid waste disposal, from the 1950s until it was filled with hydraulic dredge material in 1976.

The scope of the removal action selected for Site 9 was based on reducing the possibility of exposure of ecological and human receptors to volatile organic compounds (VOCs) in shallow subsurface soil. The contaminants of potential concern (COPCs) identified for Site 9, Area 3, were trichloroethene (TCE), tetrachloroethene (PCE), and cis-1,2-dichloroethene (DCE). Soil vapor extraction (SVE) was identified as the recommended alternative for Site 9. The removal action for Area 3 included a vapor extraction system using horizontal extraction wells to extract VOCs from the vadose zone and vertical passive air injection points to enhance airflow through the vadose zone and increase the volatilization of VOCs in soil. The 1995 U.S. Environmental Protection Agency (EPA) Region IX industrial preliminary remediation goals (PRGs) and a calculated incremental lifetime cancer risk (ILCR) of $1x10^{-4}$ were initially identified as interim removal action cleanup concentrations for the NTCRA. DTSC later requested that the 1999 industrial PRGs also be included in the evaluation.

Extraction of well field vapors from Area 3 began on January 12, 1998. The Area 3 well field was online (under active remediation) from January 1998 until October 1998. Vapor concentrations measured at the wellheads using field-monitoring equipment and corresponding laboratory analytical results approached asymptotic levels after several months of SVE system operation. Extraction of soil vapor from the Area 3 well field was discontinued in October 1998 and preparations were made to conduct a rebound test. Soil vapor samples were collected at the SVE wellheads on November 2, 1998, and January 30, 1999, for rebound monitoring. Little or no rebound in VOC concentrations was observed in the Area 3 samples.

Confirmation soil samples were collected at IR Site 9, Area 3, in March 2000 to verify the effectiveness of the NTCRA. The samples were collected in accordance with the final project plan and the approved verification soil-sampling plan dated February 23, 2000. The analytical results for verification samples were used to calculate the 95 percent upper confidence limit (95% UCL) of the mean concentration for each of the Area 3 COPCs (TCE, PCE, and cis-1,2-DCE). The 95% UCL on the mean concentration of cis-1,2-DCE was below the 1995 PRG, but exceeded the 1999 PRG. PCE exceeded both the 1995 and 1999 PRG. However, TCE and PCE were less than the $1x10^{-4}$ ILCR concentration established for these compounds. As such, analytical results for the Site 9, Area 3, verification soil samples indicate that the interim removal action objectives have been met and that remaining concentrations of Area 3 COPCs are below one or both of the interim removal action concentrations.

The non-time-critical removal action at Site 9, Area 3 is complete. Although the interim goals of the non-time-critical removal action at Area 3 were met, additional removal actions or other remediation activities may be deemed necessary to attain final site closure. Light non-aqueous phase liquids (LNAPLs) were observed at several sampling locations during collection of verification soil samples for the removal action closeout. Analytical results for soil samples collected from areas of LNAPL-impacted soil indicated the presence of fuel hydrocarbons and SVOCs. Additional remediation at Area 3 may be necessary to address the presence of LNAPLs, fuel constituents, SVOCs and/or residual concentrations of VOCs in soil and/or groundwater. This issue will be further evaluated in the Feasibility Study/Corrective Measures Study currently underway.

Section 1
Introduction and Background

This removal action closure report presents the results of a non-time-critical removal action (NTCRA) in which soil vapor extraction (SVE) was used to remove volatile organic compounds (VOCs) from soil at Installation Restoration (IR) Site 9, Area 3, Naval Air Station (NAS) North Island, Coronado, California. IR Site 9 is the location of the former Chemical Waste Disposal Area (CWDA). The NTCRA was performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The NTCRA was conducted by OHM Remediation Services Corporation (OHM) for the U.S. Department of the Navy (DON), under Southwest Division Naval Facilities Engineering Command (SWDIV) Remedial Action Contract (RAC) N68711-93-D-1459, Delivery Order (DO) No. 0036. Removal action closeout activities relevant to the NTCRA at Site 9, Area 3, are being conducted under DO No. 0139.

The DON has worked in cooperation with the California Department of Toxic Substances Control (DTSC), the lead State agency during the implementation of this NTCRA. The NTRCA was intended as an interim measure. The action memorandum/removal action work plan prepared in 1995 by Bechtel National, Inc. (Bechtel) used the 1995 U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRGs) and the technical limits of SVE to develop interim cleanup goals for the NTRA at Site 9 (SWDIV, 1995). The draft feasibility study/corrective measures study prepared by Jacobs Engineering Group Inc. (Jacobs) in 1997 identified interim cleanup goals based on the 1995 industrial PRGs and an incremental lifetime cancer risk (ILCR) of $1x10^{-4}$ (Jacobs, 1997). DTSC later requested that the 1999 industrial PRGs also be included in the evaluation. The interim removal action objectives specified in the action memorandum did not include attainment of final site closure or remediation of groundwater. Cleanup levels for the final cleanup and closure of the site will be determined as part of the ongoing feasibility study process.

The NAS North Island IR Program is conducted in compliance with the interim measures corrective action requirements of the 1989 Resource Conservation and Recovery Act (RCRA) Hazardous Waste Facility Permit issued by the DTSC. The RCRA permit is currently held by the Navy Public Works Center (PWC), San Diego Operations, at NAS North Island. IR Site 9 is considered a solid waste management unit (SWMU) under the RCRA permit (Jacobs, 1995).

This report was prepared in accordance with and contains the required elements of the site closure report format outlined in the CERCLA National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (EPA, 1990). Table 1-1 presents an outline of the required elements of the report and the number of the section in which each element is discussed.

1.1 Site Location and History

NAS North Island is located in San Diego County, California, at the northwestern end of the Silver Strand Peninsula, which separates San Diego Bay from the Pacific Ocean. The base is adjacent to the city of Coronado, approximately 1 mile west of downtown San Diego across San Diego Bay. The population of the city of San Diego is more than 1 million. The city of Coronado has a population of approximately 27,000, and the base has approximately 15,000 nonresidential personnel. NAS North Island was commissioned in 1917 to provide services and material in support of aviation activities and units as designated by the Chief of Naval Operations. The base is fully operational and is considered vital to Pacific Naval Operations.

Site 9 is located in the southwestern portion of NAS North Island. The site encompasses approximately 38 acres bounded by N 3rd Street West on the north, Moffett Road on the west, an empty field on the east, and the Naval Weapons Center on the south. Site 9 is the location of the CWDA, which was formerly used for the disposal of liquid chemical waste starting in the 1940s. Chemicals were initially dumped into a low-lying 5-acre depression in the northeast corner of Site 9. Disposal in this area was discontinued when it became apparent that mixing of wastes was generating reactions that caused fires. Part of the depression was excavated and backfilled with clean, compacted, fill during construction of the aircraft run-up pad and taxiway in 1974. The remainder was filled with soil and concrete rubble in 1978 (Harding Lawson Associates [HLA], 1989). Beginning in 1968, wastes were segregated into four parallel trenches near the eastern edge of Site 9. These trenches were used for disposal of solvents, caustics, acids, and Sermetel W (a semisynthetic, high-temperature coating of ceramic and metallic carbide compounds). Disposal of wastes in the trenches was discontinued in the mid-1970s when the Industrial Waste Treatment Plant (IWTP; IR Site 11) was completed (Bechtel, 1995). Estimates of the volume of liquid chemicals disposed of at Site 9 range from 300,000 to 800,000 gallons per year (Brown and Caldwell, 1983). The maximum quantity of liquid waste potentially disposed of at Site 9 has been estimated to total approximately 32 million gallons over a 30-year period (Jacobs, 1991).

Removal Area 3, the subject of this report, is located in the southwestern portion of the large unimproved area south of North 3rd Street West and extends to the fenceline bordering the Naval Weapons Center (NWC). This area was used intermittently for liquid waste disposal, from the 1950s until it was filled with hydraulic dredge material in 1976 (HLA, 1989). The location of Removal Area 3 is shown in Figure 1-1.

1.2 Environmental Setting

The environmental setting of IR Site 9 has been described in various documents produced during site assessment and remediation activities. These documents include the remedial investigation/RCRA facility investigation report (Jacobs, 1995), the action memorandum/ removal action work plan (SWDIV, 1995), the engineering evaluation/cost analysis (EE/CA) (Bechtel, 1995), and the final project plan (OHM, 1996). Important aspects of the environmental setting of IR Site 9 are briefly summarized in the following sections.

1.2.1 Terrestrial Biota

Two sensitive annual plant species have been identified as present or potentially present at IR Site 9. During a botanical survey conducted in November 1995, Nuttall's lotus (*Lotus nuttallianus*) was found at Site 9 in Removal Areas 1 and 3. Coast woolly-heads (*Nemacaulis denudata* var. *denudata*) are found west of Site 9 and are generally known to occur in the same habitat as Nuttall's lotus. Mitigation measures were undertaken in accordance with the California Environmental Quality Act (CEQA) to protect these sensitive plant species as part of the implementation of the NTCRA at Site 9.

Site 9 has been designated as an alternative nesting area for the California least tern (*Sterna antillarum browni*), although the site is currently not used by nesting terns. Several sensitive animal species have been identified at Site 9. The site is occupied by burrowing owls (*Speotyto cunicularia*), a Federal Category 2 candidate for listing and a California Department of Fish and Game (CDFG) species of special concern. There is an active owl burrow complex approximately 800 feet east of Area 3. Site 9 is also commonly used for foraging and perching by great blue herons (*Ardea herodias*), which are classified as a "special animal" by the CDFG. A large population of San Diego black-tailed jackrabbit (*Lepus californicus bennettii*), a Federal Category 2 candidate species and CDFG species of special concern, is also present at Site 9. Details of existing environmental conditions are available in the environmental conditions and protection plan, prepared as part of the final project plan (OHM, 1996).

1.2.2 Geology and Surface Soil

Geologically, NAS North Island consists primarily of the late Pleistocene Bay Point Formation, with Recent beach deposits along the southern margin and Quaternary artificial fill deposits around the western, northern, and eastern perimeters of the island. The Bay Point Formation is composed primarily of marine, fossiliferous, loosely consolidated, fine- to medium-grained sand (Science Applications International Corp. [SAIC], 1995).

Three artificial fill lithologic units (defined as Q_{af1}, Q_{af2}, and Q_{af3}) are present within the Site 9 area as a result of three separate fill events (Jacobs, 1994). The first artificial fill, $Q_{af1,}$ was placed in 1936 as hydraulic fill on coastal margins during dredge and fill operations. Q_{af2} was generated in 1976 by construction of the Ammunition Pier. Q_{af2} covers an area of approximately 720,000 square feet, rising 8 to 10 feet above the surrounding land surface, and has a maximum thickness of approximately 15 to 16 feet. Q_{af3} was placed in 1978 and covers an area of approximately 15 acres between 3rd Street West and the aircraft run-up pad.

The topography of Site 9 is relatively flat, except where artificial fill unit Q_{af2} is present. The general elevation of the site is 10 to 12 feet above mean lower low water (MLLW). The elevation in the areas of the Q_{af2} fill materials is approximately 13 to 22 feet MLLW.

The uppermost layer of native soil at Site 9 consists of approximately 100 feet of poorly graded sand and silty sand with shell beds. Three fine-grained units have been identified in the sequence. The "A" clay/silt is a thin, discontinuous clay, clayey sand, and silt layer that occurs at a depth of about 35 feet below ground surface in the southeastern portion of the site and approximately 70 feet below ground surface in the southwestern portion of the site. The

"B" clay is a laterally extensive unit of sandy, silty clay, with clayey sand lenses, that occurs at a depth of 84 feet below ground surface in the northeast corner of the site and at 105 feet below ground surface in the southwest corner. The thickness of the "B" clay unit ranges from 5 feet in the northeastern corner to 21 feet in the southwestern corner, with an average thickness of approximately 14 feet. The "C" clay occurs at approximately 120 to 150 feet below ground surface, has an average thickness of 32 feet, and dips west and south. A sandy unit occurs between the "B" and "C" clay layers and consists of approximately 40 feet of poorly graded sand, silty sand, and clayey sand with silt lenses. The "C" clay overlies a thin sand layer and more clays (Bechtel, 1995).

1.2.3 Groundwater

The groundwater surface at NAS North Island varies in depth from approximately 27 feet below ground surface near the center of the island to mean sea level along the shoreline. The shallow water-bearing zone extends to the "B" clay and is unconfined. The shallow water-bearing zone includes an intruding wedge of brackish seawater underlying a moderately saline freshwater aquifer. The groundwater gradient in the shallow water-bearing zone beneath NAS North Island is between 0.0004 to 0.0007 foot per foot, and the flow direction is to the west-northwest. The rate of groundwater movement was estimated to be between 0.052 and 0.091 foot per day (19 and 33 feet per year). Pumping tests conducted in both the shallow unconfined and deeper confined water-bearing zones near the western end of NAS North Island in 1994 resulted in calculated hydraulic conductivity values typical for well-sorted sands and gravel with a high intrinsic permeability (Fetter, 1988). This indicated that the sands at NAS North Island are highly suitable for SVE and air sparging (AS) removal technologies. Groundwater from NAS North Island discharges to San Diego Bay and the Pacific Ocean.

The vadose zone at Site 9 extends approximately 8 to 10 feet below ground surface and consists of relatively permeable materials conducive to SVE. (The vadose zone at Area 3 is approximately 8 feet thick.) The saltwater interface occurs at approximately 40 feet below ground surface at the west end of the site, increasing to about 70 feet below ground surface at the east end of the site (Bechtel, 1995).

Groundwater beneath NAS North Island is not used for drinking, irrigation, or industrial supply. The California Regional Water Quality Control Board (RWQCB), San Diego Region, classifies the entire Coronado hydrologic area as having neither existing nor potential beneficial uses. In addition, the Coronado hydrologic unit is exempt from municipal consideration (CEQA Mitigated Negative Declaration; DTSC, 1996).

1.3 Site Investigation Activities Leading to the Removal Action

IR Site 9 was first identified in 1983 during an initial assessment study (IAS) conducted by Brown and Caldwell (1983) for the Naval Energy and Environmental Support Activity (NEESA) in response to CERCLA. The IAS identified soil contamination at IR Site 9 (the

CWDA) that presented an unacceptable risk and required remediation (Brown and Caldwell, 1983).

1.3.1 Site Chronology

The chronology of events leading up to and including the completion of the NTCRA at Site 9, Area 3, is summarized as follows:

1983 – Brown and Caldwell conducts an IAS for NEESA. IR Site 9 determined to pose significant threat to human health and the environment.

1985 – HLA conducts a verification study to determine whether chemical contamination existed at sites identified in the IAS as potentially contaminated.

1988 – HLA conducts a characterization study to evaluate the nature and extent of contamination. This study was later redesignated as a remedial investigation (RI) to bring the program into compliance with CERCLA.

1989 – HLA completes an RI report for the CWDA (Site 9). The Department of Health Services (DHS), now the DTSC, conducts a RCRA facility assessment (RFA) and designates IR Site 9 as SWMU 9.

1991 – Jacobs completes a site inspection report and remedial investigation/feasibility study (RI/FS) project work plan.

1993 – Jacobs conducts the first phase of a remedial investigation(RI)/RCRA facility investigation (RFI) field investigation at Site 9. The field investigation included a land survey, radiological survey, geophysical survey, soil-gas survey, and soil and groundwater sampling.

1994 – Jacobs presents findings of the first phase RI/RFI field investigation at Site 9 in a technical memorandum. Results of soil-gas survey indicated high levels of VOCs at Site 9 (Area 3). Soil and groundwater samples confirmed the presence of VOCs and semivolatile organic compounds (SVOCs) at Site 9.

1995 – Bechtel completes an action memorandum/removal action work plan and final EE/CA for non-time-critical removal actions at IR Sites 9 and 11. SVE was chosen as the selected interim remedy for Site 9.

1996 – OHM completes a final project plan for the NTCRAs at IR Sites 9 and 11. Permitting was completed, SVE wells and vapor monitoring wells were installed, and treatment systems were constructed at Sites 9 and 11.

1997 – Jacobs completes the Draft Feasibility Study (FS)/Corrective Measures Study (CMS) for IR Site 9. The FS/CMS is used to evaluate technologies and perform cost comparisons with recommendations for the most suitable technologies to remediate IR Site 9 in order to obtain final site closure. The FS/CMS is part of an ongoing

process conducted under CERCLA and RCRA guidelines with the objective of bringing Site 9 to final site closure. The FS/CMS was initiated and developed independently of the non-time-critical removal actions implemented at Site 9.

1997 – SVE system installation completed. System start-up at Site 9 in March 1997.

1998 – SVE system wells at Site 9, Area 3, brought online on January 12, 1998. Area 3 wells shut down in October 1998 when contaminant of potential concern (COPC) concentrations are reduced to asymptotic levels, indicating technical limitations of SVE system had been reached. Rebound monitoring performed in November 1998.

1998 – Bechtel conducts a pilot demonstration project using NoVOCs in-well stripping technology and Thermatrix thermal oxidation system to remediate VOCs in groundwater. The system could only be operated intermittently due to problems with bio-fouling and chemical precipitation in the treatment well. The total treatment time was equivalent to 3-months of operation over a 10-month period.

1999 – Rebound monitoring performed in January 1999. SVE operations in Area 3 officially terminated in March 1999 after rebound data indicated COPC concentrations were not increasing.

2000 – Verification soil samples collected at Area 3 in March 2000. OHM prepares removal action closeout report for NTCRA at IR Site 9, Area 3.

1.3.2 Remedial Investigation/RCRA Facility Investigation

In 1993, Jacobs conducted a first phase RI/RFI at the site. VOCs, SVOCs, polychlorinated biphenyls (PCBs), petroleum hydrocarbons, and metals were detected in soil and groundwater samples that were collected mainly in Area 1. A soil-gas survey identified elevated concentrations of trichloroethene (TCE), tetrachloroethene (PCE), and toluene in the vicinity of Area 3. These results were similar to the results of a previous soil-gas survey conducted by HLA in 1988.

The following is excerpted from the technical memorandum prepared by Jacobs to present the findings of the first phase RI/RFI (Jacobs, 1994, pp. 3-20 through 3-26):

"The soil gas survey conducted by HLA in 1988 detected trichloroethene (TCE), tetrachloroethene (PCE), and toluene… The Phase I soil gas survey detected high levels of PCE and TCE (greater than 10,000 µg/L) and toluene (greater than 1,000 µg/L) in the southern portion of the site just north of Buildings 743 and 744. Other areas of the survey yielded much lower levels of PCE, TCE, and toluene (less than 85 µg/L) and are considered less significant . . . . Based on both data sets, the following statements can be made:

- The soil gas plume has not extended west toward San Diego Bay, as both surveys are in general agreement on the western extent of the TCE, PCE, and toluene plumes.
- High concentrations (>1,000 µg/L) of TCE, PCE, and toluene occur immediately north of Buildings 743 and 744.

- An area along the eastern edge of the recent Phase I survey yielded high TCE and PCE concentrations (>10,000 µg/L). This area needs to be further characterized by either extending the soil gas survey eastward or collecting soil samples within the area.

- The high soil gas readings may indicate an area of soil contamination that could be a contributing source to shallow groundwater contamination (approximately 8 feet below ground surface [bgs]) in this area.

- No shallow groundwater monitoring wells are present within approximately 200 feet of the highest soil gas concentrations and no HydroPunch samples were collected from this specific area; however, TCE in particular has been detected in high concentrations in the shallow groundwater zone underlying the site."

1.3.3 Supplemental Subsurface Soil Investigation

During a second phase RI/RFI conducted in 1994 to 1995, 32 soil borings were drilled and sampled to a maximum depth of approximately 10 feet below ground surface in Areas 1, 3, and 8 at Site 9. Analytical results for soil samples collected from depths of 1 to 5 feet below ground surface in Area 3 indicated that concentrations of TCE, PCE, and cis-1,2-dichloro-ethene (DCE) exceeded EPA Region IX 1995 industrial PRGs. The maximum concentrations reported for these compounds were 160 parts per million (ppm) for TCE, 900 ppm for PCE, and 250 ppm for cis-1,2-DCE (Bechtel, 1995).

1.3.4 Groundwater Sampling during NoVOCs Pilot Study

In 1998 to early 1999, Bechtel National Inc. conducted a pilot study using NoVOCs ™ in-well stripping technology to remediate volatile organic compounds (VOCs) in groundwater at IR Site 9. The technology consists of a process where air is injected into the groundwater using a diffuser, creating an air-lift and *in situ* stripping of VOCs from groundwater circulating within the well (Bechtel, 2000a). Groundwater samples were collected to support the NoVOCs pilot study, including samples from two cone penetrometer test (CPT) borings (S9-CPT-01 and S9-CPT-02) located in Area 3. Reported results from S9-CPT-01 indicated VOC contamination from approximately –2.5 to –4 feet mean lower low water (MLLW), with total VOC concentrations reported at 34,100 ug/L. The highest concentration of total VOCs reported in S9-CPT-02 was 407 ug/L from 1 to 0 MLLW (Bechtel, 2000b).

1.4 Human Health and Environmental Risk Assessment Summary

The human health risk assessment (HHRA) conducted by Jacobs in 1994 concluded that VOCs were the predominant chemical class driving the cancer risk and noncancer hazard for Site 9. The excess cancer risk contour of $1x10^{-6}$ due to exposure to VOCs was used to define removal area boundaries at Site 9. The cancer risk for Removal Areas 3 and 1 exceeded the NCP cancer risk criterion of $1x10^{-4}$. The noncancer hazard for Removal Areas 3 and 1 also exceeded the noncancer screening criterion of 1.0 by at least an order of magnitude. These two areas were recommended for interim removal actions (Bechtel, 1995). Cleanup levels for final site cleanup will be determined as part of the feasibility study process. The

feasibility study will consider risk-based scenarios based on the protection of ecological receptors, as well as the protection of human health (Jacobs, 1997).

1.5 Contamination Addressed by the NTCRA

The scope of the removal action selected for IR Site 9 was based on reducing the possibility of exposure of human and ecological receptors to VOCs in shallow subsurface soil, under both current industrial and future residential scenarios (Bechtel, 1995). Five VOCs were identified in vadose zone soil at Site 9 at concentrations exceeding EPA Region IX 1995 industrial PRGs: cis-1,2-DCE, 1,1-DCE, PCE, TCE, and vinyl chloride.

Two areas were included in the NTCRA for Site 9: Removal Area 1 (the former CWDA), and Removal Area 3. Removal Area 1 was delineated by the 1,000-ppm total VOC soil isoconcentration contour in the vicinity of the former liquid waste disposal area (Area 1) and liquid waste disposal pits (Area 8) in the northeast portion of Site 9. Removal Area 3 was delineated by the 400-ppm total VOC soil isoconcentration contour immediately north of Buildings 743 and 744 (Area 3) in the southwest portion of Site 9. The removal area boundaries were designed to include all soil sampling locations where VOCs exceeded the EPA Region IX 1995 industrial PRGs.

Most of the liquid waste disposal activities at Site 9 occurred within the boundaries of Removal Area 1. At the time of preparation of this report, SVE removal of VOCs (enhanced by steam injection) was under way at Removal Area 1. The SVE wells at Area 3 were shut down after field monitoring instruments indicated an asymptotic decrease in VOC concentrations at system influent sampling ports. This removal action site closeout report was prepared to document the attainment of remedial action goals at Area 3. The COPCs specific to Area 3 are TCE, PCE, and cis-1,2-DCE.

Section 2
Removal Action Development and Evaluation

The decision by the DON to undertake an NTCRA at IR Site 9 was based on conclusions reached by the HHRA for the site (SWDIV, 1995). NTCRAs apply to releases of contaminants for which there is a potential threat to human health or the environment where a greater than 180-day planning period is required (EPA, 1993). This NTCRA also complies with provisions for conducting interim measures as outlined in the Hazardous Waste Facility Permit issued by the California DTSC on December 21, 1989, and reissued on December 3, 1997, to the Navy PWC, San Diego Operations, at NAS North Island (SWDIV, 1995).

The scope of the removal action implemented at IR Site 9 was based on reducing the possibility of exposure of human and ecological receptors to VOCs in shallow subsurface soil under a current industrial scenario. The evaluation of removal action alternatives focused on *in situ* treatment of VOCs in the vadose zone and limited treatment of contaminated groundwater in the upper saturated zone to decrease the potential for recontamination of the vadose zone (SWDIV, 1995).

2.1 Removal Action Objectives

Based on CERCLA, the NCP, HHRA, applicable or relevant and appropriate requirements (ARARs), and removal action work plan requirements, the objectives of the NTCRA conducted at IR Site 9 were as follows:

- Reduce the mass of VOC contamination in the vadose zone, resulting in a corresponding reduction in risk to human health
- Use *in situ* treatment technologies
- Use limited treatment and/or extraction of contaminated groundwater in the upper saturated zone to decrease the potential for recontamination of the vadose zone
- Prevent exposure of human receptors to VOCs in vadose zone soil
- Minimize migration of VOCs from Site 9 to the San Diego Bay.

The removal action was to be continued until the technical and feasible limits of the preferred technology were attained. The removal action objectives do not include groundwater remediation or final site closure (Bechtel, 1995).

2.2 Engineering Evaluation/Cost Analysis

An EE/CA was prepared for Site 9 in accordance with current EPA and DON guidance documents for an NTCRA under CERCLA.

Removal action alternatives were proposed and evaluated in the EE/CA based on reducing the potential for exposure of human receptors. The proposed alternatives addressed the *in situ* treatment of the COPCs in the vadose zone and in the groundwater to decrease the potential for recontamination of the vadose zone. The following five removal action alternatives were proposed and evaluated based on implementability, effectiveness, and cost:

- No action
- SVE
- AS with SVE
- Two-phase vacuum extraction
- Vadose zone *in situ* bioremediation
- Two-phase *in situ* bioremediation.

SVE was identified as the recommended alternative for Site 9. The alternative included a vapor extraction system using horizontal extraction wells to extract VOCs from the vadose zone and vertical passive air injection points installed to enhance airflow through the vadose zone and increase the volatilization of VOCs in soil (Bechtel, 1995).

2.3 Applicable or Relevant and Appropriate Requirements

Potential ARARs for the removal action at IR Site 9 were identified in the action memorandum (SWDIV, 1995). As the lead Federal agency, the DON identified Federal ARARs for the selected removal action alternative. As the lead State agency, the DTSC identified State ARARs for the removal action (Bechtel, 1995).

2.4 Interim Removal Action Cleanup Goals

The action memorandum approved in 1995 stated that EPA Region IX 1995 industrial PRGs and the technical limits of SVE would be used to determine the cleanup goals for the interim removal action. The draft feasibility study/corrective measures study (Jacobs, 1997) indicated that an ILCR of $1x10^{-4}$ could also be used as an interim cleanup goal. Table 2-1 lists the 1995 PRGs, the 1999 PRGs, and the ILCRs for identified COPCs at IR Site 9, Area 3.

Section 3
Chronology of the Removal Action

Remedial activities were conducted at IR Site 9 from April 1996 through October 1998 and included permitting; determination of required CEQA mitigation; and SVE system design, construction, optimization, operation and maintenance, and demobilization. Photographs of the IR Site 9 SVE system are presented in Appendix A.

3.1 Main Phases Leading to Removal Action

Before the implementation of SVE remediation activities at IR Site 9, premobilization activities performed included system design modifications, permitting and compliance with regulatory requirements, conducting land surveys and utility investigations, and holding a preconstruction conference with key project personnel for project planning purposes.

3.1.1 Permitting and Compliance Issues

Because IR Site 9 is a CERCLA site, the NTCRA was conducted under the regulatory purview of the DTSC. Permit applications for installation of horizontal SVE wells, air injection wells, and soil vapor monitoring wells were submitted to the San Diego County Site Assessment and Mitigation Division. These permit applications were submitted to comply with CERCLA substantive permit requirements and to serve as a courtesy notification and provide information to the County. No permit fees were paid. Permit No. W96083 was obtained for the installation of 33 air injection wells and 26 soil vapor monitoring wells at IR Site 9. Of these wells, 12 air injection wells and 8 soil vapor monitoring wells were installed in Removal Area 3.

A permit application was also submitted to the San Diego County Air Pollution Control District (APCD) for operation of the SVE and activated carbon treatment systems at both IR Sites 9 and 11 to comply with CERCLA substantive permit requirements. No permit fees were paid. In accordance with APCD Rule 20.3, emissions of VOCs were offset by the purchase of emission reduction credits for 3 tons per year. The SVE treatment system was rated at 99 percent efficiency for VOC removal. Based on a maximum estimated influent VOC concentration of 2,500 parts per million by volume (ppmv), maximum allowable VOC emissions were established at 25 ppmv (OHM, 1996).

3.1.2 SVE System Design

Design parameters for the SVE systems installed at IR Sites 9 and 11 were based on the results of two pilot tests conducted at IR Site 11. The first pilot test was conducted by SAIC in 1994 and was used to determine flow rates and influent composition and concentrations (SAIC, 1995). The second pilot test was conducted by Terra Vac (under SAIC) in 1995 and was used to determine an average influent concentration (Terra Vac, 1995). The SVE system was designed to pump the extracted air through vapor-phase activated carbon (VPAC) to remove VOCs. When the VPAC neared its adsorption capacity and VOCs in the exhaust

reached 25 ppmv, the system was designed to switch the vapor flow to a second VPAC vessel with clean regenerated carbon. The saturated carbon vessel was designed to use steam to regenerate the carbon by desorbing and removing the VOCs. The VOCs and steam were condensed and separated, and the condensed VOCs were sent off site for disposal. A pad was designed for the equipment to provide secondary containment in the event of a possible leak.

3.2 Remediation Activities Performed

Remediation activities performed at Site 9 included SVE system construction and start-up, system optimization, operation and maintenance, system shutdown, and waste disposal.

3.2.1 System Construction

The SVE system at IR Site 9 was constructed in accordance with the approved design documents and the work plan (OHM, 1996). Construction of the Site 9 SVE system began in June 1996, with the installation of the treatment pad in Removal Area 1. The initial phases of construction involved installation of horizontal SVE wells in Area 1 North and Area 1 South (the portions of Removal Area 1 north and south, respectively, of North 3rd Street West). Site preparation and grading began at Removal Area 3 in August 1996.

Installation of horizontal SVE wells at Area 3 began in September 1996. The horizontal SVE wells were installed in open trenches dug by an excavator. Air injection wells were installed using drill rigs equipped with hollow-stem augers. Work was conducted mainly at night and on weekends in order to accommodate the weapons loading schedule at the nearby Ammunition Pier (Pier B). Well construction in Area 3 was temporarily halted on October 3, 1996, after civilian and military personnel working in Buildings 743 and 744 at the NWC complained of nausea, headaches, and/or sore throats, apparently associated with strong odors from the remediation site. The fugitive odors were determined to be due to an uncovered soil stockpile. The stockpile was immediately covered and no other incidents were reported. Subsequent air monitoring along the fenceline perimeter of Area 3 indicated that airborne concentrations of VOCs were well below permissible exposure limits set by the California Division of Occupational Safety and Health. The health and safety plan was amended to include more extensive air monitoring of the well fields and SVE system during construction and system operation. The remaining well construction activities were conducted during weekend hours on November 23 and 24, 1996, to minimize the potential for exposure of NWC personnel.

The completed Area 3 well field consisted of 7 horizontal SVE wells (93-HW-01 through 93-HW-07) and 12 (vertical) air injection wells (93-AI-01 through 93-AI-12). In addition, eight vapor monitoring probes (93-MP-01 through 93-MP-08) were installed around the perimeter of Area 3. The well field layout is shown in Figure 3-1. The Area 3 well field was connected to the Site 9 SVE system via aboveground piping. Boring logs and well construction details for SVE, air injection, and soil vapor monitoring wells are presented in Appendix B.

3.2.2 System Start-Up, Optimization, and Operation and Maintenance

Extraction of well field vapors (SVE system start-up) from Removal Area 1 (Area 1 North) began on March 10, 1997. Initial operations were conducted 8 hours per day. Beginning on August 23, 1997, the system was operated 24 hours per day, with limited downtime for routine maintenance. Extraction from Area 3 began on January 12, 1998 (OHM, 1998).

System optimization involved continuous adjustments to flow rates from each well to maximize the efficiency of VOC extraction by maintaining the highest VOC concentrations possible in the system effluent. The SVE system was designed for a total VOC influent concentration of 2,500 ppmv, with total allowable effluent emissions of 25 ppmv. The IR Site 9 SVE system showed influent concentrations of methane ranging from 2,500 ppmv at project start-up to 41 ppmv by November 1997. The treatment system effluent monitoring equipment was changed to allow methane to be measured separately from other compounds. Because methane cannot be adsorbed by activated carbon, it was released into the atmosphere. The San Diego APCD does not regulate emission of methane into the atmosphere if the levels are below the lower explosive limit (50,000 ppmv) because methane presents an insignificant health risk. The change in effluent monitoring equipment (to account for the presence of methane) resulted in a dramatic increase in the adsorption of nonmethane VOCs beginning on May 3, 1997 (OHM, 1998).

From August 1997 through October 1998, the Site 9 SVE system was operated almost continuously, except for brief shutdown periods for repairs or routine maintenance. The Area 3 well field was online (under active remediation) from January 1998 until October 1998. VOC influent concentrations were measured periodically over the duration of the soil SVE system operation. Vapor samples were collected at the wellheads of the horizontal SVE wells in Area 3 and analyzed by field instrumentation and/or EPA Method TO-14. Field instruments included both a flame-ionization detector (FID) and a photoionization detector (PID). The results of the field FID and PID measurements are presented in Table 3-1. Table 3-2 presents laboratory analytical results for soil vapor samples.

Vapor concentrations measured at the wellheads by the field monitoring equipment (FID/PID) and the corresponding TO-14 results were observed to approach asymptotic levels after several months of operation of the SVE system. Influent concentrations based on FID readings decreased from maximums of 1,000 to 2,500 ppmv at the beginning of extraction from Area 3 to less than 100 ppmv. PID readings showed a similar trend, decreasing from maximum concentrations of more than 1,000 ppmv at start-up to 200 ppmv or less. Concentrations in Area 3 wells remained low after SVE system operation ended. The TO-14 sample results for individual COPCs showed similar magnitudes in concentrations, confirming the FID/PID readings. Vapor concentrations from each well, as determined by Method TO-14 as well as field measurements, are shown in Figure 3-2. The graphs show the asymptotic decline in COPC concentrations, as well as the absence of concentration rebound following removal of the Area 3 wells from active remediation in October 1998.

3.2.3 System Shutdown

Extraction of soil vapor from the Area 3 well field was discontinued in October 1998 and preparations were made to conduct a rebound test. The results of the test were used to

determine whether the NTCRA objectives had been met or the area required further remediation.

3.2.4 Waste Disposal

Condensation within the SVE system was treated in the system air stripper and discharged to the base industrial sewer system. Spent carbon was shipped to Crosby & Overton, Inc., in Long Beach, California, for regeneration. Contents of the solvent storage tank were sent to Chemical Waste Management in Azusa, California, for disposal. Transport manifests for wastes generated by the IR Site 9 SVE system will be included in an appendix to the Site 9 removal action closure report upon completion of the ongoing interim removal action at Site 9, Area 1. This site is currently undergoing remediation by a pilot-scale thermally enhanced free product recovery and SVE system that will be upgraded to a full-scale operation by mid-summer 2000.

3.3 Community Relations Activities

The public has been involved throughout the removal action decision-making process by means of the Restoration Advisory Board (RAB) meetings held monthly at the City of Coronado Public Library. Documents and supplemental information prepared under this project have been made part of the Administrative Record and are available for public review at the following information repository:

City of Coronado Public Library
640 Orange Avenue
Coronado, California 92118

RAB meeting minutes documenting discussions or recommendations relevant to the removal action at Site 9, Area 3, are presented in Appendix C.

Section 4
Effectiveness of the Removal Action

According to the EE/CA, the removal action is complete when the following criteria are met:

- The mass of VOCs removed from the vadose zone soil approaches an asymptotic limit when plotted against operating time of the SVE system
- Intermittent operation of the SVE system does not result in a rebound (significant increase) in soil vapor VOC concentrations when the system is not operating.

Although SVE operations are still ongoing at Removal Area 1 based on the continued presence of high influent concentrations of VOCs, the field and laboratory analytical data for Removal Area 3 indicated an asymptotic decrease in influent VOC concentrations. Therefore, the Area 3 well field was disconnected from the Site 9 SVE system and rebound monitoring was performed.

4.1 Verification of Removal Action

To verify that the NTCRA was complete, a rebound test was conducted and confirmation soil samples were collected for analysis of chlorinated VOC concentrations in vadose zone soil.

4.1.1 Rebound Test Results

To identify possible rebound of VOC concentrations in soil after SVE remediation activities in Area 3 ended, soil vapor samples were collected at the SVE wellheads on November 2, 1998, and January 30, 1999. Soil vapor samples were analyzed for VOCs by EPA Method TO-14. Little or no rebound in VOC concentrations was observed in the Area 3 samples. Analytical results for the rebound samples are presented in Table 3-2 and shown graphically in Figure 3-2.

4.1.2 Results of Verification Soil Sampling

Confirmation soil samples were collected at IR Site 9, Area 3, to verify the effectiveness of the NTCRA. The samples were collected in accordance with the final project plan and the approved verification soil sampling plan dated February 23, 2000 (OHM, 2000). A total of 31 primary and 4 duplicate samples were collected from the site, which was equivalent to 1 primary soil sample for every 500 cubic yards of contaminated soil in the treated area. Sample locations were selected using the Oak Ridge National Laboratory computer program, Visual Sampling Plan, which generates random sampling locations on a base map. The depths of the various samples were assigned using the random number generator in Microsoft Excel to select a depth between 1 and 8 feet below ground surface. Groundwater at the site occurs at a depth of approximately 8.5 feet below ground surface. The sampling began on March 7 and was completed on March 9, 2000. The final surveyed locations of the 31 verification soil samples are shown in Figure 3-1.

Laboratory analytical results for the Area 3 verification soil samples are presented in Table 4-1. TCE and PCE were detected in two verification samples at concentrations exceeding the respective 1995 and 1999 industrial PRGs. The highest concentrations were detected in soil sample 93-SB-31, collected from a depth of 4 feet below ground surface. In this sample, TCE was detected at a concentration of 140 milligrams per kilogram (mg/kg), PCE was detected at a concentration of 360 mg/kg, and cis-1,2-DCE was detected at a concentration of 110 mg/kg. The next highest concentrations of target analytes were detected in sample 93-SB-10, collected at a depth interval of 8.0 to 8.5 feet below ground surface. In this sample, TCE, PCE, and cis-1,2-DCE concentrations were 23, 62, and 17 mg/kg, respectively. Concentrations for all remaining samples were below the respective industrial PRGs.

The sampling plan for verification soil sampling identified the following decision rules for the attainment of cleanup goals at Area 3:

1. If the analytical results for verification soil samples indicate that the 95 percent upper confidence limit (95% UCL) of the mean concentration for each identified COPC is below its respective 1995 PRG (Table 2-1), it will be concluded that the interim removal action objective has been met. DTSC has since requested that the 1999 PRGs also be used in the evaluation.

2. If the analytical results for verification soil samples indicate that the 95% UCL of the mean concentration for an identified COPC is not below its PRG (both 1995 and 1999 values), but is less than the $1x10^{-4}$ ILCR concentration (listed in Table 2-1), it will be concluded that the baseline risk to human health has been reduced in accordance with the technical limitations of SVE and that the removal action objective has, therefore, been met (OHM, 2000).

Table 4-2 lists the sample statistics and the 95% UCL of the mean concentration for each of the Area 3 COPCs (TCE, PCE, and cis1,2-DCE) detected in the verification samples. The 95% UCL on the mean concentration of cis-1,2-DCE was below the industrial PRG for this compound and thus meets the requirements of decision criterion 1. Although the 95% UCL on the mean concentration of TCE and PCE exceeded the industrial PRGs, they were less than the $1x10^{-4}$ ILCR concentrations and thus meet the requirements of decision criterion 2. Analytical results for the Site 9, Area 3, verification soil samples indicate that the interim removal action objectives have been met.

Additional analysis was conducted on two verification soil samples from Area 3 after the field geologist noted the presence of a dark, oily liquid in the samples. Sample 93-SB-31 was analyzed for total extractable petroleum hydrocarbons (TEPH) and SVOCs. Sample 93-SB-08 was analyzed for SVOCs only. The analytical results indicated the presence of a fuel hydrocarbon in sample 93-SB-31, characterized by the analytical laboratory as a mixture of JP-5, diesel, and motor oil. No SVOCs were detected in this sample; however, the presence of free product in 93-SB-31 could have masked the presence of SVOCs due to an elevated detection limit of 25,000 micrograms per kilogram (µg/kg). Several SVOCs were detected in sample 93-SB-08 at concentrations ranging from 1,900 to 13,000 µg/kg. Analytical results for these two samples are presented in Table 4-3. Copies of the analytical

laboratory reports and chain-of-custody documentation for verification soil samples are presented in Appendix D.

Section 5
Conclusions and Recommendations

The low concentrations of chlorinated VOCs remaining in soil at IR Site 9, Area 3, confirmed that the remediation goals of the NTCRA have been met. In summary, the interim removal action has reduced the risk of adverse effects to human health due to the presence of chlorinated VOCs in the vadose zone at the site and has accomplished the following:

- SVE wellhead vapor concentrations were reduced from a maximum of 2,500 ppmv observed at the beginning of SVE operations to maximum concentrations of 100 to 200 ppmv, as measured by the field FID and PID instrumentation.
- No significant rebound was observed in vapor concentrations over a 3-month period following shutdown of the vapor extraction system.
- Analytical results for verification soil samples indicated that remaining concentrations of Area 3 COPCs were below one or both of the interim removal action goals specified in the decision criteria for the attainment of cleanup goals.

Requirements of the interim removal action have been met and the NTCRA at Site 9, Area 3 is complete. Additional removal actions or other remediation activities may be deemed necessary to attain site closure based on remaining concentrations of VOCs and/or other contaminants in soil and groundwater at the site. In particular, the presence of light non-aqueous phase liquids (LNAPLs) was noted at several sampling locations during the collection of verification soil samples. Analytical results for LNAPL-impacted soil samples indicated the presence of fuel hydrocarbons (JP-5, diesel, and motor oil-range) and SVOCs. Additional remediation at Area 3 may be necessary to address the presence of LNAPLs, fuel constituents, SVOCs and/or residual concentrations of VOCs in soil and/or groundwater. This issue will be further evaluated under the FS/CMS.

Section 6
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Appendix A
Photographs of Site 9 SVE System

Appendix B
Soil Boring Logs and Well Completion Diagrams

	Date		Date
93-AN-1	24 November 1996	93-MP-1	24 November 1996
93-AN-2	23 November 1996	93-MP-2	24 November 1996
93-AN-3	24 November 1996	93-MP-3	24 November 1996
93-AN-4	23 November 1996	93-MP-4	24 November 1996
93-AN-5	23 November 1996	93-MP-5	24 November 1996
93-AN-6	23 November 1996	93-MP-6	24 November 1996
93-AN-7	23 November 1996	93-MP-7	24 November 1996
93-AN-8	23 November 1996	93-MP-8	24 November 1996
93-AN-9	24 November 1996	93-MP-9	24 November 1996
93-AN-10	23 November 1996		
93-AN-11	23 November 1996		
93-AN-12	23 November 1996		

Appendix C
RAB Technical Review Report, Meeting Minutes, and Recommendations

RAB Meeting	Date
#34	23 March 1997
#35	01 April 1997
#36	26 June 1997
#37	30 July 1997
#48	20 August 1998
#51	19 November 1998
#54	31 March 1999
#55	21 April 1999
#56	20 May 1999
#59	16 September 1999

Appendix D
Laboratory Analytical Data

This appendix contains laboratory analytical data for all samples collected at Site 9, Area 3. Only the Administrative Record of this report contains a paper version of this appendix. All other copies of this appendix are contained only in the CD version of this report.

Sample Date	**COC Number**	**Analytical Data Package**
06 January 1997	202518	130113
30 July 1997	197404	127212
30 January 1998	202576	130513
25 February 1998	202457	130898
27 April 1998	216247	131852
27 May 1998	208077	132298
09 June 1998	208081	132519
25 June 1998	208083 / 208084	132773
08 September 1998	208160 / 208161	133923
14 October 1998	208123 / 208124	134551
02 November 1998	208179	134929
28 January 1999	208220 / 208221	136056
07 March 2000	A11657	00C072A
08 March 2000	A11660 / A11662	00C086
09 March 2000	A11661	00C095