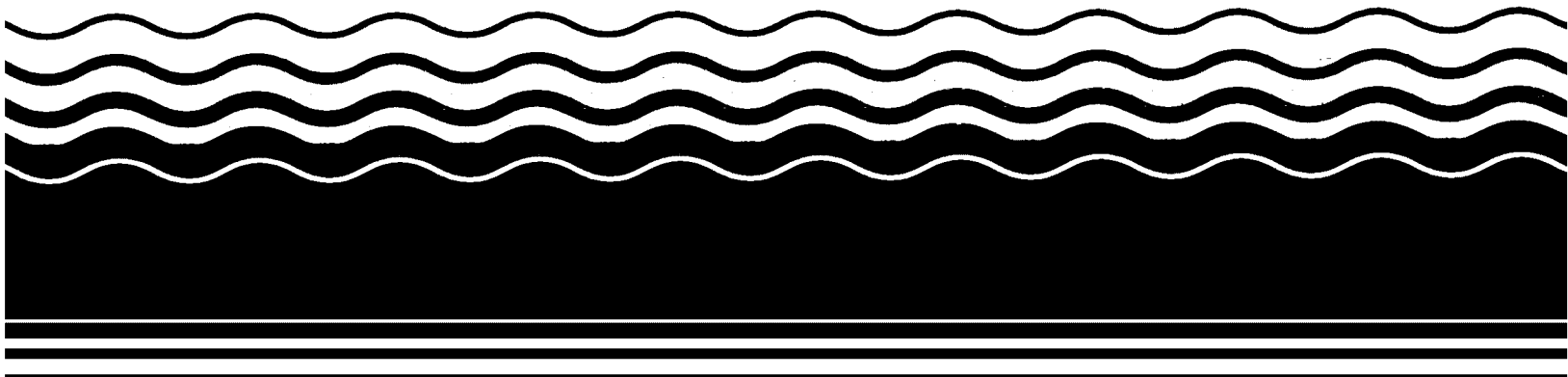




Superfund Record of Decision:

Queen City Farms, WA



REPORT DOCUMENTATION PAGE		1. REPORT NO. EPA/ROD/R10-93/054	2.	3. Recipient's Accession No.																			
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12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460				14.																			
15. Supplementary Notes PB94-964617																							
16. Abstract (Limit: 200 words) <p>The 320-acre Queen City Farms site is a former pig farm located in Maple Valley, King County, Washington. Land use in the area is predominantly rural and residential. Adjoining the site to the north is the Cedar Hills landfill, a municipal landfill operated by King County. The Queen City Farms (QCF) site is bounded to the west by woodlands, a gravel sorting facility, and private residences; and to the south by undeveloped marshy areas, which extend partially within the site boundary. The Cedar River is located approximately one mile to the west of the site. The QCF site overlies five saturated hydrogeologic units, including Aquifer 1 and Aquifer 2. Aquifer 1 is a perched sand and gravel aquifer in the area of the IRM; and Aquifer 2 is unconfined and extends throughout the site and beyond site boundaries. The private residents who live in the vicinity use Aquifer 2, which appears to be recharged by Aquifer 1 and is located downgradient of the site to the south and southwest, to obtain their drinking water supply. Current land use at the site consists of 2 major commercial operations: yard-waste composting and sand and gravel mining. Past waste disposal practices at the QCF site are documented poorly. From 1955 until the late 1960s, local industry used the site to dispose of industrial waste liquids, including paint, petroleum products;</p> <p>(See Attached Page)</p>																							
17. Document Analysis <table border="0"> <tr> <td>a. Descriptors</td> <td colspan="5"> Record of Decision - Queen City Farms, WA Second Remedial Action - Final Contaminated Media: soil, debris, gw, sw Key Contaminants: VOCs (PCE, TCE, toluene, xylenes), other organics (PAHs, PCBs, pesticides), metals (chromium, lead), inorganics (cyanide) </td> </tr> <tr> <td>b. Identifiers/Open-Ended Terms</td> <td colspan="5"></td> </tr> <tr> <td>c. COSATI Field/Group</td> <td colspan="5"></td> </tr> </table>						a. Descriptors	Record of Decision - Queen City Farms, WA Second Remedial Action - Final Contaminated Media: soil, debris, gw, sw Key Contaminants: VOCs (PCE, TCE, toluene, xylenes), other organics (PAHs, PCBs, pesticides), metals (chromium, lead), inorganics (cyanide)					b. Identifiers/Open-Ended Terms						c. COSATI Field/Group					
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c. COSATI Field/Group																							
18. Availability Statement		19. Security Class (This Report) None		21. No. of Pages 128																			
		20. Security Class (This Page) None		22. Price																			

Abstract (Continued)

organics, solvents, and oils. Primarily, the wastes were disposed of in three unlined ponds (Ponds 1, 2, and 3) located in the northeast portion of the site, which were closed under another IRM in 1986. Ponds 4, 5, and 6 were used to dispose of whey and animal waste from a hog farming operation conducted onsite from the mid-1950s until 1964. A building in the western portion of the site was leased by 4-Tek Industries (4-Tek) and used to repackage and recycle solvents until 1986. Bulk chemicals were stored and mixed in the storage area, and surface water runoff from the area was drained into a sump that eventually drained to an outlet west of the pad area. In 1980, EPA and the State identified elevated levels of VOCs in soil in the vicinity of the 4-Tek facility that may be attributed to spillage during plant operations. Later in 1980, EPA ordered QCF to complete a well restoration program and, in 1984, to conduct additional site investigations. These studies documented elevated levels of VOCs, PAHs, and PCBs in the sludge ponds and in underlying soil, which have migrated into and contaminated onsite ground water. In addition, LNAPLs, determined to be primarily a mixture of fuel oils, were found to be a source of ground water contamination in Aquifer 1, in the vicinity of the IRM Area. In 1985, QCF implemented an IRM for Ponds 1, 2, and 3, which included separation, onsite stabilization, and offsite disposal of sludge; capping associated soil; and implementing engineering controls and ground water monitoring. In 1988, after sand and gravel excavation activities uncovered 32 buried crushed drums, contaminated soil, and other materials, EPA ordered these removed and disposed of offsite. In 1990, approximately 170 yd³ of soil containing VOCs and 40 yd³ of concrete were excavated and removed offsite. For the purpose of remediation, the site has been divided into three study areas: the IRM and associated ground water contamination, the Buried Drum Area (BDA), and the 4-Tek Industries areas. This ROD addresses soil, debris, and onsite/offsite ground water contamination at these three areas. The primary contaminants of concern affecting the soil, debris, ground water, and surface water are VOCs, including PCE, TCE, toluene, and xylenes; other organics, including PAHs, PCBs, and pesticides; metals, including chromium and lead; and inorganics, including cyanide.

The selected remedial action for this site includes isolating contaminated soil by constructing a vertical barrier system/slurry wall around the IRM to contain 280,000 yd³ of contaminated soil onsite; excavating and treating 10,000 yd³ of contaminated soil and debris from the BDA offsite, with disposal of soil with high levels of contamination offsite at a permitted hazardous waste landfill; removing and pretreating onsite, if necessary, approximately 100 yd³ of debris containing metals and organics, with subsequent offsite treatment or offsite disposal at a solid waste or hazardous waste landfill; placing approximately 4,000 yd³ of soil with low levels of metal, PAH, and PCB contamination below an extension of the existing IRM cap, and backfilling the excavated area with clean soil; dewatering and onsite treatment of ground water recovered within the IRM area using a treatment system that may include oil and water separation, filtration, air stripping with air emission controls, and carbon adsorption treatment, with offsite discharge to a POTW; providing a contingent remedy for extraction and onsite treatment of Aquifers 1 and 2 using air stripping, with discharge of the treated ground water onsite to surface water and provision of an alternate water supply, if ground water monitoring indicates that cleanup levels are exceeded at the offsite areas; removing the LNAPLs, from within and adjacent to the IRM, and incinerating them offsite; conducting treatability studies during the RD to determine the effectiveness of venting, and providing a contingency for venting of IRM soil, based on study results; constructing a surface water diversion system to prevent infiltration of water into the IRM BDA cap; monitoring onsite and offsite ground water, surface water, and private drinking water wells; and implementing institutional controls, including deed, land, and ground water use restrictions. The estimated present worth cost for this remedial action is \$50,011,000, which includes an estimated annual O&M cost of \$2,030,000 for 30 years.

EPA/ROD/R10-93/054
Queen City Farms, WA
Second Remedial Action - Final

Abstract (Continued)

PERFORMANCE STANDARDS OR GOALS:

Soil and ground water cleanup goals are based on SDWA MCLs and cancer and Model Toxics Cleanup Regulations (MTCA) risk data. Chemical-specific ground water cleanup levels for Aquifer 1 are based on a cancer risk of 10^{-5} , and include total chromium 80 ug/l; 1,2-DCE 70 ug/l; trans-1,2-DCE 100 ug/l; carcinogenic PAHs 0.01 ug/l; PCBs (total) 0.01 ug/l; PCE 1 ug/l; TCE 5 ug/l; and vinyl chloride 0.02 ug/l. Chemical-specific soil cleanup goals are based on MTCA, and include arsenic 20 mg/kg; cadmium 40 mg/kg; chromium 400 mg/kg; lead 250 mg/kg; and total and carcinogenic PCBs 1 mg/kg.



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101**

**RECORD OF DECISION
DECLARATION, DECISION SUMMARY,
AND
RESPONSIVENESS SUMMARY**

FOR

**FINAL REMEDIAL ACTION
QUEEN CITY FARMS SUPERFUND SITE
MAPLE VALLEY, KING COUNTY, WASHINGTON**

DECEMBER 1992

DECLARATION

SITE NAME AND LOCATION

Queen City Farms
Maple Valley, King County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial actions for the Queen City Farms Site (Site or QCF Site), in Maple Valley, King County, Washington, which were chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1986, 42 U.S.C. §§9601 et. seq., Pub. L. 99-499 (CERCLA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300, Published in 55 Fed. Reg. 8666, et. seq., on March 8, 1990 (NCP). This decision is based on the administrative record for the Site.

The State of Washington concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response actions selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The remedial actions described below are the final response actions planned for the Site. An Initial Remedial Measure (IRM) was performed at the Site in 1986 that included removal and containment measures which addressed sludge and liquid contamination at the Site. The IRM only partially addressed soil contamination, and did not deal with ground water contamination at the Site. The cleanup actions described in this ROD address the threats to ground water and soils posed by trichloroethene (TCE) and other contaminants at the site. Long-term management controls are necessary to maintain the integrity of the cleanup.

For purposes of the evaluation and selection of cleanup alternatives, the Site was divided into the following three study areas: (1) the IRM and associated ground water contamination, (2) the Buried Drum Area (BDA), and (3) 4-Tek Industries. The selected remedy addresses all three study areas.

The major components of the selected remedy are:

For the IRM and associated ground-water contamination:

- Isolation of contaminated soils by construction of a vertical barrier system/slurry wall around the IRM.

- Dewatering, treatment and off-site discharge of the water within the IRM.
- Contingent extraction and treatment of Aquifer 1 ground water outside the IRM. On-Site discharge of treated ground water to the Main Gravel Pit Lake or equivalent surface water body.
- Removal and off-site incineration of LNAPL from within, and adjacent to, the IRM.
- Contingent venting of IRM soils. The effectiveness of venting will be determined by treatability studies to be conducted during remedial design.
- Contingent extraction and treatment of contaminated Aquifer 2 ground water. Discharge of extracted ground water to the Main Gravel Pit Lake or equivalent surface water body.

For the BDA:

- Excavation of approximately 10,000 cubic yards of soil and debris from the BDA. Off-Site treatment and disposal of the soils with high levels of contamination at a permitted hazardous waste landfill. On-Site treatment of debris prior to recycling or disposal of debris at a solid waste or hazardous waste landfill. Placement of soil with low levels of contamination below an extension of the existing IRM cap. Backfilling of the uncontaminated soil.
- Construction of a surface water diversion system, to prevent infiltration of water into the IRM/BDA cap.

For 4-Tek Industries:

- Sampling and analysis of the shallow ground-water zone, and Aquifer 2, at the 4-Tek facility at least twice per year for 5 years. Should contamination be found above cleanup levels, then the ground water would be extracted and, if necessary treated on Site. Treated ground water would be discharged to the Main Gravel Pit Lake or equivalent on-site surface water body.

Site-Wide Actions:

- Deed restrictions and institutional controls on land and ground-water use.
- Long-term ground-water and surface water monitoring.

Off-Site Areas

- Long-term monitoring of private drinking water wells, with a contingency for providing an alternative water supply, should Site-related contaminants exceed cleanup levels.
- Continued long-term monitoring of surface water and ground-water in the southern portion of the Cedar Hills Landfill.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces, toxicity, mobility, or volume as a principal element.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

12/31/92
Date

Dana A. Rasmussen
Regional Administrator
Environmental Protection Agency
Region 10



DEC 23 1992

OFFICE OF
REGIONAL ADMINISTRATOR

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

December 23, 1992

Ms. Dana Rasmussen
Regional Administrator
U.S. EPA, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Dear Ms. Rasmussen:

Re: Record of Decision for the Queen City Farms Superfund Site

The Washington State Department of Ecology has reviewed the Record of Decision for the Queen City Farms Superfund Site near Maple Valley, King County. We concur with the following selected remedies, described in chapter ten of the document:

- To isolate and consolidate contaminated soils with a slurry wall/cap and passively vent their main portion;
- to extract and treat, if necessary, contaminated ground water from within the containment structure plus various aquifers outside this and another operable unit;
- to dispose off-site of the most contaminated, excavated materials;
- to monitor ground water extensively on and off-site;
- and to apply and maintain comprehensive administrative controls.

We recognize contaminants will remain on-site, because removal is not practicable and some contaminants cannot be effectively treated or completely destroyed. The selected remedies are consistent with the Model Toxics Control Act Regulations (Chapter 173-340 WAC).

We are looking forward to the cleanup activities at this site.

Sincerely,

Carol L. Fleskes
Program Manager
Toxics Cleanup Program

CLF:MHR:jw

cc: Howard Orlean, EPA
Timothy L. Nord, Ecology
Michael Ruef, Ecology



**DECISION SUMMARY
FINAL REMEDIAL ACTION**

**QUEEN CITY FARMS SUPERFUND SITE
MAPLE VALLEY, KING COUNTY, WASHINGTON**

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1.0 SITE NAME AND LOCATION

Queen City Farms
Maple Valley, King County, Washington

2.0 SITE DESCRIPTION

2.1 Setting

The 320-acre Queen City Farms Site (Site or QCF Site) is located adjacent to Cedar Grove Road, approximately three miles northwest of Maple Valley, King County, Washington (Figure 1). It is situated in a predominantly rural, wooded, residential neighborhood. The Site was the location of a former pig farm and is owned by Queen City Farms, Inc (QCF, Inc).

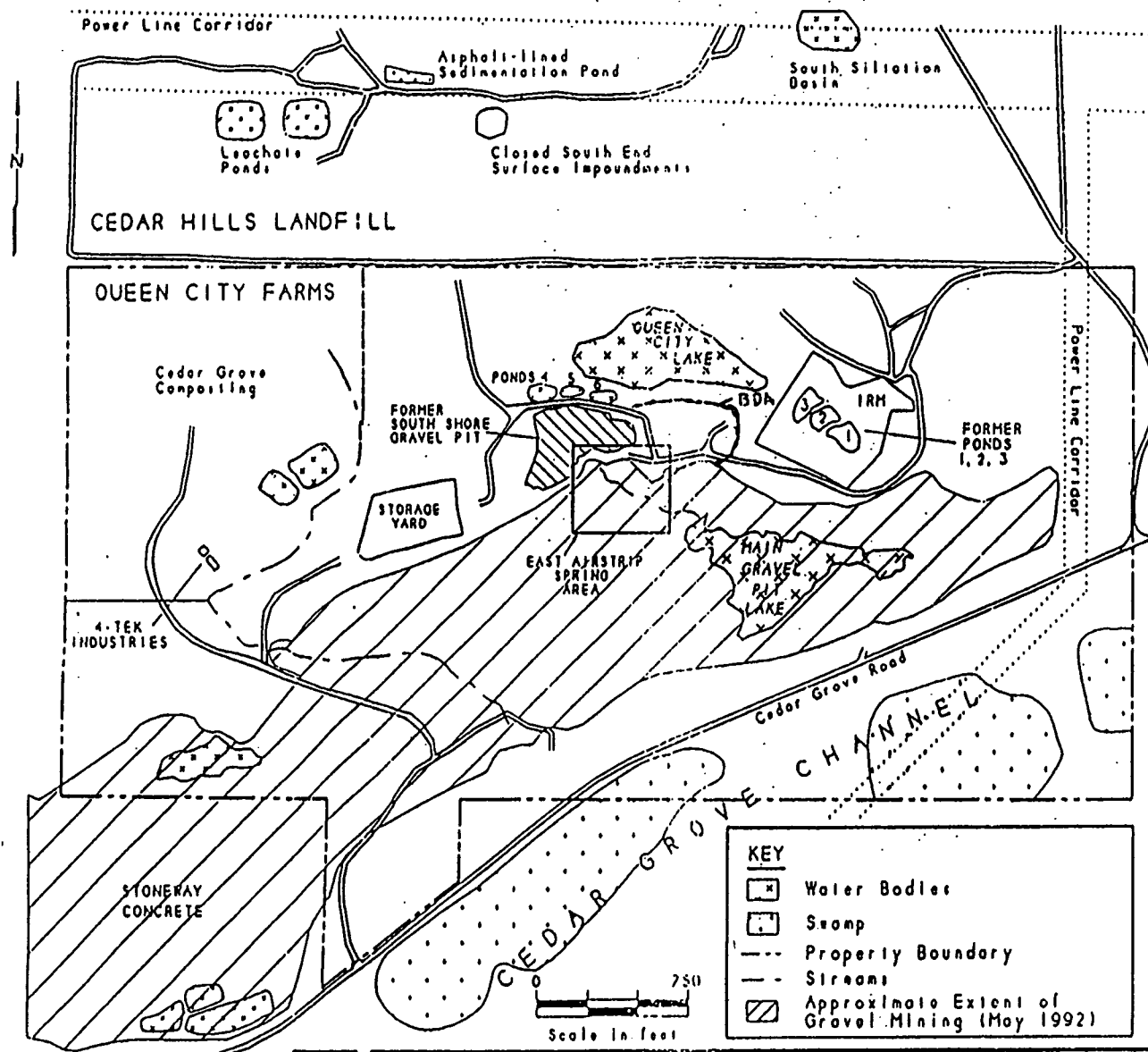
Adjoining the QCF Site to the north is the Cedar Hills Landfill, a municipal landfill, which is operated by King County (Figure 2). The Site is bounded to the west by wooded land owned by Plum Creek Timber Company, and a gravel sorting facility operated by Stoneway Concrete Inc (Stoneway). The south side of the Site is also partially bounded by the Stoneway gravel sorting facility and by private residences. Across Cedar Grove Road to the south is an undeveloped marshy area. Some of this marsh is within the QCF property boundary and the remainder is privately owned. The eastern side of the Site is bounded by 228th Avenue SE which provides access to Cedar Hills Landfill. Private residences are located to the east of 228th Avenue SE.

2.2 Topography

The QCF Site is located on a rolling upland area on the north side of a broad northeast-southwest trending valley (Cedar Grove Channel). The southwestern third of this valley drains into the Cedar River, approximately 1 mile to the west of the Site. The central and northeastern portions of the channel drain into the Issaquah Creek Basin.

The QCF Site slopes from an approximate elevation of 535 feet above mean sea level (MSL) near the northeast and northwest corners to an approximate elevation of 360 MSL along Cedar Grove Road to the south. Gravel mining operations in the south-central portion of the Site have also lowered the surface topography to an approximate elevation of 360 MSL. The Cedar Grove Channel in the southeast portion of the QCF property is slightly lower than Cedar Grove Road.

The Site topography is characterized by varied glacial terrain that includes rolling upland, a seasonal kettle lake (Queen City Lake), delta and kame terraces, and a steep descending slope in the floor of Cedar Grove Channel. Sand and gravel mining of the glacial outwash deposits has significantly modified the topography of the southern half of the Site. A



POOR QUALITY
ORIGINAL

General Site Plan

FIGURE 2

seasonal lake has formed in the south-central portion of the Site in a depression left by extensive gravel mining (Main Gravel Pit Lake). Construction of a yard waste composting facility has also altered the topography in the northwest portion of the Site.

2.3 Land Use

Figure 2 shows the general plan of the QCF Site. The QCF Site includes six former waste ponds, a now closed and reclaimed sand and gravel pit which was operated by Stoneway, the former Queen City airstrip, the former 4-Tek Industries facility and Queen City Lake. A yard waste composting facility, operated by Cedar Grove Composting, Inc. is located in the northwest corner of the Site.

Current land use at the QCF Site is consistent with King County zoning, and consists of two major commercial operations: 1) sand and gravel mining, and 2) yard-waste composting. Mining operations began in the southwest corner of the QCF Site in the mid-1970s and expanded across the southern portion of the Site and then northward until sand and gravel resources were depleted in 1992. Currently, Stoneway has implemented a Reclamation Plan which has been approved by King County, and required slope regrading, stabilization and hydro-seeding.

Yard-waste composting is currently being conducted at a facility, owned and operated by the QCF Site property owners, which is located on approximately 26 acres in the northwest portion of the Site. The Cedar Grove Composting facility accepts compostable yard-waste collected as part of the City of Seattle's and King County's recycling programs. Composted product from this facility is sold commercially for use as a soil amendment.

Immediately south of the composting facility is a building which was used by 4-Tek Industries for repackaging of various chemicals and solvents. This building is now used by Cedar Grove Composting Company. The west-central portion of the Site contains a fenced storage yard which is used by the property owners to store heavy equipment related to current and past commercial operations at the Site.

The north-central and northeastern portions of the Site are not currently used for commercial purposes. Queen City Lake, a seasonal lake with no surface outlet, occupies much of the north-central portion of the Site. The Initial Remedial Measure (IRM) area, location of a 1986 remediation activity, is located on approximately 4 acres in the northeastern portion of the Site.

Currently, there is no residential use of the QCF Site. One abandoned residence is located immediately east of the IRM area. Private residences, located down-gradient to the south and southwest of the QCF Site use ground water for drinking water. Figure 3 shows the locations of the off-site drinking water wells.

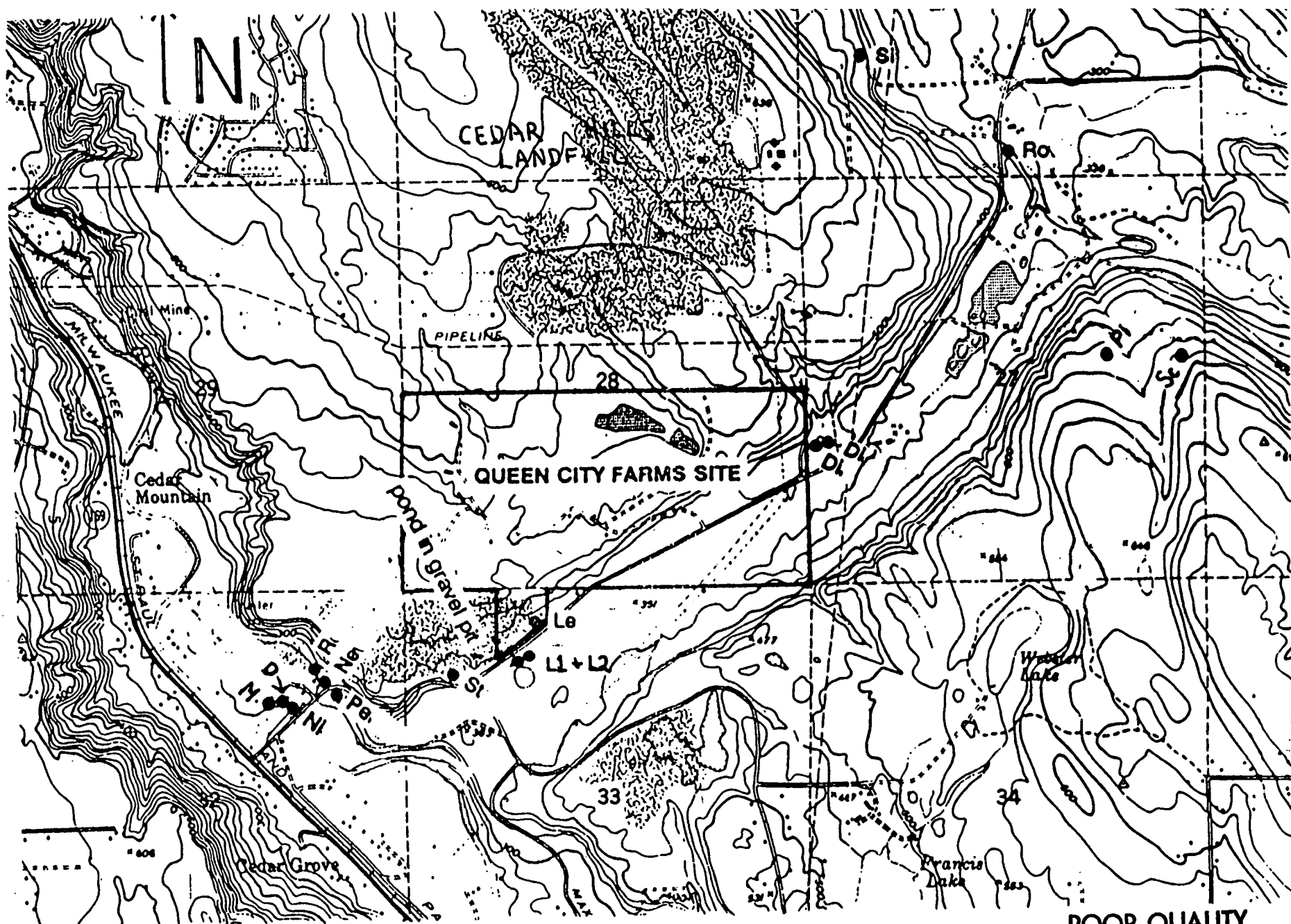


FIGURE 3
LOCATION OF WELLS SAMPLED DURING OFF-SITE STUDY

POOR QUALITY
ORIGINAL

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

3.1 Past Disposal Activities

Past waste disposal practices at the QCF Site are poorly documented. From approximately 1955 until the late 1960's, local industry used the QCF Site for disposal of industrial waste liquids. These wastes included paint and petroleum products, organic solvents, and oils. Most records available indicate that the wastes were primarily disposed of in three unlined ponds located in the northeast portion of the Site. These ponds, known as Ponds 1, 2, and 3 (Figure 2), were closed as the focus of the IRM in 1986.

Wastes were transported to the ponds in tanker trucks and subsequently discharged directly to the ponds. Wastes were also poured into the ponds from drums and, on occasion, the drums themselves were placed into the ponds. Ponds 1, 2, and 3 were reportedly burned periodically by the operators, Seattle Disposal Company, in order to reduce waste volume.

Ponds 4, 5, and 6, located immediately to the south of Queen City Lake, are believed to have been used for disposal of whey and animal waste produced by a hog farming operation conducted on Site between the mid-1950's and 1964.

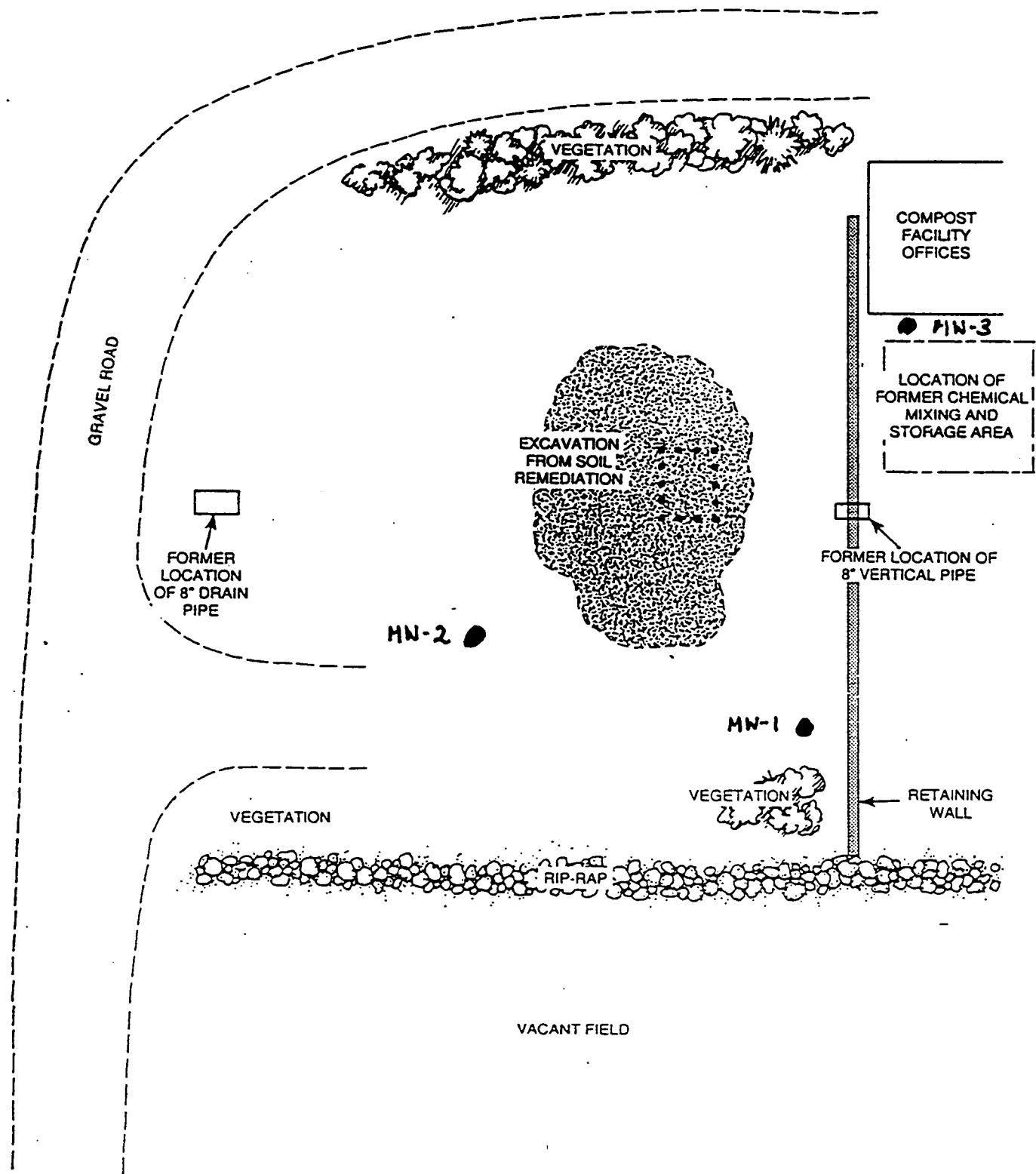
4-Tek Industries (4-Tek) leased a building in the western portion of the Site for the purpose of recycling solvents. The company purchased degreasers and surfactants in bulk and repackaged them into smaller containers. 4-Tek then sold the repackaged chemicals to the government and to oil recovery companies. The plant operated until 1986.

A schematic of the 4-Tek portion of the QCF Site is shown in Figure 4. Bulk chemicals were stored and mixed in a storage area, located south of the plant offices. Surface water runoff from the chemical storage and mixing area drained through an 8-inch vertical pipe to a sump located below the retaining wall west of the plant buildings. The sump was located in the middle of a concrete pad with approximately 3 feet of soil covering the pad. A second 8-inch pipe drained to an outlet west of the pad area. In 1980, the United States Environmental Protection Agency (EPA) and the Washington Department of Ecology (Ecology) sampled soils in the vicinity of the 4-Tek facility. These soils contained detectable levels of volatile organic compounds that were probably due to spillage which occurred during 4-Tek operations.

3.2 Past Remedial and Removal Activities

Past remedial and removal activities have addressed three areas of the Site: (1) Ponds 1, 2, and 3 (2) the Buried Drum Area (BDA) and (3) the area of 4-Tek Industries operations.

CEDAR GROVE COMPOSTING FACILITY



Parametrix, Inc.



MW = Monitoring Well

----- Aerial extent of soil excavation

..... Former sump location

NOT TO SCALE

Figure 4
Schematic Diagram of 4-TEK Site

3.2.1 Ponds 1, 2, and 3

In 1980 the six waste ponds were first sampled by EPA. The analyses of water, sludge and sediment samples taken from the ponds identified 44 contaminants including metals, volatile and semi-volatile organics, and PCBs. In May 1983, EPA began a test well drilling program to investigate the extent of soil and ground-water contamination around the ponds. In August 1983, QCF, Inc. signed a Consent Order pursuant to Section 106 of CERCLA, 42 U.S.C. §9606 to complete the well drilling program. The analyses of soil and ground-water samples taken during these field investigations confirmed the presence of 24 of the original 44 contaminants.

In August and September 1984, QCF conducted an additional field investigation in the immediate vicinity of Ponds 1, 2, and 3. The purpose of this investigation was to determine the volume of the industrial waste sludges in the ponds, and the volume of contaminated soil adjacent and beneath these ponds. This investigation determined the volume of industrial waste sludge in Ponds 1, 2, and 3 to be approximately 5200 cubic yards. The volume of the contaminated soil immediately beneath and adjacent to the ponds was estimated to be 16,800 cubic yards. Samples taken from the sludge and soils confirmed the presence of significant concentrations of heavy metals, volatile organics, semi-volatile organics, polyaromatic hydrocarbons (PAHs), and PCBs.

Subsequent to this second investigation, QCF, Inc. began work on a Focused Feasibility Study (FFS) to examine possible initial remedial measures for the removal and/or containment of the wastes in Ponds 1, 2, and 3, and in the underlying and adjacent soils. In June 1985, QCF, Inc. submitted the FFS to EPA. The FFS evaluated eleven initial remedial alternatives under the broad categories of infiltration prevention, ground-water diversion, contaminated soils isolation or removal and chemical sludge stabilization, solidification, isolation or removal, and incineration.

In October 1985, QCF, Inc. signed a Consent Order pursuant to Section 106 of CERCLA 42 U.S.C. §9606 for implementation of Initial Remedial Measures (IRM) for Ponds 1, 2, and 3. The evaluation conducted in the FFS, and the selected alternative for the IRM were documented in an Enforcement Decision Document issued by EPA on October 24, 1985.

The IRM was constructed at Ponds 1, 2, and 3 in late 1985 and in 1986 and included the following:

- separation of chemical sludge into liquid and solid phases;
- stabilization of the liquid portion of the sludge with _____ limestone flour and/or kiln dust;
- disposal of the stabilized sludge at an off-site hazardous waste landfill;

- installation of a ground water/surface water diversion system to prevent surface water and near-surface ground water from migrating through the contaminated soil left in place beneath the former ponds;
- installation of a multi-layered cap over the contaminated soils; and,
- installation of a ground-water monitoring system.

3.2.2 Buried Drum Area

During sand and gravel excavation activities conducted by Stoneway in March and April of 1988, buried crushed drums, contaminated soils, liquid wastes and other materials were discovered in an area approximately 400 feet south of Queen City Lake and 750 feet west of the IRM. Samples taken of these waste materials contained polyaromatic hydrocarbons (PAHs), pentachlorophenol (PCP), toluene, ethylbenzene, tetrachloroethene (PCE), xylenes, and heavy metals. On August 15, 1988, a work plan was submitted by QCF, Inc. to EPA and Ecology for removal of all exposed drums and drum pieces. Upon EPA and Ecology approval of the work plan, the removal was accomplished during August and September, 1988.

Thirty-two over-pack drums were used to contain recovered crushed drums. One drum was used to contain recovered liquids and three roll-off truck boxes were used to contain heavily contaminated soils and recovered crushed drums. These materials were transported off Site and disposed of in accordance with Section 121(d)(3) of CERCLA, 42 U.S.C. §9621(d)(3), Sections 3004 and 3005 of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§9624 and 9625, and all other applicable State and Federal regulations.

3.2.3 4-Tek Industries

Soil sampling conducted by QCF, Inc. at 4-Tek in 1985 and 1987 confirmed the presence of volatile organics including PCE, trichloroethene (TCE), toluene and methylene chloride. In May 1990, QCF, Inc. signed a Consent Order pursuant to Sections 104 and 122 of CERCLA, 42 U.S.C. §§9604 and 9622 to conduct removal cleanup activities at the 4-Tek property. In May and June 1990, under EPA oversight, excavation, soil removal, confirmatory soil sampling and water sampling from the sump were conducted by QCF, Inc. Approximately 170 cubic yards of soil containing volatile organics and 40 cubic yards of concrete were excavated and removed to an off-site hazardous waste landfill.

3.3 Off-Site Studies

In addition to the three on-site study areas, two investigations were conducted off site in localities adjacent to the QCF Site.

3.3.1 Cedar Hills Landfill

In order to determine whether the Cedar Hills Landfill, which is adjacent to, and lies north of the Site, was contributing ground water or surface water contamination to the QCF Site, King County signed a CERCLA Section 106 Consent Order, pursuant to 42 U.S.C. §9606, with EPA to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the southern portion of the landfill. The RI was completed in January 1991. The results of the RI are summarized as follows:

- No evidence was found of contamination in excess of regulatory standards migrating from Cedar Hills Landfill to the QCF Site due to ground-water transport.
- Surface water that flows across the property line from Cedar Hills Landfill to Queen City Lake does not appear to have any impact on the chemical water quality in the lake.

3.3.2 Off-Site Domestic Well Study

EPA, Ecology, and the King County Health Department sampled off-site domestic drinking water wells in 1981, 1984, and 1986 to determine whether ground-water contamination related to QCF was migrating off-site. Results of these studies indicated that no contamination related to the QCF Site was found in these off-site wells. In December 1991, EPA sampled 12 private drinking water wells in the vicinity of the Site. One of the off-site domestic water wells contained detectable levels of TCE which were below health-based standards. The source of this contamination has not been identified, but may be related to the QCF Site.

3.4 Enforcement Activities

In October 1980, EPA and Ecology conducted a Site Investigation (SI) of the soil, water and sediment from the six former waste ponds at the QCF Site. Results of the SI revealed the presence of heavy metals and organic compounds in water and sludge samples collected from Ponds 1, 2, and 3. Ponds 4, 5, and 6 contained agricultural waste.

In August 1983, EPA and QCF, Inc. signed a Consent Order requiring QCF, Inc. to conduct a shallow ground water investigation pursuant to Section 106 of CERCLA, 42 U.S.C. §9606.

The QCF Site was proposed for inclusion on the National Priorities List (NPL) in September 1983. In September 1984, the QCF Site was placed on the NPL.

In September 1985, EPA issued information request letters, pursuant to Section 104(e) of CERCLA, 42 U.S.C. §9604(e), to 45 potentially responsible parties (PRPs), including QCF, Inc., and The Boeing Company.

Pursuant to Section 106 of CERCLA, 42 U.S.C. §9606, EPA, QCF, Inc., and The Boeing Company signed a Consent Order in October 1985 for implementation of the IRM source control measures at Ponds 1, 2, and 3. This Consent Order was amended in July 1986 to extend the milestone dates of implementation of the source control measures. Subsequently, QCF, Inc. signed a Consent Order with Ecology in January 1986, to implement the source control measures under the authority of Revised Code of Washington (RCW) 90.48.120.

In March 1986, in No Damaging or Unsightly Municipal Pollution, Inc. v. King County, No. C82-186V, the U.S. District Court held that Queen City Lake receives surface water runoff from the Cedar Hills Landfill. This decision proved important in later enforcement actions regarding coordination of activities at the QCF Site with activities at Cedar Hills Landfill.

In July 1987, pursuant to Sections 106 and 122(d)(3) of CERCLA, 42 U.S.C. §§9606, 9622(d)(3), EPA and Ecology notified 25 PRPs of their intent to conduct a Remedial Investigation and Feasibility Study (RI/FS) of the QCF Site.

In November 1987, EPA issued Special Notice Letters to QCF, Inc., The Boeing Company, the Washington Department of Natural Resources, and King County. The Special Notice Letters invoked a 60 day negotiation moratorium for the financing and implementation of RI/FS activities at the Site pursuant to Section 122(e)(2) of CERCLA, 42 U.S.C. §9622(e)(2). In addition, in accordance with Section 107 of CERCLA, 42 U.S.C. §9607, the Special Notice Letter demanded reimbursement of past EPA costs, including all future EPA costs at the Site, as well as payment of interest on these costs.

The Boeing Company, QCF, Inc., and EPA signed a Consent Order in May 1988 requiring The Boeing Company and QCF, Inc. to undertake the RI/FS pursuant to Section 106 of CERCLA, 42 U.S.C. §9606.

Under the authority of Section 106 of CERCLA, 42 U.S.C. §9606, EPA and King County signed a Consent Order in June 1988 requiring King County to undertake an RI/FS on the southern portion of the Cedar Hills Landfill, adjacent to the QCF Site.

In May 1989, EPA issued a Unilateral Order (Order) to Stoneway and QCF, Inc., pursuant to Section 106 of CERCLA, 42 U.S.C. §9606. This Order called for Stoneway and QCF, Inc. to cease and desist from conducting any excavation activities in designated areas of the QCF Site due to the presence of buried crushed drums, drum remnants, contaminated soils, liquid wastes and other materials.

Under the authority of Section 122 of CERCLA, 42 U.S.C. §9622, EPA issued a Special Notice Letter to QCF, Inc. in July 1989. The Special Notice Letter invoked a 60 day negotiation

moratorium for the financing and implementation of response activities at the 4-Tek portion of the QCF Site.

In May 1990, EPA and QCF, Inc. signed a Consent Order requiring QCF, Inc. to undertake removal activities at the 4-Tek portion of the QCF Site pursuant to Sections 104 and 106 of CERCLA, 42 U.S.C. §§9604 and 9622. In addition, under the authority of Sections 104 and 122 of CERCLA, 42 U.S.C. §§9604 and 9622, EPA, QCF, Inc., and Stoneway signed a Consent Order which prohibited Stoneway and QCF, Inc. from excavating in certain areas of the Site. This Consent Order between EPA, QCF Inc., and Stoneway superceded the May 1989 Unilateral Order.

In May 1992, EPA and King County signed a Consent Order pursuant to Section 106(a) of CERCLA, 42 U.S.C. §9606(a), requiring King County to undertake a long-term surface water and ground-water monitoring program on the southern portion of the Cedar Hills Landfill.

3.4.1 Reports Produced by Potentially Responsible Parties Under Consent Orders with EPA

- February 7, 1985, Hart Crowser & Associates On Behalf of QCF, Inc., "Focused Remedial Investigation, Queen City Farms, King County, Washington"
- June 28, 1985, Hart Crowser & Associates, On Behalf of QCF, Inc., "Focused Feasibility Study for Remedial Action, Queen City Farms, King County, Washington"
- January 29, 1987, Hart Crowser & Associates On Behalf of QCF, Inc., "Site Remediation Documentation Report, Source Control Remedial Action, Queen City Farms, Washington"
- February 24, 1988, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc., "Queen City Farms, Initial Remedial Measures, First Year Performance Monitoring Report"
- April 20, 1990, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc., "Remedial Investigation Report, Queen City Farms, King County, Washington" (RI)
- April 20, 1990, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc. "Baseline Risk Assessment, Queen City Farms, King County, Washington" (BRA)
- January 31, 1991, King County Solid Waste Division, "Cedar Hills Regional Landfill, South Cedar Hills Remedial Investigation"
- July 31, 1992, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc., "Supplemental Remedial

Investigation Report, Queen City Farms, King County, Washington" (SRI)

- July 31, 1992, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc., "Baseline Risk Assessment Addendum" Queen City Farms, Remedial Investigation" (BRAA)
- July 31, 1992, Landau Associates Inc. On Behalf of The Boeing Company and QCF, Inc. "Draft Feasibility Study Report, Queen City Farms, King County, Washington" (Draft FS)

3.4.2 Major Reports Prepared and/or Issued by EPA

- October 24, 1985, "Enforcement Decision Document, Initial Remedial Measure Alternative Selection"
- July 1992, ICF Technology Incorporated On Behalf of EPA, "Summary Data Report, Queen City Farms Sampling of Off-Site Water Supply Wells"
- September 1992, "Data Summary Report, Four-Tek Portion of Queen City Farms Superfund Site, Maple Valley, King County, Washington"
- September 1992, " Feasibility Study Addendum, Queen City Farms Superfund Site, Maple Valley, King County, Washington" (FS Addendum)
- September 30, 1992, "Superfund Fact Sheet, The Proposed Plan, Queen City Farms Superfund Site, Maple Valley, Washington" (Proposed Plan)

4.0 COMMUNITY RELATIONS

The RI, BRA, SRI, BRAA, Draft FS, FS Addendum, and the Proposed Plan were released to the public for comment on September 30, 1992. The public comment period extended from October 2, 1992 to November 2, 1992. The RI/FS and supporting documentation were made available to the public in both the administrative record and information repositories maintained at the Superfund Records Center in Region 10, the Issaquah Public Library and the Maple Valley Public Library. The notice of availability of the RI/FS documents was published in the "Voice of the Valley" and in the "Issaquah Press" on October 14, 1992. A public meeting was held at the Lake Wilderness Elementary School in Maple Valley on October 21, 1992. The meeting was attended by seventeen people which included four representatives of the PRPs. At this meeting, representatives from EPA presented the results of the RI/FS and EPA's preferred remedial alternative. In addition, EPA answered questions about the preferred alternative and about problems at the Site. A transcript of the meeting is available at the information repositories listed above. Response to comments received at the public meeting and during the public comment period is included in the Responsiveness Summary, which is part of this ROD.

EPA Region 10 community relations activities at the Site included the following:

- April 1981: EPA samples five drinking water wells from residences located adjacent to the Site.
- November 1983: The Seattle-King County Department of Public Health (SKCDPH), EPA, Ecology, and the Washington State Department of Social and Health Services jointly conduct a drinking water survey of 105 residences that draw water from wells in the area of the Site.
- January 1984: Based on the survey results, EPA, Ecology and SKCDPH jointly sample 46 drinking water wells within a 3.2 mile radius of the Site.
- April 1984: EPA, Ecology and SKCDPH jointly issue a press release describing the final results of the drinking water sampling program.
- August 1, 1984: Draft Community Relations Plan is released to the public.
- October 10, 1985: EPA conducts a public meeting regarding the work plan and Consent Order for the surface cleanup of Ponds 1, 2, and 3.

- April 1986: EPA samples 11 SKCDPH designated potable water supply wells in the vicinity of the QCF Site.
- August 22, 1986: EPA and SKCDPH release the results of the potable water supply well study to residents. The results of this study indicate that contaminants from the QCF Site have not migrated to potable water supplies.
- January 1989: The Community Relations Plan is revised and released. A Fact Sheet is released updating the community on Site activities.
- October 18, 1989: EPA publishes a Notice of Public Availability in the Issaquah Press which announces the availability of the administrative record for the QCF Site at the Issaquah Public Library.
- February 7, 1990: EPA issues a Fact Sheet describing RI/FS activities at the Site.
- August 1990: EPA representatives meet with local officials and members of the community to discuss their concerns about the Site and to review the progress of the RI/FS, prior to updating the Community Relations Plan.
- September 14, 1990: EPA issues a Fact Sheet updating the community on the Community Relations Plan and on the need for additional work at the IRM and 4-Tek study areas.
- October 1990: The revised Community Relations Plan is published and distributed to the information repositories.
- November 1990: EPA identifies the need to sample off-site private drinking water wells to ensure that ground-water contamination from the Site had not spread. Information was coordinated with the Seattle-King County Department of Public Health (SKCDPH), Ecology and The Boeing Company.
- March - June 1991: Community participants in the off-site drinking water well study are contacted, and interviewed by representatives of EPA.
- April 9, 1991: EPA issues Fact Sheet on results of the remedial investigation of the southern portion of the Cedar Hills Landfill, and the start of the off-site drinking water well monitoring program.
- December 1991: EPA samples 11 off-site drinking water wells.

- January 22, 1992: EPA issues a Fact Sheet updating community on status of work on-site and off-site.
- April 14, 1992: EPA sends letters to residents whose wells were sampled to inform them of the results.
- April 20, 1992: EPA issues Fact Sheet updating community on results of off-site drinking water well sampling study.
- May 12, 1992: EPA representatives meet with members of the Cedar Hills Citizen Review Committee to discuss the progress of the RI/FS and off-site drinking water well study.
- June 1, 1992: Representatives of EPA meet with the Maple Valley Area Council to discuss the progress of the RI/FS.
- July 1992: The Summary Data Report describing the results of the off-site drinking water well study is completed and placed in the administrative record.
- September 30, 1992: EPA distributes copies of the Proposed Plan to community members.
- October 21, 1992: Public Meeting to take comments and answer questions regarding the Proposed Plan.

5.0 SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

The remedial actions addressed by this Record of Decision are the final remedial actions planned for the QCF Site.

Residual waste in subsurface soil which is associated with past disposal activities around Ponds 1, 2, and 3 is the most significant existing contaminant source area at the QCF Site. Subsurface soil is contaminated with chromium, PCBs, PAHs, and volatile organics.

The presence of ground water in contact with contaminated soil below the IRM area have caused contaminants to migrate from the subsurface soils to the ground water. A volatile organic contaminant plume has developed in the ground water which threatens off-site drinking water supplies.

Heavy metal, PCB, PAH, volatile, and semi-volatile contamination remaining in soil from the Buried Drum Area, may serve as a continual source to ground-water contamination.

Volatile organic contamination in shallow ground water which may be associated with past activities at the 4-Tek property may serve as a continual source of deep ground-water contamination.

The remedial actions described in this ROD will address the presently known remaining threats to human health and the environment posed by contaminated soils and ground water at the QCF Site.

6.0 SITE CHARACTERISTICS

6.1 Geology and Soils

The QCF Site is underlain by glacial deposits from the most recent period of glaciation known as the Vashon Stade of the Fraser glaciation (Vashon). These sediments overlie pre-Vashon soils and sediments which were deposited by streams and lakes. Twelve stratigraphic units were identified on the Site (Figure 5), consisting of six pre-Vashon units, five Vashon units, and recent deposits. Stratigraphic units of Vashon age include till, ice contact, and outwash deposits which can be correlated to similar geologic units throughout the Puget Sound Basin. Pre-Vashon deposits have not been correlated outside the Cedar River Valley.

In general, stratigraphic relationships between Vashon deposits are complex, pinching out or grading laterally into other units or soil types over relatively short distances within the QCF Site boundary. Pre-Vashon deposits conversely are generally continuous laterally at the QCF Site, however geologic data collected off-site indicate that these deposits may be of limited regional extent. A north-south geologic cross section through the IRM Area showing the relationship of some of these stratigraphic units is shown in Figure 6.

The well-sorted Vashon sands and gravels have been mined extensively in the central portion of the Site by Stoneway. This portion of the Site is currently dominated by a gravel pit face which in the past has served as a valuable tool for correlating stratigraphic units across the Site. The gravel pit face is currently undergoing reclamation and will be regraded to a 2:1 slope and then hydroseeded with grass.

6.2 Surface Water Hydrology

Major surface water features in the vicinity of the QCF Site are shown in Figure 7. The upland area encompassing the QCF Site and Cedar Hills Landfill is bounded by major surface water drainage channels; to the north by Mason Creek, to the east by Issaquah Creek, and to the west by the Cedar River. Cedar Grove Channel, a northeast-southwest trending drainage swale, occupies the area directly south of the QCF Site. Surface water on the drift plain north and south of the QCF Site includes a number of small lakes and streams. Streams draining to the south, towards Cedar Grove Channel, discharge into seasonal lakes with no surface outlet or infiltrate directly into the ground. Other streams discharge directly into the major drainage channels.

Seven drainage basins have been delineated in the vicinity of the QCF Site (Figure 8). The Queen City Lake Basin, the Main Gravel Pit Lake Basin, and the Stoneway Pit Sub-Basin drain into seasonal lakes that have no surface outlet. Surface water in the

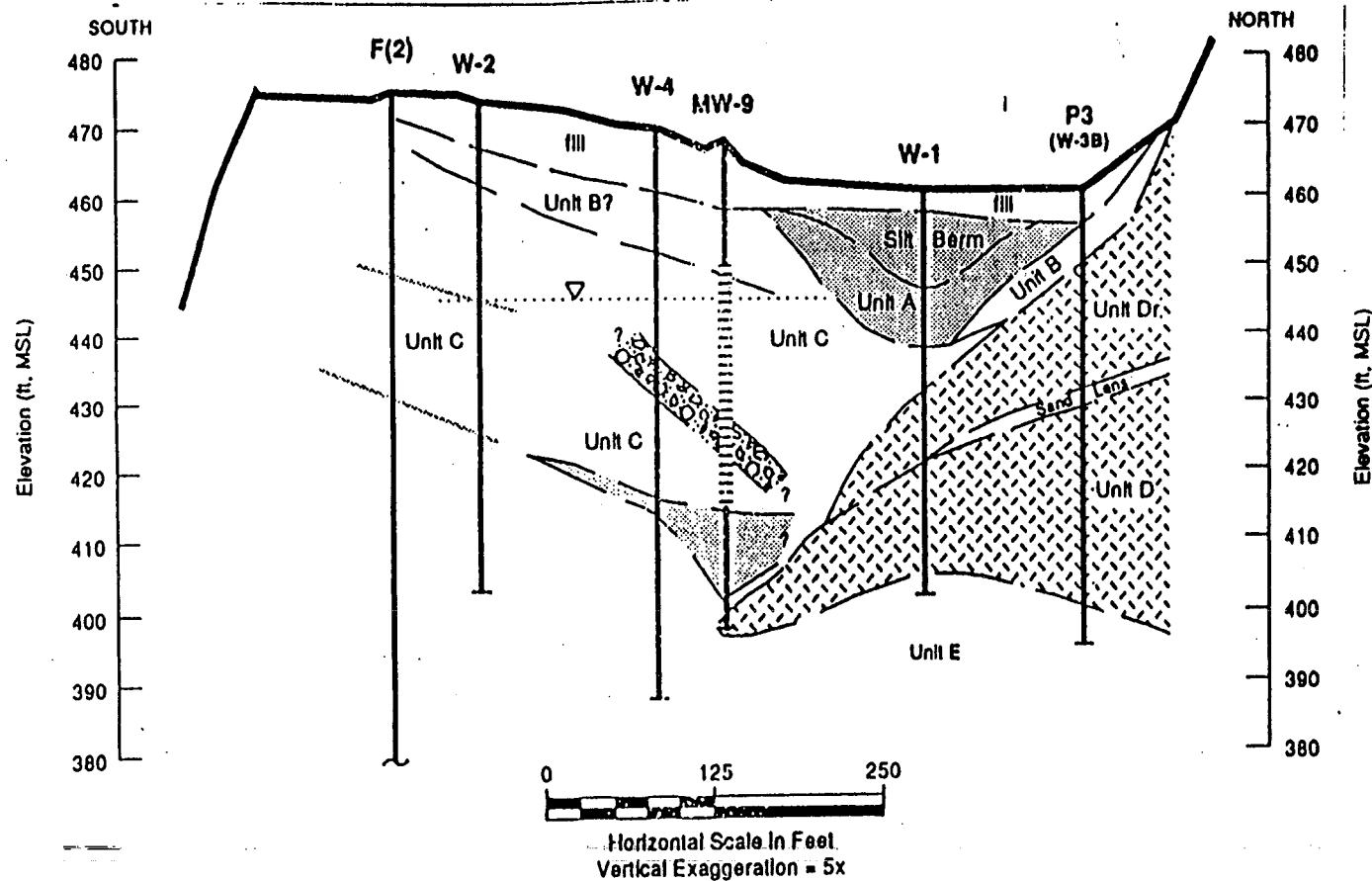
AGE	STRATIGRAPHIC UNIT	DESCRIPTION
↑ RECENT	(A)	Clayey SILT, SILT, silty fine SAND
↑ ↓	(B)	Poorly- to well-sorted CLAY, SILT, SAND, and GRAVEL (ice contact deposit) (locally water-bearing within Aquifer 1 and Aquifer 2)
↓	(C)	Stratified, poorly to well-sorted SAND and GRAVEL with occasional interbedded clayey SILT and "Flow Till" (recessional outwash and deltaic deposits) (locally water-bearing within Aquifer 1 and Aquifer 2)
VASHON STAGE	(Dr)	Unsorted CLAY, SILT, SAND, and GRAVEL (till deposited during recessional phase) (Till Aquitard)
↓	(D)	Unsorted CLAY, SILT, SAND, and GRAVEL (lodgement till, Till Aquitard)
↓	(E)	Stratified poorly to well-sorted SAND and GRAVEL with occasional silty GRAVEL interbeds (advance outwash) (locally water-bearing within Aquifer 2)
↓	(F)	Well-sorted, slightly silty to silty, very fine, fine and medium SAND with occasional clayey SILT to silty CLAY interbeds (upper section is dark red-brown to orange-brown color; occasional wood fragments, water-bearing within Aquifer 2)
↓	(G)	SILT, clayey SILT, fine sandy SILT, and silty fine SAND (occasional wood fragments) (Aquitard 2)
↓	(H)	Well-sorted very fine to medium SAND with sandy GRAVEL and gravelly SAND interbeds (occasional wood fragments) (water-bearing within Aquifer 3)
PRE-VASHON UNDIFFERENTIATED DRIFT	(I)	SILT and fine sandy SILT (containing abundant wood fragments) to gravelly SILT with occasional SAND and sandy GRAVEL interbed (Woody Aquitard)
↓	(J)	Interbedded sandy GRAVEL, gravelly SAND, silty sandy GRAVEL, sandy SILT, and SAND (Deep Water-Bearing Zone)
↓	(U)	CLAY, with closely spaced slickensides with interbedded SILT and very fine SAND (Undifferentiated Pre-Vashon Quaternary lacustrine sediments)

Note: Stratigraphic Units I and J are based in part on interpretation and generalization of boring log data for monitoring wells MW-24, MW-53, and MW-54 at Cedar Hills Landfill.



Stratigraphic Units Beneath QCF

Figure . 5



KEY

Note: This cross section has been generalized from project field data. Variations between this cross section and actual soil conditions may be encountered. The project boring logs and written reports must be referenced for a proper understanding of the nature of subsurface materials.

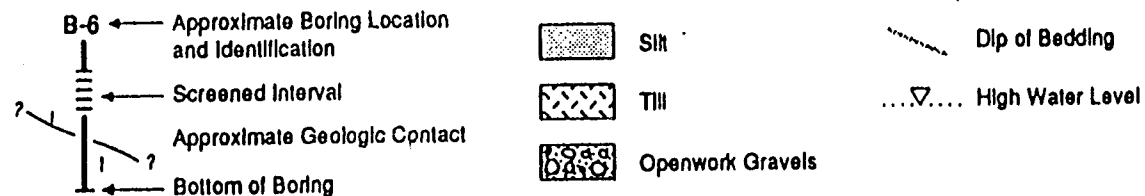
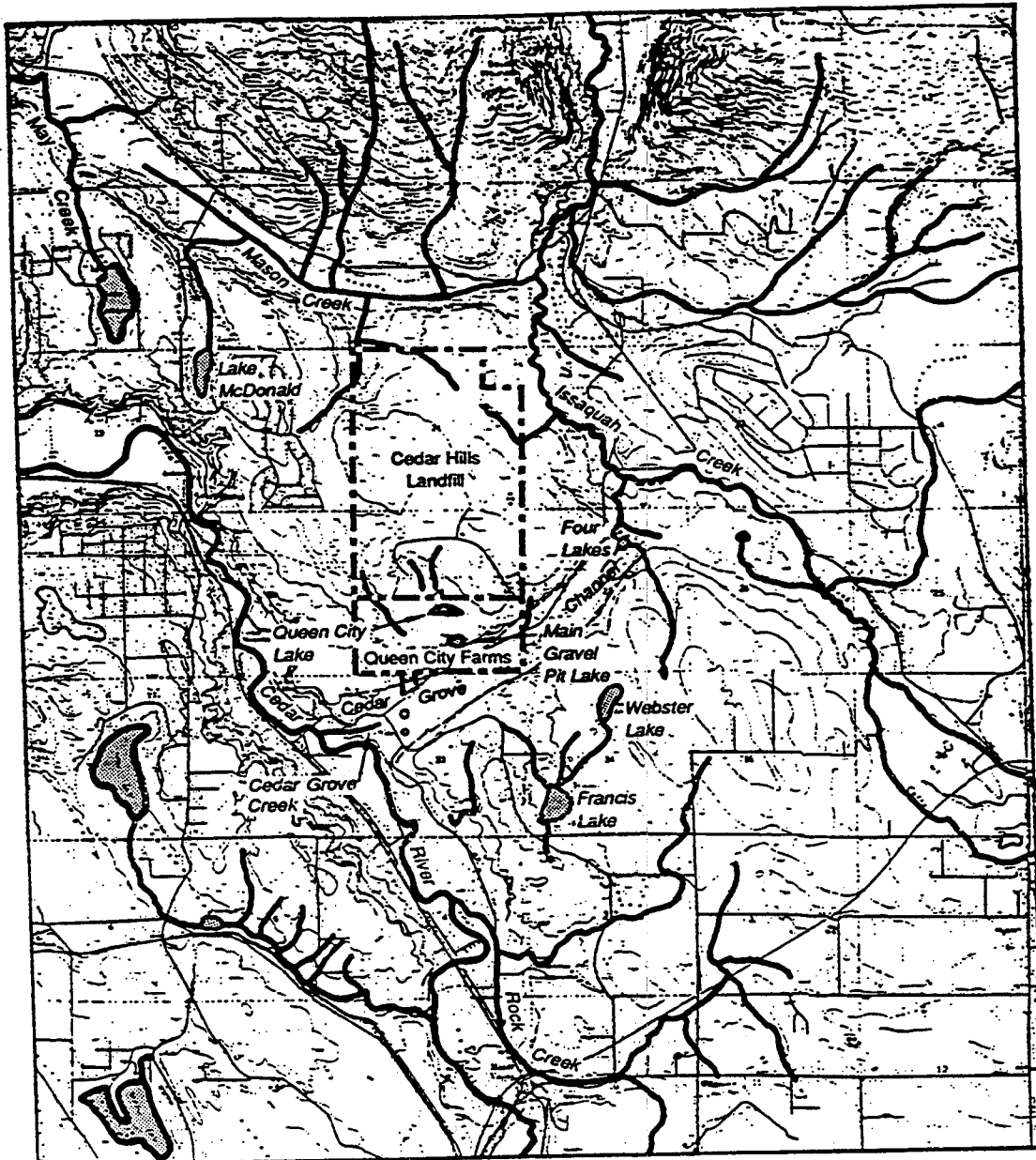


FIGURE 6
GEOLOGIC CROSS-SECTION THROUGH IRM AREA



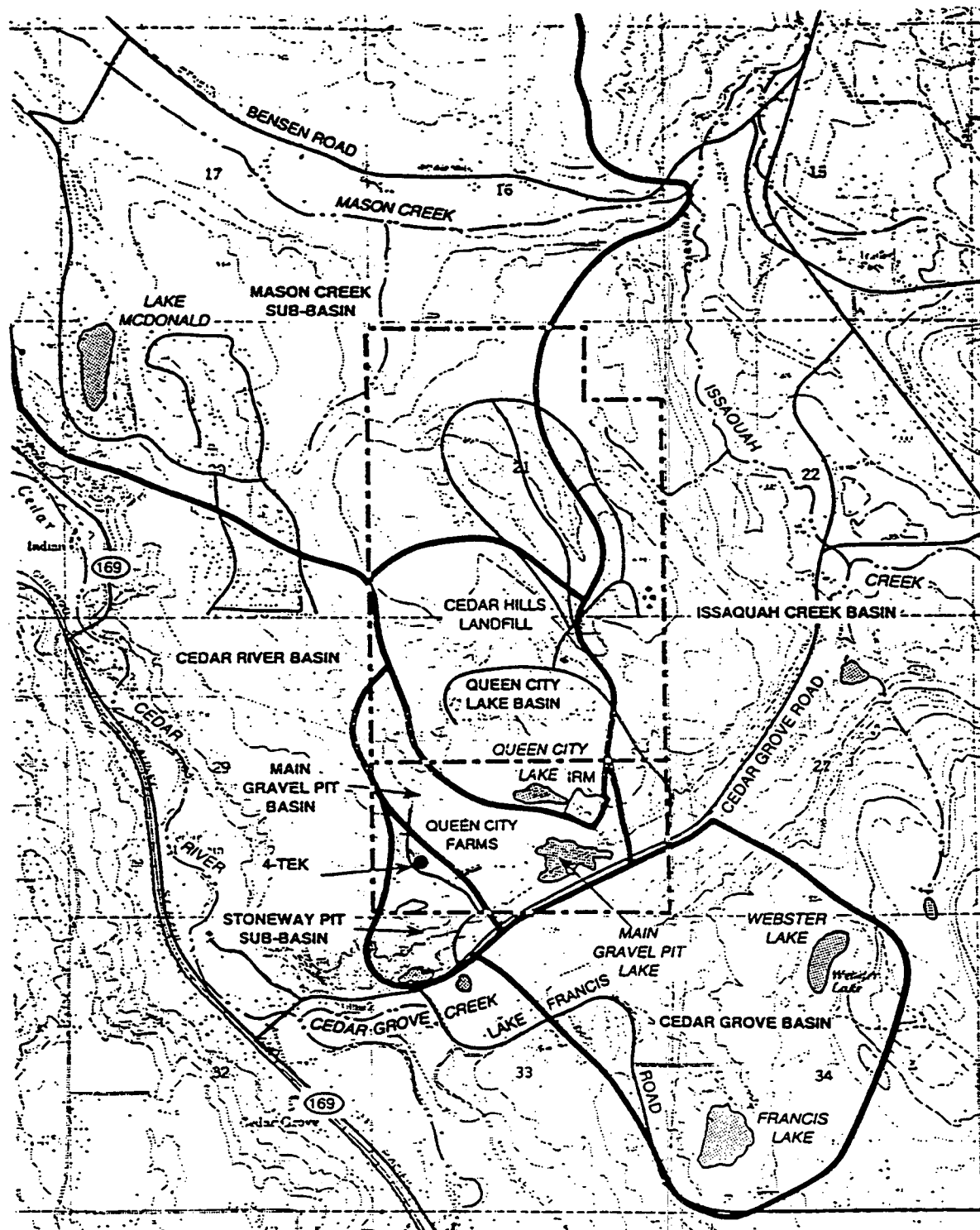
Source: Base map after King County (1987).

KEY

- Property Boundaries
- Drainage Courses
- Water Bodies



FIGURE 7
SURFACE WATER IN THE VICINITY OF QUEEN CITY FARMS



SCALE IN FEET
0 1,250 2,500

-  Lakes and Ponds
-  Property Boundary
-  Roads
-  Streams
-  Drainage Basin Boundary

Figure 8.
Drainage Basins in the Vicinity
of Queen City Farms (Landau 1990)

Cedar Grove Basin appears to infiltrate Cedar Grove Creek. Surface water in the Cedar River Basin, the Mason Creek Sub-Basin, and the Issaquah Creek Basin discharges to the respective river or creek.

Six of the seven drainage basins include portions of the QCF Site. Surface water within these basins is characterized by a number of seasonal lakes, streams, and springs. Seasonal precipitation patterns cause lake levels and stream and spring flows to vary widely. Prior to 1991, surface water flow and excessive precipitation during the wet season would cause Queen City Lake to overflow periodically. A culvert (Erosion Control Measure) was installed by QCF Inc. and Stoneway in 1991 which diverted water from the outlet of Queen City Lake to the lower gravel pit (Main Gravel Pit Lake). With the installation of the Erosion Control Measure, excessive surface water runoff and flooding has been controlled. With the exception of a few springs, surface water on the QCF Site normally dries up by late summer.

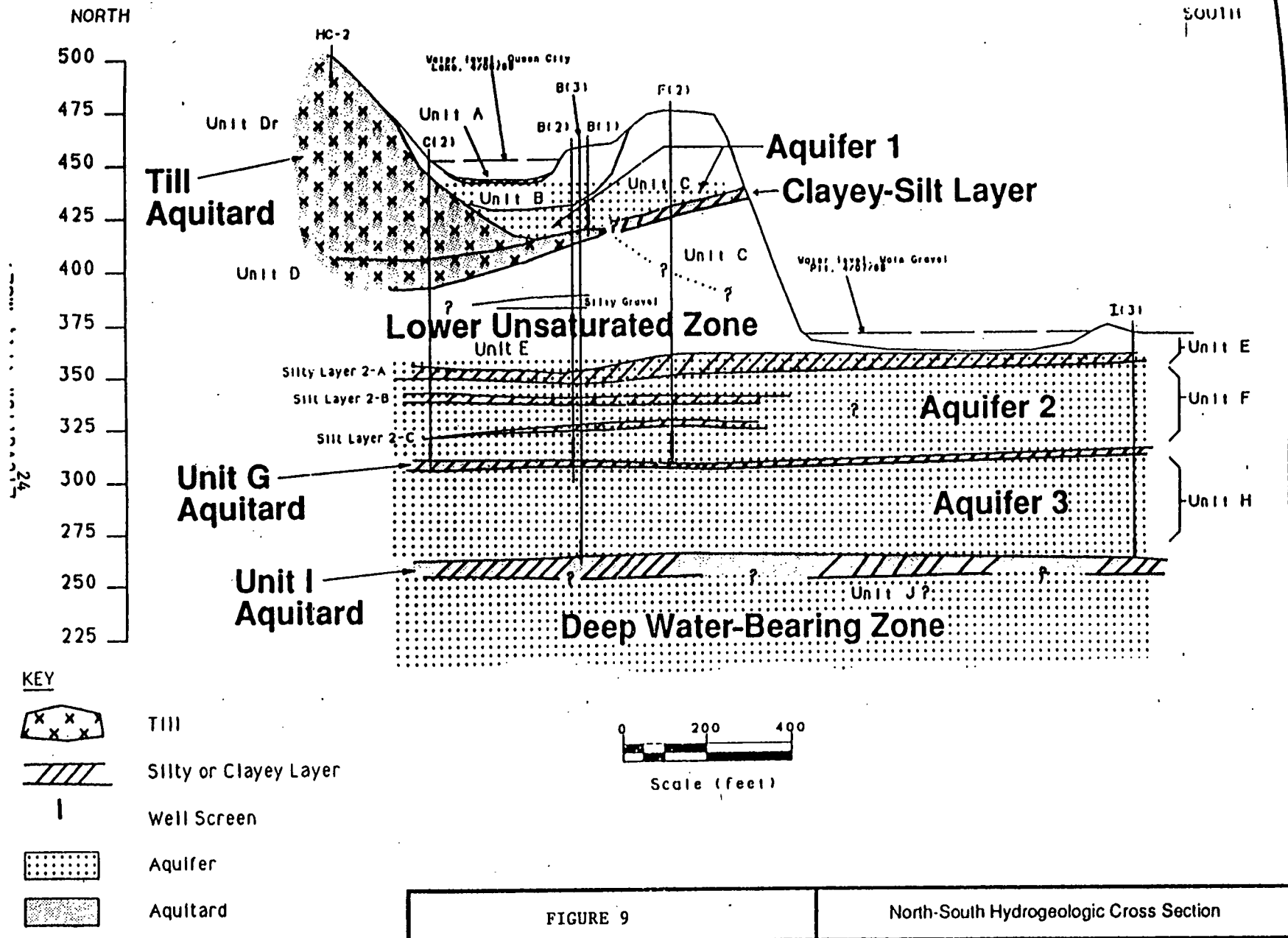
6.3 Ground Water Hydrology

The QCF Site is located within a regional ground-water recharge zone. Surface water recharges the shallow water-bearing zones and hydraulic gradients direct ground-water flow from the upper aquifers to the lower aquifers.

Twelve hydrogeologic units have been identified at the QCF Site. Hydrogeologic units are grouped into two unsaturated units, five saturated units, and five aquitards. Unsaturated units are formations, or groups of formations, that do not have sufficient water to monitor in a well. A north-south hydrogeologic cross-section is shown in Figure 9.

The five saturated units identified at the QCF Site include the following:

- 1) **The Near-Surface Water-Bearing Zone** (not shown on Figure 9) - This unit comprises ground water in the weathered glacial till and near-surface deposits, is generally limited in extent and restricted to the northern portion of the QCF Site and to the Cedar Hills Landfill.
- 2) **Aquifer 1** - This unit is a perched sand and gravel aquifer which is very permeable, is limited in extent and restricted to the northern portion of the QCF Site in the vicinity of the IRM.
- 3) **Aquifer 2** - This aquifer is unconfined and consists of a series of sands and silts which extend throughout the QCF Site and beyond the Site boundaries.



4) **Aquifer 3** - This aquifer is confined and, is similar to Aquifer 2, consists of a series of sands and gravels which extend throughout the Site and beyond the Site boundaries.

5) **Deep Water-Bearing Zone** - This sand and silt aquifer is confined and is most likely of regional extent.

Aquifers 2 and 3 and the Deep Water-Bearing Zone represent a continuous sequence of sands and silts separated by two relatively thin clay and silt aquitards.

Ground-water flow direction at the QCF Site is generally from the north to the south, with some important exceptions that are discussed in greater detail in the section entitled "Routes of Contaminant Migration."

6.4 Extent of Contamination

6.4.1 Soil

Soil contamination on Site is generally confined to identified potential source areas. Soil and sediment sampling conducted during the RI focused primarily on previously identified source areas and other potential areas of contamination.

Although the IRM conducted in 1986 removed much of the source materials from the QCF Site, soil beneath former Ponds 1, 2, and 3 are contaminated due to years of leaching of the waste materials. No subsurface soil samples were taken from the IRM area below former Ponds 1, 2, and 3 during the RI. Previous sampling, conducted by Hart-Crowser on behalf of QCF Inc. in 1983, 1985, 1986, and 1987, revealed high concentrations of metals, volatile organics, semi-volatile organics, and PCBs. The range and frequency of contaminant concentrations detected in soils remaining beneath former Ponds 1, 2, and 3 is shown in Table 1. Contaminants of concern from these soils include chromium, cyanide, TCE, DCE, toluene, xylene, PAHs, and PCBs. Because ground water is in contact with these soils, the IRM soils are still serving as a continuous source to ground-water contamination at the Site.

Contaminants detected in post-removal samples from surface and subsurface soils of the BDA include arsenic, chromium, copper, lead, PCBs, PAHs, PCP, 1,2,4-trichlorobenzene, phthalates, PCE and TCE. The range and frequency of contaminant concentrations detected in subsurface soils from the BDA is shown in Table 2. Based on magnetometer studies, five test pits were excavated to depths ranging from 8 to 15 feet below surface. Drums and wastes encountered in the test pits indicated that damaged, empty drums, or drums that would not easily drain were placed in the burial area. All drums encountered during the RI contained either a very viscous tar-like material or residual solid sludge or cake material. Samples of native soil were taken

TABLE 1
SUMMARY OF SUBSURFACE SOIL CONTAMINANTS IN FORMER PONDS 1, 2 AND 3
(IRM AREA)

Constituent	Pre-RI Soil Data Beneath the IRM (a)		Subsurface Soil at (or Near) Perimeter of IRM (b)	
	Concentration Range	Frequency of Detection (c)	Concentration Range	Frequency of Detection
<u>Inorganics (mg/kg)</u>				
Arsenic	1.1 - 24	19/19	1.3 B - 5	27/27
Barium	29 - 170	12/12	35.3 - 93.7	27/27
Beryllium	0.3 - 0.8	11/12	20.3	1/6
Cadmium	0.08 - 38	18/19	0.64 - 7.9	25/27
Chromium	16 - 31000	39/39	17.4 - 1320	27/27
Cobalt	NA		4 B - 9.3	4/6
Copper	12 - 530	19/19	10.9 - 133	27/27
Cyanide	0.2 - 38	9/23	ND	
Lead	1.7 - 510	18/19	1.6 - 3.9	25/27
Manganese	NA		161 - 452	16/16
Mercury	0.3	2/12	0.85	1/18
Nickel	16 - 89	19/19	13 - 43.1	27/27
Selenium	0.6	2/12	ND	
Silver	0.2 - 2.9	8/12	ND	
Thallium	ND		0.34	1/5
Vanadium	NA		37.4 - 47	6/6
Zinc	26 - 600	19/19	25.6 - 54	27/27
<u>Organics (ug/kg)</u>				
Aroclor-1016	46010	1/32	ND	
Aroclor-1254	850 - 39600	7/32	270 - 7600	7/25
Aroclor-1260	92 - 862000	26/32	230 - 18000	10/25
beta-BHC	92	1/32	ND	
1,2,4-Trichlorobenzene	ND		52 J - 2700	6/26
2,4-Dimethylphenol	8.1	1/12	ND	
2-Methylnaphthalene	7800 - 190000	4/12	610 - 970	3/26
Acenaphthene	530 - 11500	10/33	ND	
Acenaphthylene	1890 - 8890	3/33	ND	
Anthracene (d)	450 - 30500	9/33	63 J - 70 J	2/26
Benzo(a)anthracene (e)	370 - 1900	3/33	ND	
Benzo(a)pyrene	300 - 2800	2/33	43	1/26
Benzo(b)fluoranthene (f)	2180 - 3270	7/33	ND	
Benzo(k)fluoranthene (f)	2180 - 3270	7/33	ND	
Benzoic acid	360	1/12	ND	
bis(2-Ethylhexyl)phthalate	130 - 7200	10/12	39 J - 300	4/26
Chrysene	570 - 96000	5/33	61 J - 64 J	2/26
Di-n-butylphthalate	60 - 860	5/12	110	1/26
Di-n-octylphthalate	100 - 690	3/12	38 J	1/26
Dibenzofuran	82 - 4400	7/12	ND	
Fluorene	52 - 19200	10/33	260 J - 320 J	2/26
Fluoranthene	240 - 78700	4/33	ND	
Naphthalene	740 - 37000	9/33	180	1/26
Phenanthrene (d)	80 - 46000	12/33	14 J - 820	4/26
Phenol	190 - 8900	4/12	21 J - 30 J	2/26
Pyrene (e)	460 - 9800	6/33	51 - 180 J	4/26
1,1,1-Trichloroethane	1500	1/12	ND	
1,1-Dichloroethane	38	1/12	ND	
1,1-Dichloroethene	49	1/12	ND	
1,2-Dichloroethane	43	1/12	ND	

TABLE 1 (Continued)
SUMMARY OF CONTAMINANTS DETECTED IN FORMER PONDS 1, 2, AND 3

Constituent	Pre-RI Soil Data Beneath the IRM (a)		Subsurface Soil at (or Near) Perimeter of IRM (b)	
	Concentration Range	Frequency of Detection (c)	Concentration Range	Frequency of Detection
1,2-Dichloroethene (total)	NA		2 J - 35	5/28
1,2-Dichloropropane	190	1/12	ND	
2-Butanone	150 - 6100	4/12	ND	
4-Methyl-2-pentanone	31	1/12	ND	
Acetone	110 - 18000	2/12	4 J - 71	16/28
Benzene	380	1/12	ND	
Chloroform	290	1/12	ND	
Ethylbenzene	T - 6200	4/12	79	1/28
Methylene chloride	T - 180000	8/12	1 J - 31	18/28
Styrene	Trace	1/12	ND	
Tetrachloroethene	1900	1/12	2 J - 12	3/28
Toluene	T - 40000	5/12	ND	
trans-1,2-Dichloroethene	T - 1300	4/12	NA	
Trichloroethene	T - 670000	6/12	3 J - 6 J	4/28
Vinyl chloride	Trace	1/12	ND	
Xylene (total)	T - 38000	5/12	210 -	1/28

- (a) Data compiled from Hart Crowser (1983, 1985b, and 1987). All data are representative of soil remaining beneath the IRM Area. Soil sample locations: HC-10, HA-10, HA-11, HA-12 (Hart Crowser 1983), HC-11, HC-12, HC-13, P-2, P-3, P-4, P-5, P-6, P-9, P-10, P-14, P-20 (Hart Crowser 1985b), P-1, P-2, P-3, PB-1, PB-2, PB-3 (Hart Crowser 1987). Results of duplicate samples are averaged.
Pond bottom soil samples (P-1, P-2, P-3) are 6:1 composites (Hart Crowser 1987).
- (b) Concentration range of detected analytes. Results of duplicate samples are not averaged.
Data inclusive of sampling events from September 1990 to March 1991 (Landau Associates 1992a).
Sample Locations MW-9, MW-10, MW-11, W-1, W-2, W-3B, W-4, W-7, and W-9
at 9 to 68 ft below ground surface.
- (c) Number of samples in which the chemical was detected/number of samples analyzed.
- (d) Anthracene and Phenanthrene = co-elutes, Hart Crowser 1985b boring and test pit soil samples.
- (e) Benzo(a)anthracene and Pyrene = co-elutes, Hart Crowser 1985b boring and test pit soil samples.
- (f) Benzo(b)fluoranthene and Benzo(k)fluoranthene = co-elutes, Hart Crowser 1985b boring and test pit soil samples.

Data Flags

- B = Lab flag for inorganics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.
- J = Lab flag for organics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.
- T = Trace.
- NA = Not analyzed.
- ND = Not detected.

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TABLE 2
SUMMARY OF CONTAMINANTS DETECTED IN BHRIED DRUM AREA

Constituent	Concentration Range (a)	Frequency of Detection (b)
<u>Inorganics (mg/kg)</u>		
Arsenic	0.55 B - 65.7 B	7/8
Barium	60.6 - 488	8/8
Cadmium	1.7 - 53	6/8
Chromium	21.5 - 97.2	8/8
Copper	18.1 - 1020	8/8
Cyanide	0.83 - 7.1	5/8
Lead	2.1 - 414	8/8
Nickel	19.4 - 65	8/8
Zinc	39.8 - 1760	8/8
<u>Organics (ug/kg)</u>		
Aroclor-1254	570 - 7200	6/8
Aroclor-1260	220 - 3700	6/8
2-Methylnaphthalene	220 J	1/8
Acenaphthene	270 J	1/8
Anthracene	24 J - 1000 J	2/8
Benzo(a)anthracene	71 J - 2300	2/8
Benzo(a)pyrene	54 J - 1800	3/8
Benzo(b)fluoranthene	39 J - 2100	2/8
Benzo(g,h,i)perylene	550 J	1/8
Benzo(k)fluoranthene	47 J - 2100	2/8
bis(2-ethylhexyl)phthalate	50 J - 1600 J	6/8
Chrysene	82 J - 2200	2/8
Dibenz(a,h)anthracene	320 J	1/8
Fluoranthene	100 J - 2200	2/8
Fluorene	390 J	1/8
Indeno(1,2,3-cd)pyrene	18 J - 600	2/8
Phenanthrene	54 J - 4300	2/8
Pyrene	90 J - 2900	2/8
Acetone	21 J	1/8
Tetrachloroethene	1 J - 33	3/8
Toluene	2 J - 10 J	3/7
Trichloroethene	1 J - 13	7/8
Xylene (total)	23 - 41	2/8

(a) Concentration range of detected analytes. Results of duplicate samples are not averaged. Data compiled from Landau Associates (1989a).

Sample Locations TP-1b, TP-1c, TP-2a, TP-2b, TP-4a, TP-4b, and TP-5a.

(b) Number of samples in which the chemical was detected/number of samples analyzed.

Data Flags

B = Lab flag for inorganics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.

J = Lab flag for organics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.

below visibly discolored soil in the test pits. These native soil samples showed some indications of contamination related to wastes encountered at higher elevations in the respective test pits. Heavy metals including chromium, copper and lead were detected in all 5 test pits. Bis(2-ethylhexyl)phthalate and TCE were detected in most of the test pits. PCBs and cyanide were detected in 2 of 5 test pits. PAHs were detected in 1 of 5 test pits. Based on these test pit sampling results, wastes from the BDA have leached into and contaminated the underlying native soils.

Heavy metals and organic compounds were detected in soil samples taken from Ponds 4, 5, and 6. A summary of contaminant concentrations in samples taken from these ponds is shown in Table 3. As noted in this table, the concentrations of metal and organic contaminants generally decrease with depth. Metal concentrations are at or below background levels at a depth of 10 feet. Organic contaminants are generally not detected below 2 feet.

Confirmatory surface soil sampling taken after completion of the 4-Tek soil removal indicated that the surface soils were clean. Post-removal subsurface soil samples taken from three monitoring wells drilled at the 4-Tek facility revealed the presence of volatile organic compounds (Table 4). Contaminants found include DCE, TCE, acetone and 2-butanone. These contaminants are most likely related to past operational and disposal practices by 4-Tek Industries.

Based on the results of the RI/FS, the total volume of solids which may require remediation at the QCF Site has been estimated at 290,000 cubic yards. An estimated 280,000 cubic yards of contaminated soil within the IRM would require further containment. 10,000 cubic yards of soil and debris from the BDA would be excavated. Of this 10,000 cubic yards, approximately 100 cubic yards of soil and debris may exhibit hazardous waste characteristics, and would require treatment prior to off-site disposal. Approximately 4,000 cubic yards of soil and debris have low levels of PAH and PCB contamination and may only require containment to prevent migration of contaminants to underlying ground water.

6.4.2 Surface Water

Surface water investigations included sampling of springs, Queen City Lake, and the Main Gravel Pit Lake. Some springs that emerge from Aquifer 1 on the north face of the Main Gravel Pit contained low levels of volatile organics including, but not limited to TCE (1.7-3.8 micrograms/liter ($\mu\text{g/l}$)), and DCE (1-46.3 $\mu\text{g/l}$). These volatile organics are apparently lost through volatilization within short distances downstream of the springs. Standing water bodies, including Queen City Lake, the Main Gravel Pit Lake and the Interceptor Trench have not been significantly affected by contaminant source areas.

TABLE 3
CONTAMINANTS DETECTED IN RI SOIL SAMPLES
COLLECTED FROM PONDS 4, 5, and 6
AT QUEEN CITY FARMS

POND 4					
SAMPLE NUMBER	P4-0	P4-2	P4-12	P4-4	
SAMPLE DEPTH	0-1.5 feet	2-3.5 feet	(P4-2 dup)	4-5.5 feet	
CHEMICAL	CONCENTRATION				
Cyanide (mg/kg)	0.84	0.63	0.67	<(a)	0.61
TOTAL METALS (mg/kg)					
Arsenic	2.9	2.8	2.9		2.7
Barium	210 N	130 N	150 N		75 N
Cadmium	1.2 N	< 0.75 N	< 0.77 N	<	0.73 N
Chromium	28 N	35 N	39 N		29 N
Copper	76	34	38		26
Lead	79	36	19		6.9
Nickel	19	19	21		21
Zinc	420	150	150		89
PESTICIDES/PCBs (ug/kg)					
4,4'-DDD	120	42	39	<	7.5
4,4'-DDE	64	23	21	<	7.5
Aroclor-1254	590	390	340	<	75
Aroclor-1260	340	< 79	< 77	<	75
Dieldrin	29	11	10	<	7.5
Endosulfan II	9.3	< 7.9	< 7.7	<	7.5
SEMI-VOLATILE ORGANICS (ug/kg)					
1,2,4-Trichlorobenzene	56 J	< 790	< 800	<	370
Benzo(b)fluoranthene	140 J	62 J	63 J	<	370
Benzo(k)fluoranthene	140 J	62 J	63 J	<	370
bis(2-Ethylhexyl)phthalate	1000 B	480 J,B	510 J,B		83 J,B
di-n-Butylphthalate	< 810	< 790	< 800		170 J
Pyrene	88 J	57 J	51 J	<	370

SAMPLE NUMBER	P4-6	P4-8	P4-10	P4-B-12	
SAMPLE DEPTH	6-7.5 feet	8-9.5 feet	10-11.5 feet	12 feet	
CHEMICAL	CONCENTRATION				
Cyanide (mg/kg)	< 0.51	< 0.44	< 0.54	< 0.54	
TOTAL METALS (mg/kg)					
Arsenic	3.9	4.7	2.9	1.7 B	
Barium	78 N	84 N	42 N	34 N	
Cadmium	< 0.83 N	< 0.81 N	< 0.8 N	< 0.74 N	
Chromium	35 N	91 N	19 N	20 N	
Copper	25	36	19	16	
Lead	4.6	2.3	2	2.1	
Nickel	27	41	18	21	
Zinc	79	59	49	55	
PESTICIDES/PCBs (ug/kg)					
4,4'-DDD	7.1 J	< 7.4	< 7.4	< 7.3	
4,4'-DDE	< 7.6	< 7.4	< 7.4	< 7.3	
Aroclor-1254	< 76	< 74	< 74	< 73	
Aroclor-1260	< 76	< 74	< 74	< 73	
Dieldrin	< 7.6	< 7.4	< 7.4	< 7.3	
Endosulfan II	< 7.6	< 7.4	< 7.4	< 7.3	
SEMI-VOLATILE ORGANICS (ug/kg)					
1,2,4-Trichlorobenzene	< 370	< 360	< 360	< 370	
Benzo(b)fluoranthene	< 370	< 360	< 360	< 370	
Benzo(k)fluoranthene	< 370	< 360	< 360	< 370	
bis(2-Ethylhexyl)phthalate	94 J,B	34 J,B	28 J,B	49 J,B	
di-n-Butylphthalate	< 370	< 360	< 360	< 370	
Pyrene	< 370	< 360	< 360	< 370	

TABLE 3 (con't.)

POND 5							
SAMPLE NUMBER	P5-0	P5-2	P5-4	P5-6	P5-8	P5-10	
SAMPLE DEPTH	0-1.5 feet	2-3.5 feet	4-5.5 feet	6-7.5 feet	8-9.5 feet	10-11.5 feet	
CHEMICAL	CONCENTRATION						
TOTAL METALS (mg/kg)							
Arsenic	2.2 N	3.7 N	5.5	3.3	4.7	4.8	
Barium	130	110	60 N	63 N	75 N	71 N	
Cadmium	1.3 N	< 0.98 N	< 0.7 N	< 0.84 N	< 0.68 N	< 0.8 N	
Chromium	36	34	25 B	29 N	27 N	21 N	
Copper	50	30	16	20	17 N	20	
Lead	36	9.4	3.8	2.5	3.3	2.4	
Nickel	32	37	19	33	22	17	
Zinc	190	130	59	52	48	41	
PESTICIDES/PCBs (ug/kg)							
4,4'-DDD	12	< 7.1	< 7.5	< 7.4	< 7.3	< 7.4	
Aroclor-1254	< 72	< 140	< 75	< 74	< 73	< 74	
Aroclor-1260	440	< 71	< 75	< 74	< 73	< 74	
Dieldrin	14	< 7.1	< 7.5	< 7.4	< 7.3	< 7.4	
Heptachlor epoxide	9.4	4.1	< 3.7	< 3.7	< 3.7	< 3.7	
SEMI-VOLATILE ORGANICS (ug/kg)							
Benzo(b)fluoranthene	79 J	< 720	< 370	< 370	< 370	< 370	
Benzo(k)fluoranthene	79 J	< 720	< 370	< 370	< 370	< 370	
Benzoic acid	< 3700	110 J	< 1800	< 1800	< 1700	< 1800	

POND 6							
31	SAMPLE NUMBER	P6-0	P6-2	P6-4	P6-6	P6-8	P6-10
	SAMPLE DEPTH	0-1.5 feet	2-3.5 feet	4-5.5 feet	6-7.5 feet	8-9.5 feet	10-11.5 feet
CHEMICAL		CONCENTRATION					
TOTAL METALS (mg/kg)							
Arsenic		2.7 N	2.5 N	3.3 N	2.3 N	2.7 N	2.7 N
Barium		180	120	110	73	77	65
Cadmium		1.1 N	< 1 N	< 1 N	< 1 N	< 1 N	< 1 N
Chromium		32	25	19	21	16	21
Copper		29	24	25	22	20	18
Lead		11	6.1	7.6	5.7	2.2	1.5
Nickel		36	30	30	30	31	24
Zinc		260	170	120	100	76	49
PESTICIDES/PCBs (ug/kg)							
Aroclor-1254		71 J	< 73	< 73	< 73	< 76	< 75
SEMI-VOLATILE ORGANICS (ug/kg)							
di-n-Butylphthalate		< 370	< 370	< 370	< 370	150 J	< 380

(a) N = Recovery of spiked sample was not within control limits.

(b) < = Indicates analyte was analyzed for, but not detected above the level indicated.

(c) B = The reported value is less than the CRDL but greater than the IDL.

(d) J = A value less than the CRDL but greater than the IDL.

Reference: Landau Associates (1989c).

CRDL: Contract Required Detection Limit
IDL: Instrument Detection Limit

TABLE 4
CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOIL AT 4-TEK

Parameter	Units	Sample Location and Date						
		MW-1	MW-1	MW-1	MW-2	MW-2	MW-3	MW-3
		**2.5 M	7.5M	12.5 M	2.5 M	7.5M	7.5M	17.5
		7/8/91	7/8/91	7/8/91	7/8/91	7/8/91	7/8/91	7/8/91
Chloromethane	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Bromomethane	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Vinyl Chloride	ug/Kg	<3.4	<3.4	<3.3	<3.4	<3.3	<3.5	<34
Chloroethane	ug/Kg	<3.4	<3.4	<3.3	<3.4	<3.3	<3.5	<34
Methylene Chloride	ug/Kg	2.5B	3.2B	2.2B	2.5B	2.2JB	2.4B	15MB
Acetone	ug/Kg	<5.7	<5.7	<5.5	<5.6	<5.5	270.0	690.0
Carbon Disulfide	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
1,1 Dichloroethene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
1,1 Dichloroethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	150.0	<11
1,2-Dichloroethene (total)	ug/Kg	<1.1	42.0	3.4	<1.1	33.0	<1.2	<11
Chloroform	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
1,2-Dichloroethane	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
2-Butanone	ug/Kg	<8.5	<8.5	<8.2	<8.4	<8.3	26.0	330.0
1,1,1-Trichloroethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	170.0	<11
Carbon tetrachloride	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Vinyl Acetate	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Bromodichloromethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
Trichlorofluoromethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
1,2-Dichloropropane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
cis-1,3-Dichloropropene	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Trichloroethene	ug/Kg	2.3	3.2	1.0M	<1.1	4.2	<1.2	<11
Dibromochloromethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
1,1,2-Trichloroethane	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
Benzene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
Trans-1,3-Dichloropropene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
2-Chloroethylvinylether	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Bromoform	ug/Kg	<3.4	<3.4	<3.3	<3.4	<3.3	<3.5	<34

TABLE 4 (CONTINUED)

Parameter	Units	Sample Location and Date						
		MW-1	MW-1	MW-1	MW-2	MW-2	MW-3	MW-3
		** 2.5 M	7.5M	12.5 M	2.5 M	7.5M	7.5M	17.5
		7/8/91	7/8/91	7/8/91	7/8/91	7/8/91	7/8/91	7/8/91
4-Methyl-2-Pentanone	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
2-Hexanone	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Tetrachloroethene	ug/Kg	93.0	31.0	37.0	9.9	1.6	<1.2	<11
1,1,2,2-Tetrachloroethane	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23
Toluene	ug/Kg	<1.1	<1.1	<1.1	0.7M	<1.1	55.0	540.0
Chlorobenzene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11
Ethylbenzene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	1.9	<11
Styrene	ug/Kg	<1.1	<1.1	<1.1	<1.1	<1.1	<1.2	<11.4
Total Xylenes	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	3.5	<23
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/Kg	<2.3	<2.3	<2.2	<2.2	<2.2	<2.3	<23

NOTE: B = Possible/Probable Blank Contamination
 J = Estimated Value (Below Detection Limit)
 M = Low Spectral Match
 ** = Depth of sample is in meters

6.4.3 Sediment

Sediment samples taken at depths of 0 - 2 feet from Queen City Lake during the RI contained low levels of chromium (25 - 51 milligrams/kilogram (mg/kg)), PCBs (less than 95 to 220 micrograms/kilogram (μ g/kg)), and bis(2-Ethylhexyl)phthalate (860 -1100 μ g/kg). No sediment samples were taken from the Main Gravel Pit Lake.

6.4.4 Light Non-Aqueous Phase Liquid (LNAPL)

An additional source of ground-water contamination is free-floating light non-aqueous phase liquid (LNAPL) which has been found in Aquifer 1 in the vicinity of the IRM Area. The extent of this LNAPL is shown in Figure 10. Contaminants detected in LNAPL samples are summarized in Table 5. The LNAPL was determined to be primarily a mixture of fuel oils based on gas chromatograph/flame ionization detector and distillation analyses. High concentrations of contaminants such as chromium (740-1400 mg/kg), PCBs (93-280 mg/kg), 2-methylnaphthalene (850-2000 mg/kg), phenanthrene (220-560 mg/kg) and total xylene (2000-3000 mg/kg) were detected in LNAPL samples.

Data collected from two monitoring wells on-site indicate that it may be possible to physically remove some of the LNAPL from Aquifer 1. The total volume of recoverable LNAPL is currently unknown. LNAPL thickness has been measured up to 5 feet in one monitoring well; however this data may be of limited use because the ground-water surface is within the 5-ft long screened interval of the well for only a short period of the year. Fluctuations in the Aquifer 1 water level below the IRM Area have caused LNAPL particles to be smeared throughout a much thicker soil interval. The vertical extent of LNAPL-containing soil may be as thick as 20 feet.

6.4.5 Ground Water

Monitoring wells in the Near-Surface Water-Bearing Zone (NWBZ) are defined as hydrologically "upgradient" to Aquifer 1 and are in locations presumably not affected by known contaminant sources. Low concentrations of metals were detected in the NWBZ including arsenic, cadmium, copper, nickel and zinc (Table 6).

Upon completion of the removal action at the 4-Tek facility, EPA required QCF, Inc. to install three shallow ground-water monitoring wells. Aquifer 1 is not present at the 4-Tek facility, and these wells were designed to be drilled down to the water table within the unweathered glacial till above the Lower Unsaturated Zone. Volatile organic contamination was found in all three wells. A summary of shallow ground-water contamination at the 4-Tek facility is shown in Table 7. Contaminants found included, but were not limited to; DCE (2-3731 μ g/l), TCE (0.9-65 μ g/l), and PCE (1-810 μ g/l).

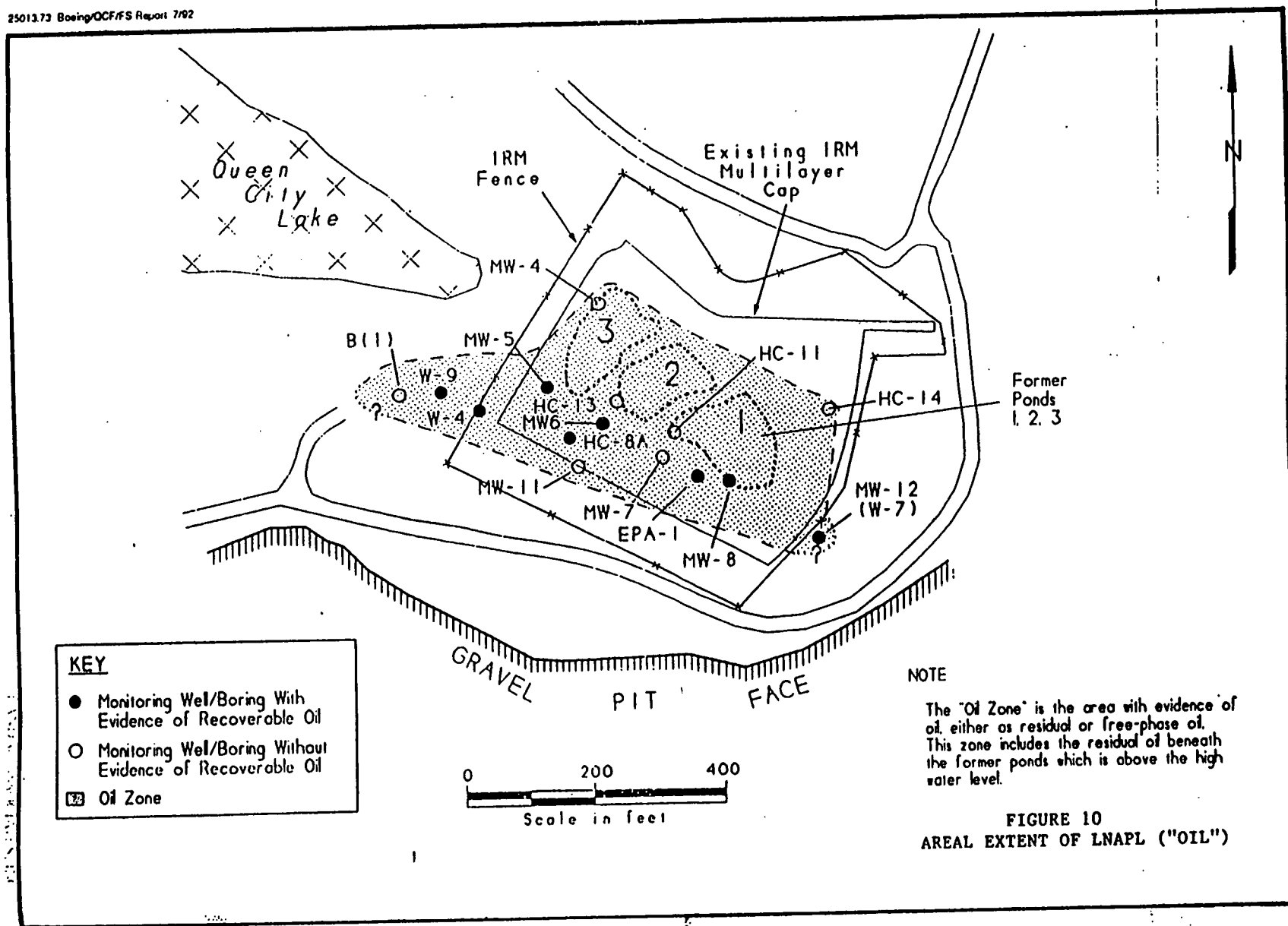


TABLE 5
CONTAMINANT CONCENTRATIONS IN LNAPL

Constituent	Concentration Range (a)	Frequency of Detection (b)
<u>Metals (mg/kg)</u>		
Arsenic	1.5 - 1.7	2/2
Barium	10 - 12	2/2
Chromium	740 - 1400	2/2
Copper	1 - 11	1/1
Iron	53	2/2
Nickel	7.3 - 8	2/2
Zinc	1 - 3.9	2/2
<u>Pesticides/PCBs (mg/kg)</u>		
Beta-BHC	0.6	1/2
Aroclor-1242	35	1/3
Aroclor-1254	170 - 280	3/3
Aroclor-1260	58 - 93	2/3
<u>Semivolatile Organics (mg/kg)</u>		
Naphthalene	220 - 370	3/3
2-Methylnaphthalene	850 - 2000	3/3
Acenaphthene	110 - 140	2/3
Di-n-butylphthalate	96 - 100	2/2
Fluorene	120 - 260	3/3
Phenanthrene	220 - 560	3/3
Anthracene	71	1/3
Pyrene	54 J - 100	3/3
Benzo(a)anthracene	42	1/2
Chrysene	55 - 80	2/3
<u>Volatile Organics (mg/L)</u>		
Acetone	690	1/2
Toluene	730	1/2
Ethylbenzene	490	1/2
Xylene (Total)	2000 - 3000	2/2
<u>Benzene, Toluene, Ethylbenzene, Xylene (mg/kg)</u>		
Toluene	3.5	1/1
Ethylbenzene	2.5	1/1
Xylene (Total)	120	1/1
<u>Other Parameters</u>		
Specific Gravity	0.8911 - 0.93	2/2
Flash Point (deg.F)	101 - 156	2/2
Viscosity @ 50 deg.C (cSt)	9.07	1/1
Viscosity @ 24 deg.C (cSt)	21.4	1/1
pH	6.4 - 6.6	2/2
Total Halogens (mg/kg)	770 - 5000	2/2
TPH (mg/kg)	4300 - 530000	3/3

(a) Concentration range of detected analytes. Results of duplicate samples are not averaged.
Data inclusive of sampling events from May 1989 to June 1991 (Landau Associates 1992a).
Sample Locations MW-8, MW-12, W-4.

(b) Number of samples in which the chemical was detected/number of samples analyzed.

Data Flags

J = Lab flag for organics: The reported value is less than the Contract Required Detection Limit
but greater than the Instrument Detection Limit.

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TABLE 6
CONTAMINANT CONCENTRATIONS IN THE NEAR-SURFACE WATER-BEARING ZONE

Chemical	Frequency of Detection(b)	Range of Sample Quantitation Limits For Not Detected Analytes		Range of Detected Analyte Concentrations	
COD (mg/L)	0/14	10.0		ND(c)	
Cyanide (ug/L)	0/7	10.0		ND	
TOTAL RECOVERABLE METALS (ug/L)					
Aluminum	4/4	--(d)		340	- 19700
Arsenic	1/4	3.1			48(e)
Barium	1/4	11.6	- 34.2		106B
Chromium	1/4	4.7	- 9.2		19.7
Copper	1/4	8.9	- 10.3		10.2B
Iron	4/4	--		282	- 17400
Lead	1/4	1.0			4.2B
Manganese	4/4	--		8.9 B	- 1050
Zinc	3/4	10.7		7.6	- 74.3
Cadmium	0/4	3.3	- 4.9		ND
Nickel	0/4	19.5	- 25.6		ND
DISSOLVED METALS (ug/L)					
Aluminum	1/7	47.4	- 140		147B
Arsenic	2/14	1.8	- 3.2	1.9 B	- 2.3 B
Barium	2/14	8.5	- 34.2	13.7 B	- 16.5 B
Cadmium	1/14	2.4	- 4.9		2.7B
Calcium	7/7	--		4800	- 17800
Iron	12/14	16.9	- 32	22 B	- 1460
Magnesium	7/7	--		740 B	- 3560 B
Manganese	11/14	2.7	- 9.1	4.0 B	- 1370
Nickel	2/14	14.9	- 25.5	26.6 B	- 35.1 B
Potassium	3/7	63		90 B	- 560 B
Silicon	4/4	--		5800	- 9500
Sodium	5/7	363		500 B	- 4400 B
Zinc	5/14	7.6	- 15.4	4.3 B	- 69.3
Chromium	0/14	3.6	- 9.3		ND
Copper	0/14	8.0	- 12.0		ND
Lead	0/14	0.9	- 2.4		ND

(b) Number of samples in which the chemical was positively detected/number of samples analyzed.

(c) ND = Not detected.

(d) "--" Analyte concentrations in all the samples analyzed are above the detection limit.

(e) B = Reported value is less than the CRDL but greater than the IDL.

TABLE 7
GROUND-WATER CONTAMINANT CONCENTRATIONS AT 4-TEK

Contaminant ^a	Frequency of Detections ^b	Range of Concentrations ^c
Acetone	16/36	3.4J ^d - 220
2-Butanone	11/36	28 - 280
Chloroethane	11/36	32 - 110
1,1-Dichloroethane	33/36	1 - 1300
1,2-Dichloroethane	4/36	3.1 - 7.5
1,2-Dichloroethene (Total)	2/3	51 - 3700
Cis-1,2-Dichloroethene	21/32	15 - 3700
Trans-1,2-Dichloroethene	17/32	0.7J - 34
2-Hexanone	1/36	8.9
Tetrachloroethene	22/36	11 - 810
Toluene	13/36	180 - 860
1,1,1-Trichloroethane	14/36	1.5 - 5.1
Trichloroethene	23/36	6.8 - 65

a = Ground-water samples were only analyzed for volatile organic contaminants

b = Number of detections per number of samples

c = All concentrations are in $\mu\text{g/l}$

d = J = Estimated value, below detection limit

The highest concentrations of ground-water contaminants are in Aquifer 1 beneath the IRM. A summary of analytical results for contaminants detected in Aquifer 1 is shown in Table 8. Contaminants detected in Aquifer 1 include, but are not limited to, chromium, DCE, TCE, and vinyl chloride. Contaminant concentrations in Aquifer 1 have varied over several years of monitoring, appearing to oscillate with changes in piezometric head levels. Aquifer 1 is limited in areal extent to the northern portion of the Site (Figure 11). The Aquifer 1 contaminant plume is therefore confined to the area of the IRM and from Queen City Lake to the gravel pit face.

Volatile organic contaminants found in Aquifer 2 include DCE and TCE (Table 9). The extent of the DCE and TCE contaminant plume and the range of TCE and DCE concentrations found in Aquifer 2 during sampling conducted in June 1991 are shown in Figures 12 and 13. As can be seen from these figures, the greatest concentration of DCE and TCE is close to the southwest corner of the IRM area. While the DCE and TCE plumes appear to be confined to the eastern portion of the Site, the extent of TCE and DCE contamination may reach as close as 200 feet from the Site boundary to the south, and may extend across the northern Site boundary on to the Cedar Hills Landfill. Aquifer 2 serves as a drinking water source for residences south and southwest of the QCF Site (Figure 3).

Heavy metals such as arsenic, chromium, and lead were detected in low concentrations in some unfiltered ground-water samples from Aquifer 2. These heavy metals were not detected in filtered ground-water samples (Table 9A).

Eight heavy metal contaminants and one semi-volatile contaminant were detected in low concentrations in samples taken from Aquifer 3, and the Deep Water-Bearing Zone.

6.5 Routes of Contaminant Migration

The major source area identified on Site which has an appreciable impact on ground-water quality is contaminated soil and LNAPL beneath the IRM area. Ground water in Aquifer 1 leaches contaminants from these materials and flows vertically through the leaky clayey-silt portion of the Aquifer 1 aquitard and discharges to the underlying sand and gravel unsaturated zone. In the unsaturated zone beneath Aquifer 1, ground water moves primarily vertically and discharges to the upper surface of Aquifer 2. It is estimated that ground water may travel from the point of recharge in Aquifer 1 to the point of recharge to Aquifer 2 in less than one year. In Aquifer 2, contaminants appear to have been transported predominantly to the north and south (Figures 12 and 13). This may be due to radial flow caused by a ground-water mound which initially developed below the IRM area, but has recently migrated to the vicinity of the Main Gravel Pit Lake due to the gravel mining operations (Figure 14).

TABLE 8
CONTAMINANT CONCENTRATIONS IN AQUIFER 1

Constituent	Concentration Range (a)		Frequency of Detection (b)
<u>Dissolved Inorganics (ug/L)</u>			
Arsenic		1.5 B	1/12
Barium	18.1 B	- 69.8 B	9/15
Cadmium	5.3	- 71.5	5/12
Chromium	18	- 3590	14/15
Copper	2.1 B	- 272	8/15
Manganese	346	- 2410	9/9
Nickel	4.7 B	- 210	8/15
Zinc	12.2 /JB	- 234	12/15
<u>Organics (ug/L)</u>			
Aroclor-1254	2.5	- 150	3/9
Aroclor-1260	23	- 85	2/9
1,2,4-Trichlorobenzene	2 J	- 18	12/15
1,3-Dichlorobenzene	2 J	- 3 J	2/15
2,4-Dimethylphenol	2 J	- 3 J	3/15
2-Methylnaphthalene	1 J	- 31	6/15
2-Nitrophenol		3 J	1/15
Acenaphthene	1 J	- 2 J	4/15
Benzoic acid	6 J	- 16 J	2/15
bis(2-Ethylhexyl)phthalate		22	1/15
Di-n-butylphthalate	1 J	- 3 J	4/15
Di-n-octylphthalate		2 J	1/15
Fluorene	1 J	- 3 J	5/15
Naphthalene	10 J	- 27	5/15
Pyrene		2 J	1/15
1,1,1-Trichloroethane	5	- 6	3/29
1,1,2-Trichloroethane	3 J	- 4 J	2/29
1,1-Dichloroethane	1 J	- 5	10/29
1,1-Dichloroethene	1 J	- 2 J	4/29
1,2-Dichloroethene (total)	20	- 2400	29/29
2-Butanone	5 J	- 6 J	2/29
Acetone	5 J	- 8 J	3/29
Benzene	3 J	- 22	10/29
Carbon disulfide		1 J	2/29
Chloroform	1 J	- 15	2/29
Ethylbenzene	1 J	- 81	17/29
Methylene chloride	99	- 9500	12/29
Tetrachloroethene	1 J	- 14 J	24/29
Toluene	4 J	- 440	13/29
Trichloroethene	10	- 4400	29/29
Vinyl chloride	2 J	- 91	18/29
Xylene (Total)	2 J	- 190	15/29

- (a) Concentration range of detected analytes. Results of duplicate samples are not averaged.
Data inclusive of sampling events from November 1988 to February 1992 (Landau Associates 1989a-d, 1992a).
Sample Locations MW-6, MW-8, MW-9, MW-11, and B(1).
- (b) Number of samples in which the chemical was detected/number of samples analyzed.

Data Flags

- B = Lab flag for inorganics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.
- J = Lab flag for organics: The reported value is less than the Contract Required Detection Limit but greater than the Instrument Detection Limit.
- /JB = Quality Assurance Coordinator flag meaning the concentration is estimated because of blank contamination.

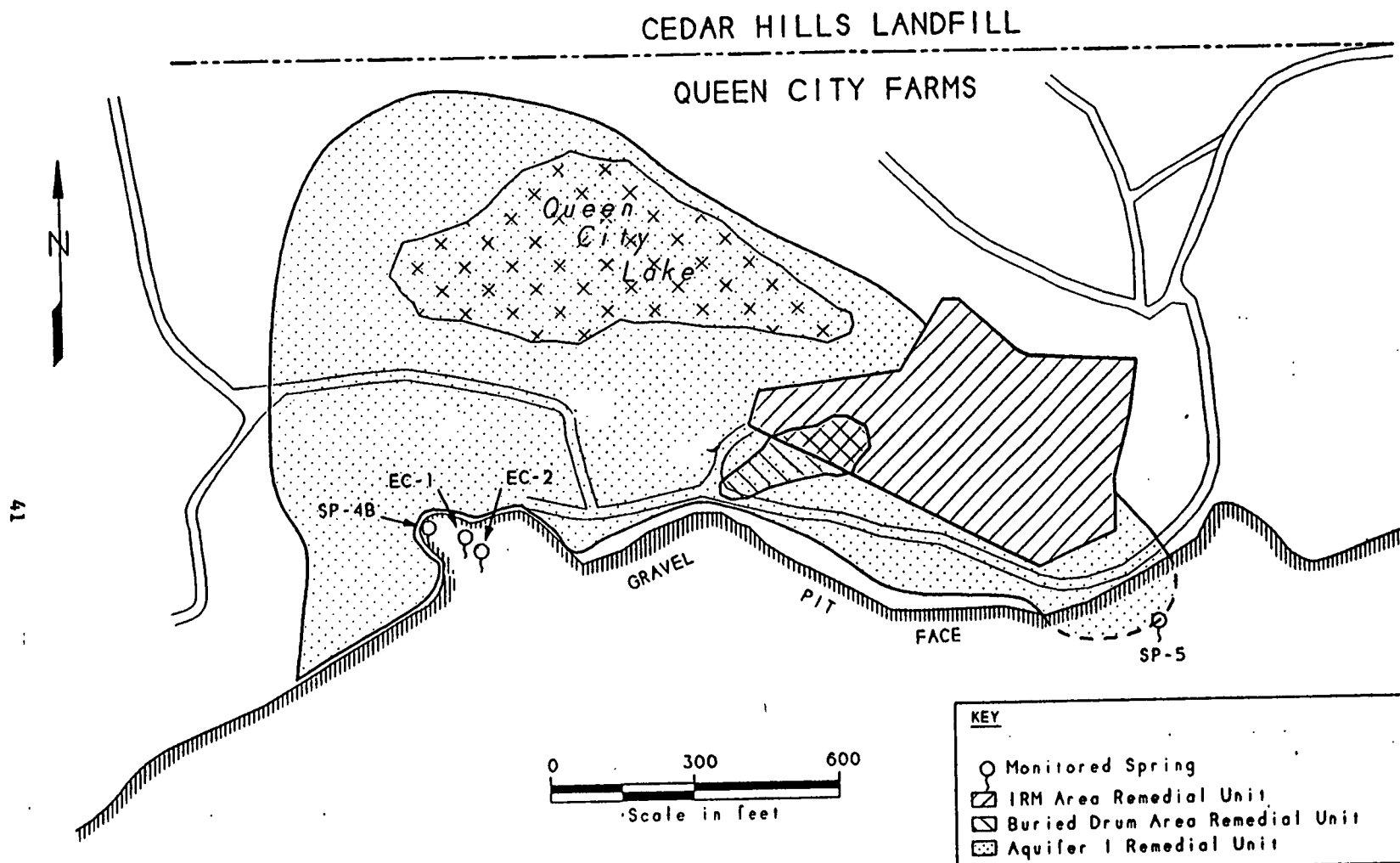
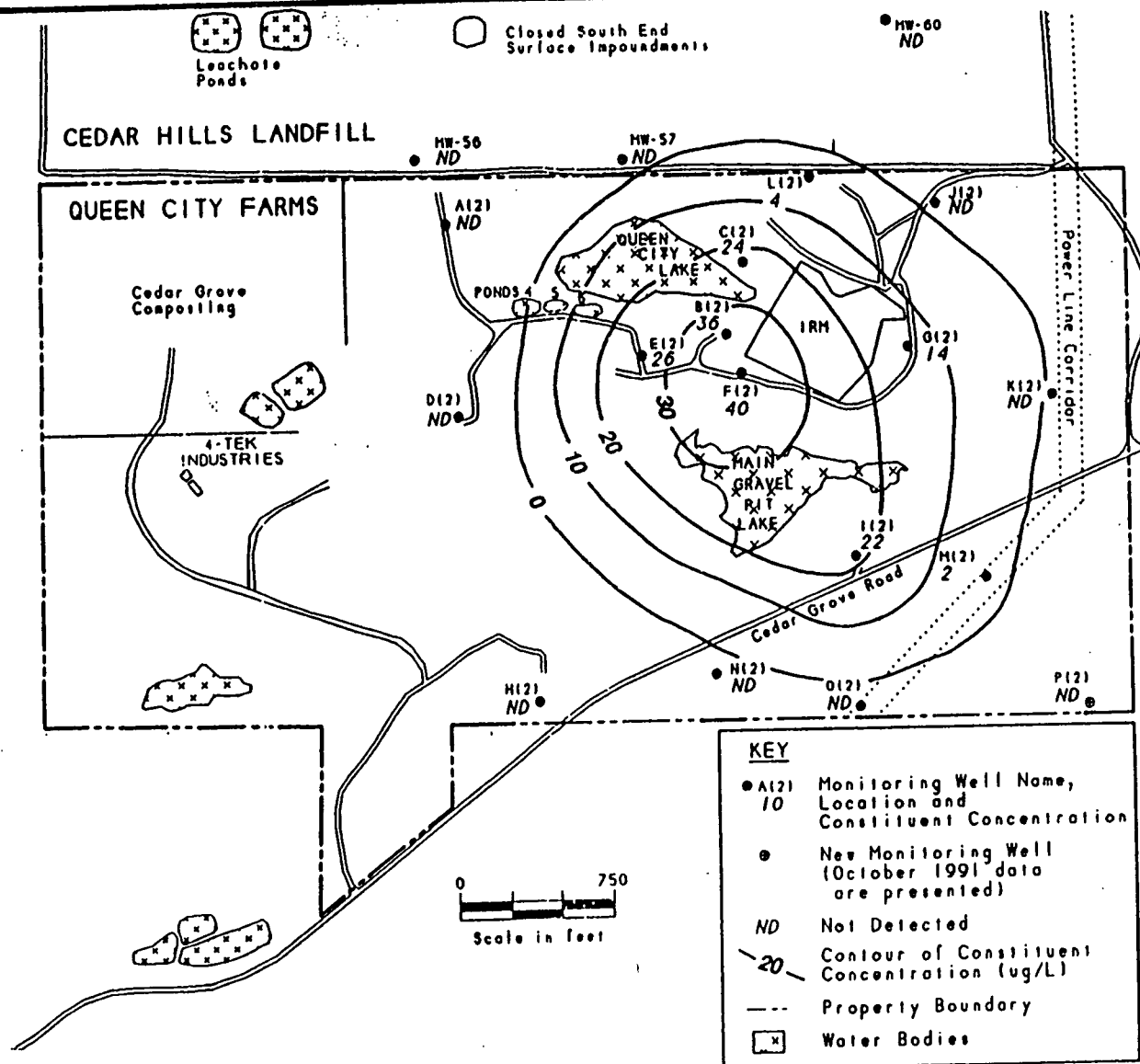


FIGURE 11 - AREAL EXTENT OF AQUIFER 1



KEY

- Al(2) Monitoring Well Name, Location and Constituent Concentration
- New Monitoring Well (October 1991 data are presented)
- ND Not Detected
- 20- Contour of Constituent Concentration (ug/L)
- Property Boundary
- ☒ Water Bodies



FIGURE 12

Distribution of DCE in Aquifer 2
June 1991

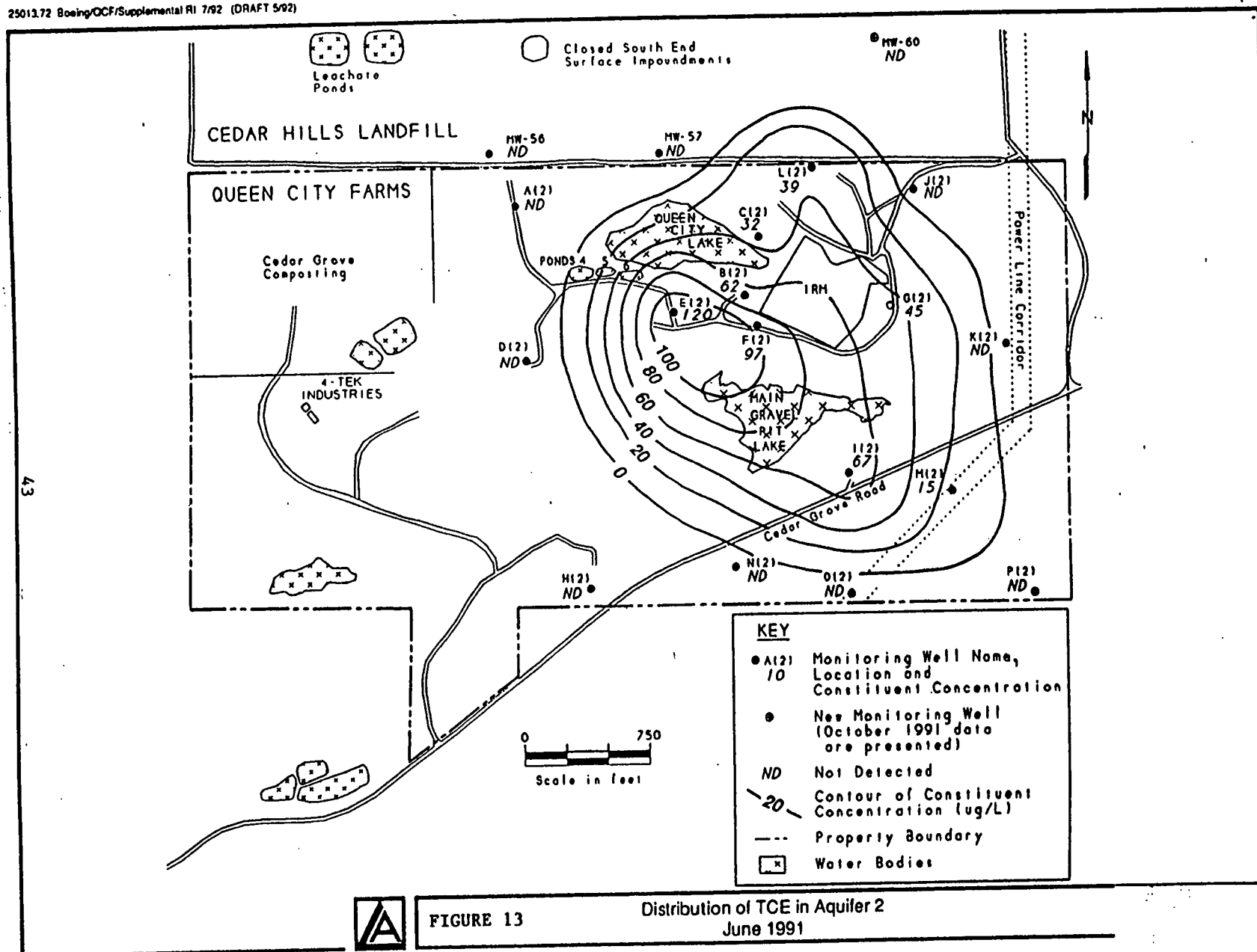
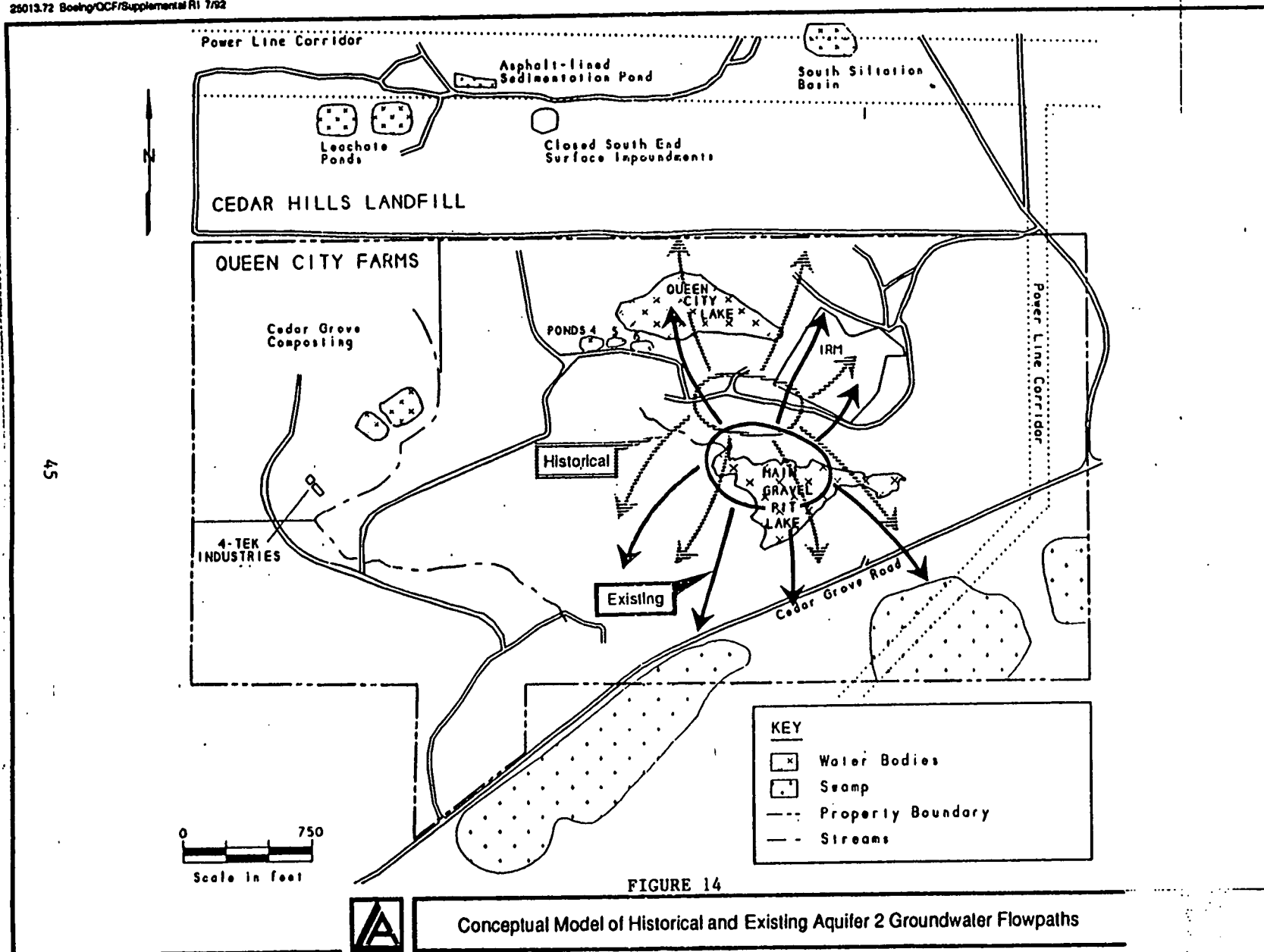
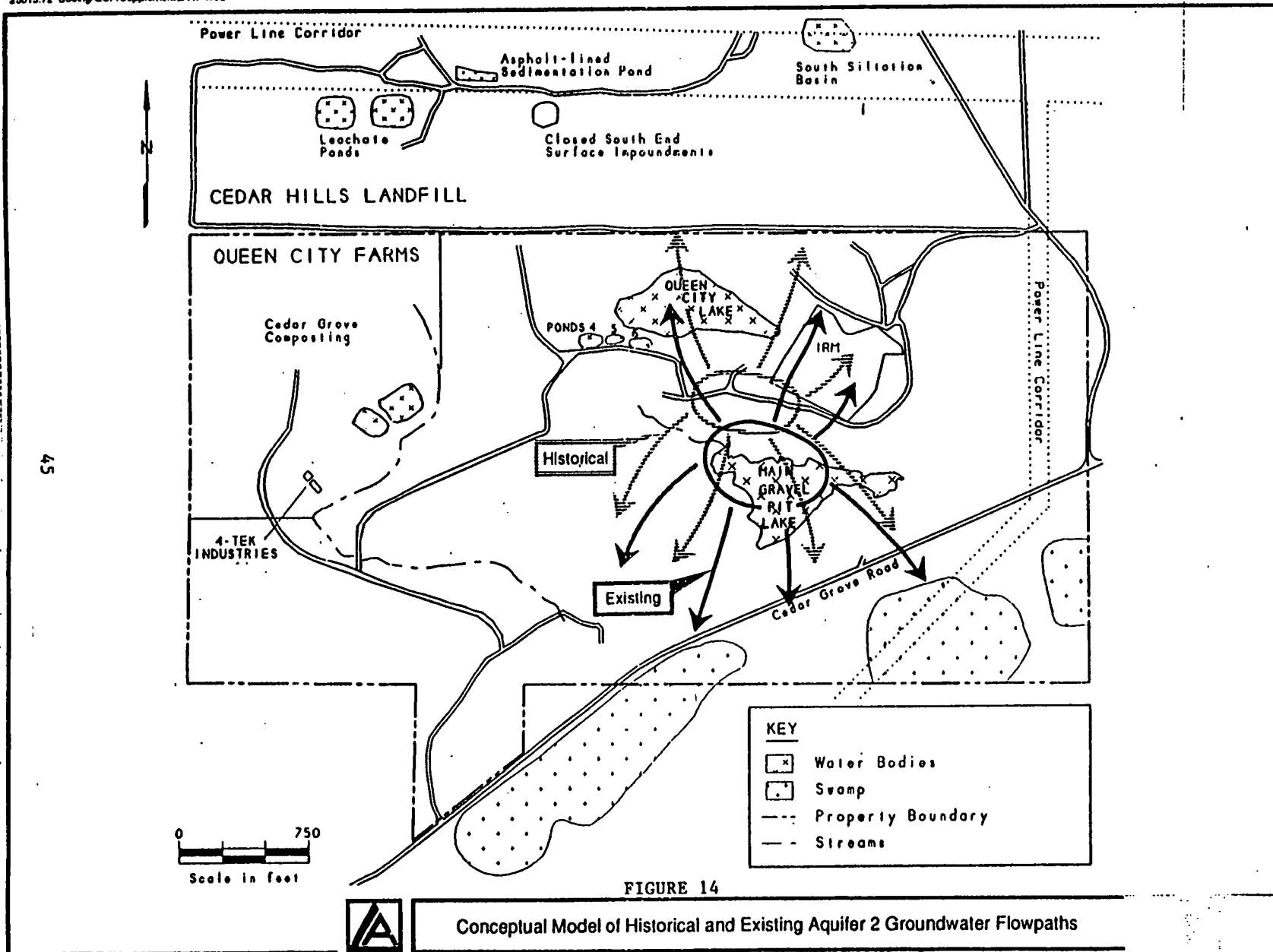


TABLE 9
SUMMARY OF VOLATILE ORGANICS DETECTED IN AQUIFER 2

<u>WELL #</u>	<u>CHEMICAL</u>	<u>CONCENTRATION RANGE^a</u>	<u># OF DETECTIONS / # OF SAMPLES</u>
A(2)	Methylene chloride	1.0 - 1.0	2/7
B(2)	1,2-Dichloroethene (total)	32 - 59	7/7
	Tetrachloroethene	1.0 - 2.0	4/7
	Trichloroethene	62 - 81	7/7
C(2)	1,2-Dichloroethene (total)	17 - 27	7/7
	Trichloroethene	31 - 45	7/7
E(2)	1,2-Dichloroethene (total)	23 - 45	9/9
	Trichloroethene	100 - 150	9/9
E(2a)	1,2-Dichloroethene (total)	12 - 22	4/4
	Tetrachloroethene	2.0 - 2.0	4/4
	Trichloroethene	69 - 77	4/4
F(2)	1,2-Dichloroethene (total)	36 - 65	7/7
	Tetrachloroethene	2.0 - 3.0	7/7
	Trichloroethene	84 - 110	7/7
G(2)	1,2-Dichloroethene (total)	4 - 14	7/7
	Trichloroethene	25 - 45	7/7
I(2)	1,2-Dichloroethene (total)	22 - 27	5/5
	Trichloroethene	59 - 99	5/5
I(2a)	1,2-Dichloroethene (total)	1.0	1/5
	Tetrachloroethene	1.0 - 2.0	4/5
	Trichloroethene	4 - 10	5/5
J(2a)	Acetone	6	1/4
L(2)	1,2-Dichloroethene (total)	3 - 5	4/4
	Trichloroethene	37 - 41	4/4
L(2a)	1,2-Dichloroethene (total)	1 - 10	4/4
	Trichloroethene	4 - 14	4/4
M(2)	1,2-Dichloroethene (total)	2.0 - 2.0	2/2
	Trichloroethene	15 - 17	2/2

a = all concentrations are in micrograms/liter





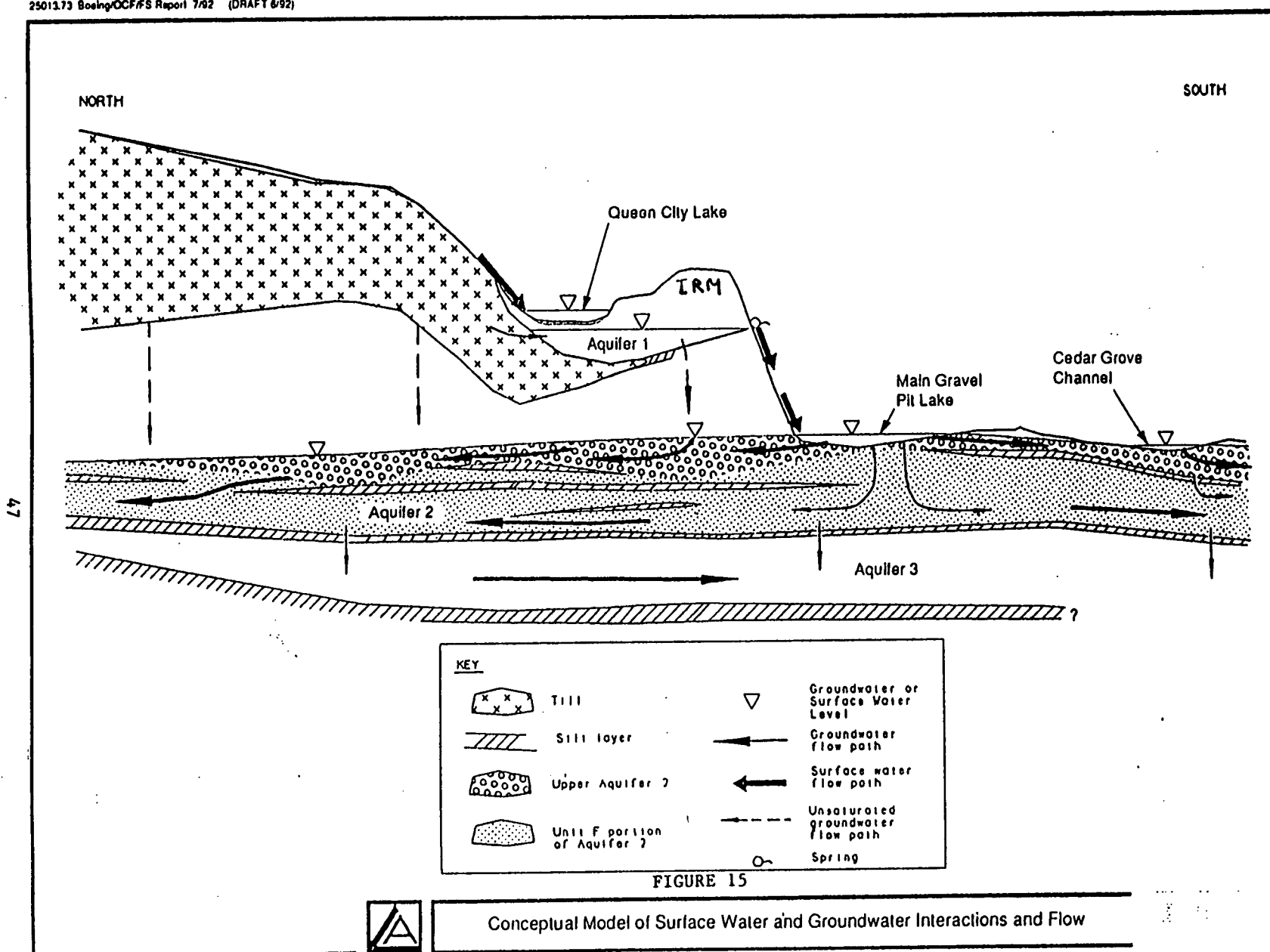
Although contaminants have not been detected in Aquifer 3 above the EPA contract laboratory required detection limit, a downward vertical hydraulic gradient is present across the aquitard between Aquifer 2 and Aquifer 3. Contaminant concentrations detected in Aquifer 2 during the 5 years since the IRM and the 2 years since the formation of the Main Gravel Pit Lake have not shown evidence of attenuation. This suggests that the vertical travel time through Aquifer 2 is at least 2 years and possibly longer than 5 years. However, the potential still exists for contaminant transport to Aquifer 3. Processes that would tend to retard significant contaminant migration include sorption and diffusion into the silt aquitard.

No direct evidence of Dense Non-Aqueous Phase Liquid (DNAPL) has been identified at the Site. However, based on the type and probable quantity of waste solvents disposed at the Site, residual DNAPL is likely to exist in Aquifer 1. Any vertical migration of DNAPL would be impeded by the Aquifer 1 aquitard system. If DNAPL is present in Aquifer 1, it is very unlikely that DNAPL has penetrated downward as far as Aquifer 2 based on the pattern of volatile organic concentrations found in Aquifer 2. TCE and DCE concentrations are relatively uniform over a large area, suggesting a broad aqueous-phase source.

In addition to the processes described above, migration of contaminants at the QCF Site have probably been influenced by gravel mining and associated activities. Site development activities changed recharge and discharge relationships for Aquifer 1 and Aquifer 2. The progressive formation of East Airport Spring due to gravel mining activities has created a discharge area in Aquifer 1 and substantially reduced discharge from the west end of the aquifer. The erosion control measure culvert created a surface water outlet for Queen City Lake and substantially reduced wet season recharge to Aquifer 1. These events had a corresponding impact on ground-water levels and flow within the aquifer including a decrease in maximum and minimum piezometric head levels, and a steeper ground-water gradient toward East Airport Spring.

A conceptual model of surface water and ground-water interactions at the QCF Site is shown in Figure 15. The creation of the Main Gravel Pit Lake has impacted Aquifer 2. A concentration of recharge to Aquifer 2 in the vicinity of the Main Gravel Pit Lake has most likely caused the presumed shifting of the location of the ground-water mound from the IRM area. In addition, horizontal and possibly vertical ground-water gradients in Aquifer 2 below the Main Gravel Pit Lake have been increased. Both the ground-water mound and the increase in recharge through the Main Gravel Pit Lake would have an impact on the contaminant concentration gradients found in Aquifer 2.

6.6 Characteristics of Contaminants Found at the QCF Site



Heavy metal contaminants detected in soil, LNAPL and Aquifer 1 ground water at the QCF Site include arsenic, chromium, copper, and lead. Arsenic is known to cause skin and lung cancer in humans. Chronic arsenic poisoning may result in loss of appetite, cramps, nausea, constipation, diarrhea, or possible liver injury. Lead is classified as a probable human carcinogen. Elevated blood lead levels in children are associated with encephalopathies and learning disabilities. Acute oral studies with animals indicate that chromium (VI) compounds are more toxic than chromium (III) compounds. The RI did not attempt to analyze chromium (III) separately from chromium (VI). Acute exposure to chromium (VI) has resulted in kidney and liver damage in humans. There is little information available on copper toxicity in humans. Copper is exotoxic to many aquatic species. Some of the metals detected on Site tend to be mobile in the environment (e.g. copper) but significant migration at the QCF Site (e.g. from Aquifer 1 to Aquifer 2) has not been documented.

Cyanide was detected in subsurface soil samples from the IRM area and the BDA. Symptoms of acute exposure to cyanide include rapid breathing, gasping, tremors and convulsions. If not treated, death may result. Neurotoxicity has been observed in humans following both inhalation and ingestion exposure. No evidence of migration of cyanide from subsurface soils to ground water has been documented at the Site.

PCBs have been detected in elevated concentrations in IRM and BDA soils, and in LNAPL. PCBs are classified as probable human carcinogens. Non-carcinogenic adverse health effects are dose-related and may include chloracne, skin rashes, burning of the eyes and skin, and liver damage. PCBs are persistent compounds in the environment, exhibiting a high affinity for particulate adsorption and a resistance to biodegradation. Sorption to organic matter and bioaccumulation in living tissues are expected to be the dominant environmental fate processes. Sampling at the QCF Site indicates that PCBs have not migrated far from the primary source areas.

PAHs have been detected in soils from the IRM area and the BDA. Evidence exists that certain PAHs are carcinogenic in humans and animals. Cancer associated with exposure to PAHs occurs predominantly in the lung following inhalation and in the skin following dermal exposure. No evidence of significant migration of PAHs from source areas to ground water has been documented at the QCF Site.

Xylene was detected in soils from the IRM area and in LNAPL. If ingested, xylene can cause liver and gastrointestinal distress in humans. If exposed via dermal contact defatting of tissue and skin can occur, and exposure via inhalation can result in irritation of both nose and throat and in central nervous system effects which include headache, narcosis, and dizziness. No evidence of migration of xylene from IRM soils or LNAPL to ground water has been documented at the QCF Site.

1,2,4-trichlorobenzene (TCB) has been detected in soils from the IRM area and in Aquifer 1 ground water. Acute exposure by humans to high concentrations of 1,2,4-TCB is poisonous. 1,2,4-TCB is a solvent which can be mobile in ground water. While 1,2,4-TCB has been detected in high concentrations in Aquifer 1 at the QCF Site, there is no evidence that it has migrated to Aquifer 2.

Toluene has been found in IRM soils at the Site. Chronic exposure of humans to toluene is toxic to the central nervous system. Toluene is a solvent which can be mobile in ground water, however there is no evidence of significant migration of toluene from the IRM source area at the QCF Site.

Tetrachloroethene (PCE) has been detected in BDA soils and in shallow ground water in the area of the 4-Tek facility. PCE has been classified as a probable human carcinogen. Inhalation of PCE can effect the central nervous system of humans, and may cause dizziness, headache, sleepiness, and incoordination. PCE is a volatile organic which can be mobile in the environment. It is unknown at this time whether PCE has migrated from the shallow ground water at 4-Tek to the deeper aquifers.

TCE has been found in soils and ground water throughout the QCF Site. When inhaled TCE may cause headache, vertigo, and visual distortion. Studies have shown TCE to be carcinogenic in animals. EPA has previously classified TCE as a possible human carcinogen. EPA is in the process of reevaluating the evidence regarding potential for human carcinogenicity of TCE. TCE is a chlorinated solvent and is very mobile in the environment. At the QCF Site, TCE has migrated from source areas to Aquifer 1 and Aquifer 2. The TCE contaminant plume in Aquifer 2 has migrated close to the Site boundaries.

Both forms of DCE (cis and trans) have been found in soils and ground water at the QCF Site. Inhalation by humans of large concentrations of trans-DCE can cause drowsiness, fatigue, and vertigo. DCE is a volatile organic which is very mobile in the environment, and at the QCF Site, DCE has migrated from source areas to Aquifer 1 and Aquifer 2 ground water.

Vinyl chloride has been detected in Aquifer 1 ground water at the Site. Vinyl chloride is a known cancer causing agent in humans. Chronic inhalation of vinyl chloride can result in Reynauds syndrome, dermatitis, hepatitis-like changes, thyroid insufficiency and acro-osteolysis as well as cancer. Vinyl chloride has not been found in source areas at the Site. A possible reason for the presence of vinyl chloride in Aquifer 1 is that anaerobic biodegradation of TCE to DCE and then to vinyl chloride may be occurring within the general IRM area.

7.0 SUMMARY OF SITE RISKS

CERCLA response actions at the QCF Site as described in this ROD are intended to protect human health and the environment from risks related to current and potential exposure to hazardous substances at the Site.

To assess the risk posed by Site contamination, a Baseline Risk Assessment was completed by Landau Associates, on behalf of The Boeing Company and QCF, Inc., as part of the Queen City Farms RI. Based on comments received from EPA, a Baseline Risk Assessment Addendum was completed by Landau Associates updating the Baseline Risk Assessment to incorporate additional data, updated EPA guidance, and amended toxicity criteria.

7.1 Human Health Risks

The QCF Site is currently used for a variety of industrial activities including sand and gravel mining, and yard-waste composting. The Site is zoned by King County for quarrying and mining. The Cedar Hills Landfill, which is operated by the King County Solid Waste Division, is located directly north of the Site. Private homes are located to the east, south and southwest of the Site. Some home owners draw their drinking water from Aquifer 2 and Aquifer 3. Home owners who draw their drinking water from Aquifer 2 may be at some risk in the future, should the TCE and DCE contaminant plume continue to migrate.

While sand and gravel mining operations on the Site property are winding down, it is expected that the Cedar Grove Composting facility will expand its operations on the Site as economic conditions permit. Deed restrictions are currently in effect for land use of the IRM area, and these deed restrictions will continue to be in effect, or expanded in the future.

An assessment of the risks to human health due to existing conditions at the QCF Site involved a 4-step process which included the identification of contaminants of concern, an assessment of contaminant toxicity, an exposure assessment of the population at risk, and a characterization of the magnitude of risk.

7.1.1 Contaminants of Concern

A total of 71 chemicals were detected at the QCF Site. Of these 52 chemicals were identified as chemicals of potential concern in soils, sediment, surface water or ground water at the Site. A list of these chemicals is shown in Table 10. The number of detected chemicals evaluated in the Baseline Risk Assessment and Baseline Risk Assessment Addendum by media are as follows:

TABLE 10
CONTAMINANTS OF POTENTIAL CONCERN AT THE QCF SITE

Acenaphthene
 Acetone
 Aluminum
 Anthracene
 Arsenic
 Barium
 Butylbenzylphthalate
 di-n-Butylphthalate
 Cadmium
 Chromium
 Copper
 Cyanide
 4,4'-DDD
 Dichloroethene (DCE; cis and trans)
 DDT
 Dieldrin
 Endosulfan
 Ethylbenzene
 bis(2-Ethylhexyl)phthalate (DEHP)
 Fluorene
 Heptachlor epoxide
 Iron
 Lead
 Magnesium (dissolved)
 Manganese
 Methylene chloride
 2-Methylnaphthalene
 Nickel
 di-n-Octylphthalate
 Pentachlorophenol
 Phenanthrene
 Polychlorinated biphenyls (PCBs) - 4 Chemicals
 Polynuclear aromatic hydrocarbons (PAHs) - 8 Chemicals
 Tetrachloroethene
 Toluene
 1,2,4-Trichlorobenzene
 Trichloroethene
 Vinyl chloride
 Xylenes
 Zinc

Surface water - 18 chemicals
Soil/Sediment - 43 chemicals

Aquifer 1 - 39 chemicals
Aquifer 2 - 13 chemicals
Aquifer 3 - 9 chemicals

7.1.2 Toxicity Assessment

Toxicity information was provided in the Baseline Risk Assessment and Baseline Risk Assessment Addendum for the chemicals of concern. Generally, cancer risks are calculated using toxicity factors known as slope factors (SFs), while noncancer risks rely on reference doses (RfDs).

SFs have been developed by EPA for estimating excess lifetime cancer risks associated with exposure to potential carcinogens. SFs are expressed in units of $(\text{mg/kg-day})^{-1}$ and are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day , to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimates of the actual cancer risk highly unlikely. SFs are derived from the results of human epidemiological studies, or chronic animal bioassay data, to which mathematical extrapolation from high to low dose, and from animal to human dose, have been applied.

RfDs have been developed by EPA to indicate the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day , are estimates of lifetime daily exposure for humans, including sensitive subpopulations likely to be without risk of adverse effect. Estimated intakes of contaminants of concern from environmental media (e.g. the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied.

The Baseline Risk Assessment and Baseline Risk Assessment Addendum relied on oral and inhalation SFs and RfDs. Because dermal toxicity factors have not been developed for the chemicals evaluated, oral toxicity factors were used in estimating noncancer risks from dermal exposure. The noncancer toxic endpoints (e.g. the affected organs) are similar for dermal and oral exposure. Cancer risks from dermal exposure could not be calculated. The toxicity factors shown in Table 11, were drawn from the Integrated Risk Information System (IRIS) or, if no IRIS values were available, from the Health Effects Assessment Summary Tables (HEAST). For chemicals which do not have toxicity values available at this time, other criteria, such as the Maximum Contaminant Level Goal (MCLG) promulgated under the Safe Drinking Water Act (SDWA) were used to assess toxicity.

TABLE 11
HUMAN TOXICITY FACTORS FOR CHEMICALS RETAINED FOR RISK QUANTIFICATION

CARCINOGENS									
COMPOUND	SLOPE FACTOR		WEIGHT OF EVIDENCE CLASSIFICATION		TYPE OF CANCER				
	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	INHALATION
Methylene chloride	7.50E-03 (b)	1.60E-03 (b)	B2 (b)	B2 (b)	LIVER (b)		LIVER (b)		LIVER AND LUNG (b)
Tetrachloroethene	5.10E-02 (a)	1.80E-03 (a)	B2-C (c)	B2-C (c)	LIVER (a)		LIVER (a)		LEUKEMIA AND LIVER (a)
Trichloroethene	1.10E-01 (a)	1.70E-02 (a)	B2-C (c)	B2-C (c)	LIVER (a)		LIVER (a)		LUNG (a)
Vinyl chloride	1.90E+00 (a)	2.95E-01 (a)	A (a)	A (a)	LUNG (a)		LIVER (a)		LIVER (a)
DDT	3.40E-01 (b)	3.40E-01 (b)	B2 (b)	B2 (b)	LIVER		LIVER		HEPATOCELLULAR
Dieldrin	1.60E+01 (b)	1.60E+01 (b)	B2 (b)	B2 (b)	HEPATOCELLULAR, MUTAGENIC		LIVER (a)		NA (a)
bis(2-Ethylhexyl)phthalate	1.40E-02 (b)	ND	B2 (b)		LIVER		LIVER		LIVER
Heptachlor epoxide	9.10E+00 (b)	9.10E+00 (b)	B2 (b)	B2 (b)	STOMACH AT POINT OF CONTACT (d)				LUNG
PAHs	7.30E+00 (b,e)	6.10E+00 (a,e)	B2 (b)	B2 (a)	HEPATOCELLULAR, DERMAL TOXICITY				HEPATOCELLULAR
PCBs	7.70E+00 (b)	ND	B2 (b)	B2 (b)	HEPATOCELLULAR ADENOMAS AND CARCINOMAS				
Pentachlorophenol	1.20E-01 (b)	1.00E-01 (h)	B2	B2	SKIN (b)				LUNG (b)
Arsenic	1.65E+00 (b)	5.00E+01 (b,f)	A (b)	A (b)					LUNG, TRACHEA, BRONCHUS
Cadmium	NA	6.10E+00 (b)	NA	B1 (b)					LUNG
Chromium (hexavalent)	ND	4.10E+01 (b)	ND	A			NA		RESPIRATORY TRACT
Nickel	ND	8.40E-01 (a,g)	NA	A			NA		
(a) Source: EPA, Health Effects Assessment Summary Tables (HEAST)									
(b) Source: EPA, Integrated Risk Information System (IRIS)									
(c) Under review by EPA work group									
(d) Source: Agency for Toxic Substances Disease Registry (ATSDR)									
(e) Value is for benzo(a)pyrene, IRIS									
(f) 30% absorption used when applying arsenic inhalation slope factor									
(g) Inhalation slope factor specific to refinery dust									
(h) Provisional slope factor									
NONCARCINOGENS									
COMPOUND	RFD (chronic unless indicated)		CONFIDENCE LEVEL		UNCERTAINTY &/OR MODIFICATION FACTORS		CRITICAL EFFECT (Oral; inhalation)		
	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	
Acetone (a)	1.00E-01	ND			U=1000	NA			Increased liver and kidney weight, nephrotoxicity
Benzoic acid (a)	4.00E+00	ND			U=1	NA			Irritation, malaise; ND
cis-1,2-Dichloroethene	4.00E+00 (sub)	ND			U=1	NA			
trans-1,2-Dichloroethene	1.00E-02 (a)	ND	Low		U=3000				No data on developmental or reproductive toxicity. Increased serum alkaline phosphatase through ingestion.
	2.00E-02 (b)	ND (b)			U=1000 (b)	NA (b)			Hepatotoxicity and nephrotoxicity
	2.00E-01 (sub-i)	ND (i)			M=1 (b)				
Ethylbenzene (a)	1.00E-01	ND			U=1000	NA			
Methylene chloride	1.00E+00 (sub-i)	ND (i)			U=100 (i)				
	6.00E-02 (b)	(3mg/cubic meter) (a)	Medium (b)		U=100 (b)	U=100 (a)			Liver toxicity; NA (a)
	6.00E-02 (sub-a)	(3mg/cubic meter) (sub-a)			M=1 (b)				
Tetrachloroethene	1.00E-02 (b)	NA (b)	Medium		U=100 (a)	U=100 (a)			Liver toxicity, NA (a)
	1.00E-01 (sub-a)	ND (sub-a)			U=1000 (b)	NA (b)			Increased liver and kidney weight to body rate ratios (b)
	2.00E-01 (b)	(0.4mg/cubic meter) (sub-b)			M=1 (b)				Hepatotoxicity, NA (a)
Toluene	4.00E-01 (sub-i)	(2mg/cubic meter) (sub-i)			U=100 (a)	NA (a)			
1,2,4-Trichlorobenzene	1.00E-02 (b)	3.00E-02 (a)			U=1000 (a)	U=1000 (a)			Eyes and nose irritation; CNS effects
	2.00E-01 (sub-a)	3.00E-02 (sub-a)			M=1 (b)				Increased liver to body weight ratio; Increased uroporphyrin(a)
Trichloroethene	ND (c)	NA			U=100 (a)	U=100 (a)			Same as chronic
Vinyl chloride	NA	NA							Cancer

Compound	ORAL	RFD (chronic) unless indicated		CONFIDENCE LEVEL	INHALATION	UNCERTAINTY &/OR MODIFICATION FACTORS		CRITICAL EFFECT (Oral; Inhalation)
		ORAL	INHALATION			ORAL	INHALATION	
Xylenes (total)	2.00E+00	(b)	3.00E-01 mg/cubic meters (a)			U=100	U=100	Hyperactivity, low body weight and increased mortality; CNS effects, nose and throat irrit.
	4.00E+00	(sub)	3.00E+00 mg/cubic meter (sub)			U=100	U=100	None, CNS effects, nose and throat irritation
di-n-Butylphthalate (a)	1.00E-01	(b)	ND			U=1000	NA	Effects on body weight gain
	1.00E+00	(sub)	ND			U=100	NA	testes, liver, and kidney.
Butylbenzylphthalate (a)	2.00E-01	(b)	ND			U=1000	NA	Effects on body weight gain
	2.00E+00	(sub)	ND			U=100	NA	testes, liver, and kidney.
bis(2-Ethylhexyl)phthalate	2.00E-02	(a)	ND (a)			U=1000(a)	NA (a)	Increased liver weight; NA (a)
	2.00E-02	(sub-a)	ND (sub-a)			U=1000 (a)	NA (a)	Increased liver weight; NA (a)
DDT (a)	5.00E-04	(b)	ND			U=100	NA	Liver lesions; ND
	5.00E-04	(sub)	ND			U=100	NA	
Dieldrin	5.00E-05	(b)	ND (i)	Medium		U=100(b)		Liver is target organ for oral exposure.
						M=1(b)		
	5.00E-05	(sub-i)	ND (i)			U=100(i)		
Endosulfan (a)	5.00E-05	(b)	ND			U=3000	NA	Mild kidney lesions; NA
	2.00E-04	(sub)	ND			U=1000	NA	
Heptachlor epoxide	1.30E-05	(b)	ND			U=1000	NA	Increased liver weight; NA
PAHs (noncarcinogenic)	NA		NA					Adverse effects at pt. of contact
PCBs	NA		NA					
Pentachlorophenol	3.00E-02	(b)	ND	Medium		U=100(b)	NA	Liver and kidney damage through ingestion; acute poisoning of circ. system thru inhalation. (b)
						M=1		Fetotoxicity; NA (a)
Arsenic	3.00E-02	(sub-a)	ND (a)			U=100(a)	NA (a)	Kerotosis and hyperpigmentation
	3.00E-04	(b)	ND (a)			U=3	NA (a)	Skin cancer (a)
Barium (a)	7.00E-02	(b)	1.00E-04			U=100	U=1000	Increased blood pressure
						M=1		Ferotoxicity
Cadmium	5.00E-04	(b)	NA	High	NA	U=10	NA	Proteinuria of the renal cortex through ingestion. (a)
	1.00E-03	(b)		High		U=10		Proteinuria of the renal cortex through ingestion. (a)
						M=1		
Chromium (III)	1.00E+00	(b)	ND			U=100		
						M=10		
Copper	3.70E-02	(a)	NA (a)					Local gastrointestinal irritation
								Only short-term effects
Cyanide	2.00E-02	(a)	ND (a)			U=500(a)	NA (a)	
	2.00E-02	(sub-a)	ND (a)			U=500(a)	NA (a)	
Manganese	1.00E-01	(b)	4.00E-04 (b)	Medium		U=1	U=900	Central nervous system effects for both oral and inhalation. (a)
Nickel	2.00E-02	(b)	ND (a)	Medium (b)		U=100(b)	NA (a)	Reduced body size and organ weight; Cancer (a)
						M=3(b)		Reduced body size and organ weight; Cancer (a)
	2.00E-02	(sub-a)	ND (a)			U=300(a)	NA (a)	
Zinc	3.00E-01	(b)	ND			U=3	NA	Anemia; NA

(a) Source: EPA, Health Effects Assessment Summary Tables (HEAST)

(b) Source: EPA, Integrated Risk Information System (IRIS)

(c) Under review by EPA work group

(d) Value has been withdrawn, but is under review by EPA.

(i) Use the long-term value, as data is inadequate to determine 10-day value

sub: Indicates the subchronic RFD and associated uncertainties and effects

NA = Not available ND = No Data

U = Uncertainty factor

M = Modifying factor

7.1.3 Exposure Assessment

The exposure assessment identified potential pathways for contaminants of concern to reach the exposed population. Exposure assumptions were based primarily on EPA regional and national guidance, including EPA Superfund Standard Default Exposure Factors, except where tailored to meet specific site conditions. Current Site use is industrial. Exposure to workers through ingestion of surface water was evaluated in the Baseline Risk Assessment. Future Site uses evaluated in the risk assessment included industrial and residential use. Pathways of exposure to potential future residents include ingestion of surface or ground water, inhalation of volatiles released during domestic use of ground water, incidental ingestion of soil, dermal contact with soil, and consumption of home-grown produce.

Standard Default Factors describe contact rate and exposure frequency and duration for an exposed individual under the Reasonable Maximum Exposure (RME) scenario. These factors describe patterns of exposure that are higher than average, and were selected with the intention that risk assessment results would be protective of individuals in the exposed population who had higher contact rates or longer exposure frequency and duration. For example, the RME described a resident who spends most of his or her time at home and lives at the same location for thirty years. An individual with a more typical exposure pattern for groundwater or soil would have less exposure. (Table 12).

Exposure point concentrations for the QCF Site risk assessment were derived in a manner consistent with the EPA guidance to evaluate Reasonable Maximum Exposures (RMEs). Since toxicity from chemical exposures may be dependent on exposure durations, the exposure models and exposure point concentrations were consistent with the exposure periods incorporated in various toxicity measures. For subchronic and chronic toxicity risks, and for carcinogenic risks, where long duration exposures are of concern (e.g., years or lifetime), RMEs are based on exposures to average concentrations over the exposure period. Estimating the average concentration based on a relatively small number of samples results in statistical sampling errors and thus, uncertainty. This uncertainty is addressed by calculating the upper 95 percent confidence interval on the arithmetic average concentration and using that value.

7.1.4 Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated by multiplying the SF (see toxicity assessment above) by the "chronic daily intake" developed using the exposure assumptions. These risks are probabilities generally expressed

TABLE 12
Reasonable Maximum Exposure (RME) and Average Exposure Factors

	<u>RME Exposure Factors (a)</u>	<u>AVERAGE Exposure Factors (b)</u>
<u>Residential Scenarios</u>		
<u>Water Ingestion</u>		
Intake Rate	2 l/day	1.4 l/day
Exposure Frequency	350 day/year	275 day/year
Exposure Duration	30 year	9 year
Body Weight	70 kg	70 kg
<u>Soil & Dust Ingestion</u>		
Intake Rate	200 mg/day (child) 100 mg/day (adult)	100 mg/day
Exposure Frequency	350 day/year	275 day/year
Exposure Duration	6 year (child) 24 year (adult)	9 year
Body Weight	15 kg (child) 70 kg (adult)	70 kg

(a) RME exposure factors from Standard Default Exposure Factors, OSWER Directive No. 9285.6-03.

(b) Average exposure factors from EPA Region 10 Supplemental Guidance for Superfund Risk Assessment, August, 1991.

in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer of 1×10^{-6} indicates that an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure to a carcinogen under the specific exposure conditions assumed.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g. lifetime) with a reference dose (see toxicity assessment above) derived for a similar exposure period. The ratio of exposure to toxicity is called a hazard quotient. Hazard quotients are calculated by dividing the chronic daily intake (CDI) by the specific RfD. By adding the hazard quotients for all contaminants of concern that affect the same target organ (e.g., liver), the hazard index (HI) can be generated.

The RME provides a conservative but realistic exposure in considering remedial action at a Superfund site. Based on the RME, when the excess lifetime cancer risk estimates are below 1×10^{-6} , or when the noncancer HI is less than 1, EPA generally considers the potential human health risks to be below levels of concern. Remedial action is generally warranted when excess cancer risks exceed 1×10^{-4} (one in ten thousand). Between 10^{-6} and 10^{-4} , cleanup may or may not be selected, depending on individual site conditions including human health and ecological concerns.

Tables 13 and 14 and the following discussion present summarized non-cancer and cancer risk characterization results for the QCF Site separately.

Non-cancer Risks:

The lifetime, adult and child non-cancer HIs for ingestion of surface water and soil are well below 1. The non-cancer HIs for ingestion and inhalation of, and dermal contact with, Aquifer 2 ground water is also below 1.

The HI for dermal contact with contaminated soil, based on a future residential scenario, is above one, with the chemical bis(2-ethylhexyl)phthalate being the major contributor to risk. The HI for dermal contact with contaminated soil, based on a future occupational scenario, is above 1.

The calculated HIs for all pathways (ingestion, inhalation and dermal contact) for Aquifer 1 ground water are greater than 1. The primary contaminant contributing to Aquifer 1 non-cancer risk is 1,2,-DCE.

A future use scenario, which included the use of soil at the Site for planting food crops, yielded an HI of 2.0, the primary contaminant of concern being cadmium.

TABLE 13
TOTAL NON-CANCER RISKS AT QCF SITE

Pathway/Scenario	Chronic HI	Primary Contaminants
Surface Water Ingestion		
Current Occupational	0.17	
Future Residential	0.24	
Surface Water VOCs Inhalation		
Future Residential	Not Calculated	
Surface Soil Ingestion		
Future Residential	0.039	
Future Occupational	0.0052	
Surface plus Subsurface Soil Ingestion		
Future Residential	0.30	
Future Occupational	0.040	
Surface Soil/Dermal Exposure		
Future Residential	2.0	Bis(2-ethylhexyl) phthalate; Endosulfan
Future Occupational	0.5	
Surface plus Subsurface Soil/Dermal Exposure		
Future Residential	2.2	Bis(2ethylhexyl) phthalate
Future Occupational	0.54	
Ground Water Ingestion (Aquifer 1)		
Future Residential	14.0	DCE
Future Occupational	5.1	DCE
Ground Water Ingestion (Aquifer 2)		
Future Residential	0.46	
Future Occupational	0.16	
Ground Water VOCs Inhalation (Aquifer 1)		
Future Residential	5.2	DCE
Ground Water VOCs Inhalation (Aquifer 2)		
Future Residential	0.32	
Ground Water Dermal Contact (Aquifer 1)		
Future Residential	1.5	DCE, naphthalene
Ground Water Dermal Contact (Aquifer 2)		
Future Residential	0.0052	
Food Crops		
Future Residential	2.0	Cadmium

TABLE 14
TOTAL CANCER RISKS AT QCF SITE

Pathway/Scenario	Risk	Primary Contaminants
Surface Water Ingestion		
Current Occupational	2×10^{-5}	Vinyl chloride
Future Residential	3×10^{-5}	Vinyl chloride
Surface Water VOCs Inhalation		
Future Residential	4×10^{-7}	Vinyl chloride
Surface Soil Ingestion		
Future Residential	6×10^{-5}	PCP, PCBs, PAH
Future Occupational	7×10^{-6}	PCP, PCBs, PAH
Surface plus Subsurface Soil Ingestion		
Future Residential	1×10^{-4}	PCP, PCBs, PAH
Future Occupational	1×10^{-5}	PCP, PCBs, PAH
Surface Soil/Dermal Exposure		
Future Residential	1×10^{-3}	PCBs, bis(2-ethylhexyl)phthalate
Future Occupational	2×10^{-4}	PCBs, bis(2-ethylhexyl)phthalate
Surface plus Subsurface Soil/Dermal Exposure		
Future Residential	6×10^{-4}	PCBs, bis(2-ethylhexyl)phthalate
Future Occupational	1×10^{-4}	PCBs, bis(2-ethylhexyl)phthalate
Ground Water Ingestion (Aquifer 1)		
Future Residential	2×10^{-1}	PCBs
Future Occupational	5×10^{-2}	PCBs
Ground Water Ingestion (Aquifer 2)		
Future Residential	2×10^{-5}	TCE
Future Occupational	5×10^{-6}	TCE
Ground Water VOCs Inhalation (Aquifer 1)		
Future Residential	3×10^{-3}	TCE, vinyl chloride
Ground Water VOCs Inhalation (Aquifer 2)		
Future Residential	1×10^{-4}	TCE
Ground Water Dermal Contact (Aquifer 1)		
Future Residential	9×10^{-3}	PCBs
Ground Water Dermal Contact (Aquifer 2)		
Future Residential	3×10^{-6}	TCE
Food Crops		
Future Residential	3×10^{-3}	PCBs

Cancer Risks:

Cancer risks associated with surface water and soil ingestion were within EPA's acceptable risk range of 10^{-4} to 10^{-6} . Cancer risks associated with dermal contact with soil were above EPA's acceptable risk range. PCBs and bis(2-ethylhexyl)phthalate were the major contaminants of concern contributing to the unacceptable cancer risk in soil.

Cancer risks for exposure scenarios associated with Aquifer 1 (ingestion, inhalation and dermal contact) are significantly above EPA's acceptable risk range. The major contaminants of concern in Aquifer 1 which contribute to risk are PCBs, 1,2-DCE, naphthalene, TCE and vinyl chloride.

Future on-site residential and occupational cancer risks associated with ingestion of Aquifer 2 ground water were within EPA's acceptable risk range; however, future on-site residential risks associated with inhalation of volatiles from domestic use of Aquifer 2 ground water are precisely at the 1×10^{-4} risk level for the RME case. (An estimate of risk for the average case, assuming use of ground water with the same exposure point concentration of contaminants for an individual with average contact rate and exposure duration as shown in Table 12, would be 2×10^{-5}). The primary contaminant of concern contributing to Aquifer 2 risk levels is TCE. Future off-site residential use of Aquifer 2 ground water was not evaluated in the risk assessment, but is of potential concern.

The future use scenario of planting food crops yielded a cancer risk level of 3×10^{-3} , the primary contaminant of concern being PCBs.

7.2 Environmental Assessment

To assess the environmental effects of the contaminants present at the QCF Site, an evaluation of potentially affected terrestrial species was conducted. No endangered or threatened species were identified in the geographical area of the Site. No aquatic receptors other than plants were identified since none of the on-site water bodies (Queen City Lake, Main Gravel Pit Lake, and the springs) can maintain aquatic animal populations.

After potential receptor populations were identified, potential ecological exposure pathways were identified. On-site surface water bodies were analyzed and contaminants of concern (TCE and DCE) associated with the Site were only detected at low levels in the intermittent springs along the gravel pit face. The TCE and DCE apparently are lost to volatilization a few feet from the face. Therefore, use of on-site surface water as a source of drinking water by wildlife does not appear to present a risk.

Based on qualitative analysis, the highest potential for wildlife contact with contaminants on-site is contact with contaminated soil. Contaminants of highest ecological concern in the soil are PCBs, PAHs, the pesticides (DDT, endosulfan, dieldrin), and the pesticide breakdown products (DDD, DDE, and heptachlor epoxide). Quantitative estimation of the potential extent of risk to wildlife due to the presence of this contaminated soil was not possible due to lack of toxicological data.

7.3 Uncertainty in the Risk Assessment

The accuracy of the risk characterization depends in large part on the accuracy and representativeness of the sampling, exposure, and toxicological data. Most assumptions are intentionally conservative so the risk assessment will be more likely to overestimate risk than to underestimate it.

One source of uncertainty is the exposure scenario used for Aquifer 1 ground water. Aquifer 1 ground water will most likely not be used as a potable water source. Aquifer 1 is limited in areal extent to the northern portion of the QCF Site. There would not be enough water in Aquifer 1 to support a potable well. Therefore the residential inhalation, ingestion and dermal contact exposure scenarios for Aquifer 1 which are presented in the risk assessment are highly unlikely to occur.

Calculations of risk for potential future users of on-site ground water in Aquifer 2 assumed that concentrations of TCE measured during the RI will remain constant in the future. An assumption of future on-site residential use of ground water probably results in an over-estimate of risk due to the small likelihood of this land use on the Site. For off-site residential use, future exposures and risks are probably less than those calculated for on-site use. At locations of current ground water use, no contaminants were detected at concentrations that would result in risks exceeding 10^{-6} . Uncertainty is introduced in estimating future concentrations at off-site locations because it is not known whether ground-water conditions in Aquifer 2 are stable or whether conditions will remain stable in the future. Recharge to the aquifers, and fate of contaminants in ground water, could be affected as surface use of the Site changes or as use of local ground water increases with continued suburbanization.

Calculations of risk for exposure to soil are likely to be overestimations. Soil samples were collected at "hot spot" locations of suspected contamination. Exposure and risk calculations assume long-term contact with the contaminant in soil through incidental soil ingestion, dermal exposure, or ingestion of garden produce. It is unlikely that this combination of prolonged exposure at the areas of high

concentration will occur because the areas of soil contamination outside the IRM area are small.

Uncertainty in the toxicity evaluation may over-estimate risks by relying on slope factors that describe the upper confidence limit on cancer risk for carcinogens. Some under-estimation of risk may occur due to lack of quantitative toxicity information for some contaminants detected at the QCF Site. Qualitative uncertainty exists in evaluating carcinogenicity of chemicals that exhibit no carcinogenicity to humans. Evidence for carcinogenicity of TCE is based on animal studies, and the weight of the evidence for TCE is under review by EPA to determine status as either B2, probable human carcinogen, or C, possible human carcinogen.

7.4 Conclusions

Dermal exposure to soils at the Site could result in excess lifetime cancer risks of 1 in 1,000. Exposure to Aquifer 1 ground water could result in unacceptable lifetime cancer and non-cancer risks. On-site risk estimates of exposure to Aquifer 2 ground water via the inhalation route are at the upper boundary of EPA's acceptable risk range and would result in a lifetime excess cancer risk of 1 in 10,000.

Based on the results of the RI/FS, concentrations of contaminants of concern in Aquifer 1 and Aquifer 2 ground water exceed chemical-specific health-based standards such as the Maximum Contaminant Levels (MCLs) set under the Safe Drinking Water Act. Aquifer 2 serves as a potential drinking water source. Aquifer 1 serves as a source of recharge and potential contamination to Aquifer 2.

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Based on the results of the risk assessment, and on the finding of the RI/FS that hazardous substances in soils from the IRM area and BDA, and contaminants in LNAPL serve as a continuous source to ground water contamination, the following remedial action goals have been established for the QCF Site:

For soils:

- Prevention of exposure to contaminated surface and subsurface soils.
- Prevention of migration of contaminants in subsurface IRM and BDA soils to ground water.
- Reduction of contaminant concentrations in subsurface IRM and BDA soils.

For ground water:

- Prevention of exposure to contaminated ground water.

- Prevention of migration of the contaminant plume.
- Restoration of ground water for future use.

8.0 DESCRIPTION OF ALTERNATIVES

The QCF Site was divided into three areas in order to facilitate evaluation of remedial alternatives. These three areas are; (1) The IRM and associated areas, (2) the BDA, and (3) the 4-Tek Industries facility. Various remedial alternatives were analyzed in detail for each area of the Site.

Estimated costs for each of the alternatives are accurate within the range of +50 percent to -30 percent. Estimated present worth costs are based on a 30-year life of the remedial alternative using a discount rate of 5 percent.

All of the evaluated alternatives, excluding the excavation and incineration alternative (IRM Alternative 7), would result in contaminants remaining on-site above health-based levels. Therefore, CERCLA requires that Site conditions be reviewed at intervals of at least every five years. If warranted by the review, remedial actions would be initiated at that time to remove, contain or treat the remaining waste.

8.1 IRM and Associated Areas

A total of seven remedial alternatives, including "no action", were considered for cleanup of contaminated soils, LNAPL, and ground water associated with the IRM area. Elements of the alternatives, excluding the "no action" alternative, are summarized in Table 15.

IRM Alternative 1 - No Action

The NCP requires that a "no action" alternative be analyzed as a potential remedial alternative for each Superfund site. For this alternative, no further action would be taken on the Site beyond that already implemented for the IRM area. The IRM cap would be protected and maintained as provided by existing institutional controls. The existing deed restriction is intended to notify any potential purchaser of the property that the land has been used to manage hazardous waste and its use is restricted. A security fence currently exists around the IRM area cap. These existing institutional controls would be maintained to restrict access to the IRM area.

IRM Alternative 2: Ground-water monitoring, institutional controls.

This alternative requires monitoring of existing ground-water wells in Aquifers 1, 2 and 3 at least twice per year. Construction and monitoring of additional wells may be required. The IRM cap would remain in place. Existing institutional controls which include a security fence around

TABLE 15
ELEMENTS OF IRM AREA REMEDIAL ALTERNATIVES

CLEANUP ELEMENT	ALTERNATIVES					
	2	3	4	5	6	7
Ground-Water Monitoring	X	X	X	X	X	X
Institutional Controls	X	X	X	X	X	
Vertical Barrier System		X	X	X	X	
IRM Area Dewatering/Ground-Water Treatment		X	X	X	X	X
LNAPL Recovery/Incineration		X	X	X	X	X
Aquifer 1 Contingent Extraction & Treatment				X	X	
Aquifer 2 Extraction & Treatment			X	X	X	X
Venting of IRM Soils				X		
Soil Vapor Extraction of IRM Soils					X	
Excavation and Incineration of IRM Soils						X
Capital Cost (K = \$Thousands; M = \$Millions)	30K	13M	16.1M	16.7M	24.8M	288M
O & M Cost (K = \$Thousands; M = \$Millions)	640K	1.2M	1.8M	1.9M	1.8M	200K
Time to Implement (years)	0.25	3	3	3	3	5

the IRM area, and land use restrictions, would be strengthened. The deed to the Site would be amended to restrict use of Aquifers 1 and 2 until the contamination in these aquifers was naturally diluted below levels set by the federal Safe Drinking Water Act, 42 U.S.C. §§300f et seq. (SDWA) and state ground water standards.

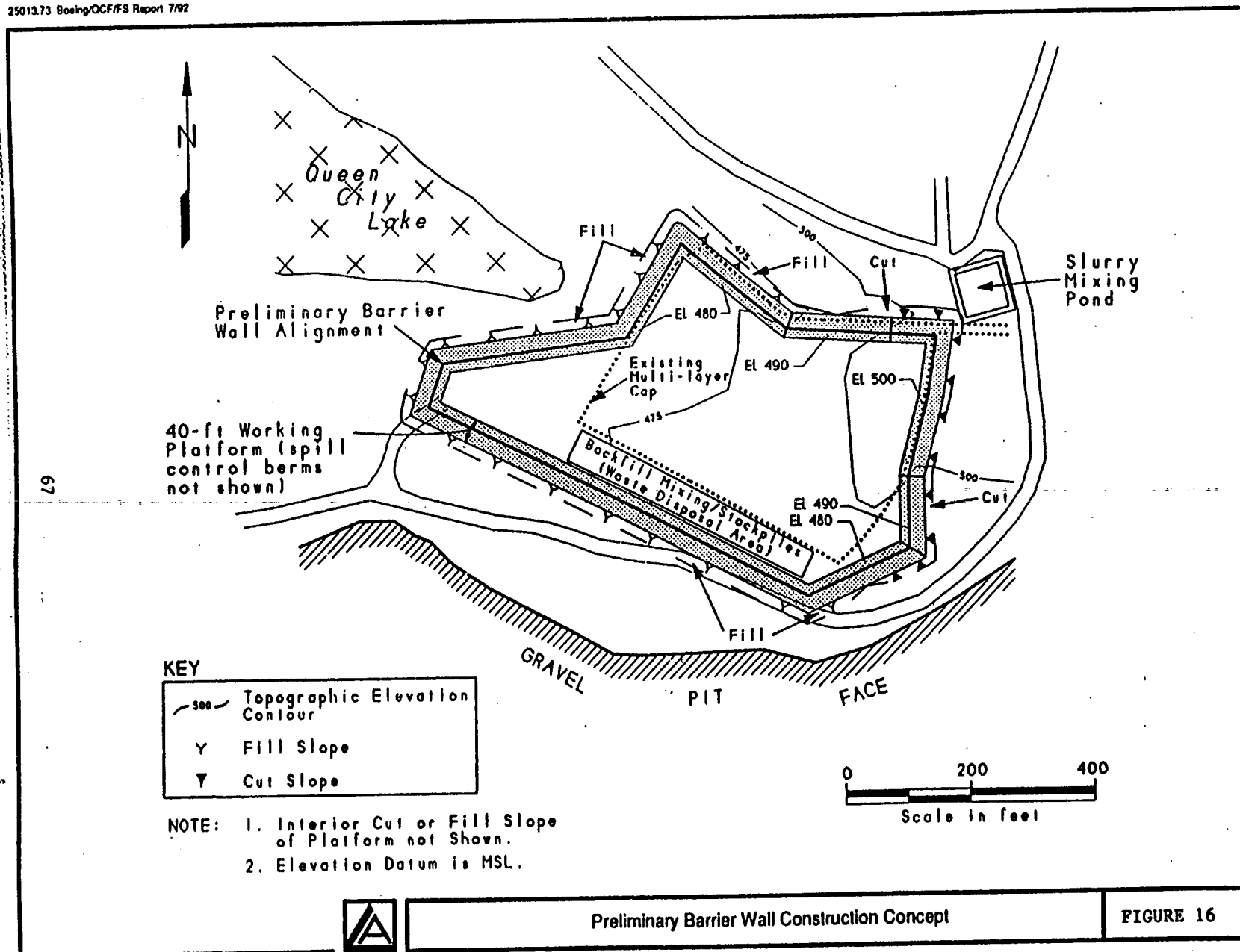
The present worth cost of this alternative for a 30-year period is approximately \$9,900,000. The estimated time to implement this alternative is approximately 3 months.

Potential applicable or relevant and appropriate requirements (ARARs) for this alternative include the SDWA Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals, 40 C.F.R. 141; and the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. (RCRA), Releases from Solid Waste Management Units regulations, 40 C.F.R. Part 264, Subpart F, and the Washington State Model Toxics Control Act (MTCA) Cleanup Standards, WAC 173-340. The SDWA Secondary MCLs, 40 C.F.R. 143, Proposed MCLs, and Health Advisories for Drinking Water are to be considered (TBC) for IRM Alternatives 2 through 7.

IRM Alternative 3: Vertical barrier, dewatering and treatment of Aquifer 1 within the IRM, recovery and off-site incineration of LNAPL, institutional controls, and ground-water monitoring.

This alternative would include installation of a vertical ground-water flow barrier system, such as a soil-bentonite slurry wall, and an expansion of the IRM cap, which would minimize ground water and surface water contact with contaminants in the IRM area. If necessary, this alternative would include an option for installation of dewatering wells to reduce piezometric heads outside of the slurry wall. A preliminary barrier wall construction concept is shown in Figure 16. If a slurry wall is used it would be keyed into the Aquifer 1 aquitard system that underlies the area. The approximate depth of the slurry wall would range between 30 and 70 feet, with a cross-sectional thickness of about 3 feet. The wall may require construction in panels to accommodate the sloping terrain within the IRM area. The existing IRM cap would be expanded to include the area bounded by the slurry wall. The existing cap surface water drainage system would be extended to convey precipitation and upgradient surface runoff away from the cap expansion area. This uncontaminated runoff would be directed to Queen City Lake, as is the runoff from the existing cap.

Extraction of ground water from within the IRM area barrier system would be implemented to prevent eventual discharge of this contaminated water through the Aquifer 1 aquitard system into Aquifer 2. Short-term dewatering would



Preliminary Barrier Wall Construction Concept

FIGURE 16

be implemented to remove and treat the ground water contained within the barrier system upon completion of construction. Extraction wells would remove water from inside the barrier system at an estimated rate of 50 gallons per minute (gpm). Based on known aquifer characteristics, it is estimated that between 1 and 5 million gallons of ground water would be extracted during the initial dewatering. Treatment of ground water from short-term dewatering would be accomplished using a temporary on-site ground-water treatment system. A likely treatment train would consist of oil/water separation, filtration, air stripping, and carbon adsorption and offgas treatment (if necessary). Treated water would most likely be discharged to a Publically Operated Treatment Works (POTW).

Long-term dewatering would be implemented to further control the mobility of residual contaminants within the barrier system through recovery of any leakage through the system. The estimated ground-water leakage rate through a competent slurry wall around the IRM area could reach 1.5 gpm. It is estimated that approximately 5 extraction wells would be needed for long-term dewatering. Extraction pumps would be automatically activated, based on ground-water level monitors within the extraction wells. Extracted ground water would be treated on Site and most likely discharged to a POTW. A permanent on-site ground-water treatment system would be installed. A likely treatment train would consist of oil/water separation, precipitation, filtration, and carbon adsorption.

LNAPL immobilization and recovery measures would be implemented to control LNAPL within the IRM area. Additional site characterization and pilot testing would be required to determine the amount of recoverable LNAPL, recovery rates and the duration of recovery. Passive skimming would be the preferred LNAPL recovery process. If feasible, LNAPL recovery wells would be installed through the IRM cap. Recovered LNAPL would be transported off-site to be incinerated at a permitted hazardous waste incineration facility.

Ground-water monitoring of Aquifers 1, 2, and 3 would be undertaken to evaluate the effectiveness of the barrier system and associated dewatering remedial actions. Within the IRM Area, LNAPL levels would also be monitored.

The present worth cost of this alternative for a 30-year period is approximately \$31,000,000. The estimated time to construct this alternative is approximately 3 years.

ARARs for this alternative include the SDWA MCLs and MCLGs, 40 C.F.R. Part 141; RCRA Land Disposal Restrictions, 40 C.F.R. Part 268; RCRA Releases from Solid Waste Management Units, 40 C.F.R. Part 264, Subpart F; RCRA

Closure/Postclosure Requirements, 40 C.F.R. Part 264, Subpart G; the Toxic Substances Control Act, 42 U.S.C. §2601 et seq. (TSCA), PCB Disposal Requirements, 40 C.F.R. Part 761.60; Clean Water Act, 42 U.S.C. 1251 et seq. (CWA), NPDES Industrial and/or Stormwater Discharge Permits regulations, 40 C.F.R. 122; Ambient Water Quality Criteria, 40 C.F.R. Part 131, Publically Operated Treatment Works (POTW) Discharge Requirements, 40 C.F.R. Part 143; Clean Air Act, 15 U.S.C. §7401 et seq. (CAA), National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50, National Emissions Standards for Hazardous Air Pollutants, 40 C.F.R. Part 60; the Model Toxics Control Act Cleanup Standards, WAC 173-340; Washington Clean Air Act, General Regulations, WAC 173-400, Volatile Emissions Standards, WAC 173-460, Controls for New Sources, WAC 173-490, and Puget Sound Air Pollution Control Agency (PSAPCA) Regulation III; the Washington State Water Pollution Control Act, Surface Water Quality Standards, WAC 173-201, Waste Discharge Program, WAC 173-216, National Pollution Discharge Elimination System (NPDES) Permit Program, WAC 173-220, and Construction of Wastewater Facilities, WAC 173-240.

IRM Alternative 4: Vertical barrier, dewatering and treatment of Aquifer 1 within the IRM, contingent extraction and treatment of Aquifer 1 outside of the IRM, recovery and off-site incineration of LNAPL, extraction and contingent treatment of Aquifer 2 ground water, institutional controls, and ground-water monitoring.

This alternative includes all the elements of IRM Alternative 3. In addition, an extraction well system would be constructed which would be designed to contain the Aquifer 2 TCE and DCE plumes. A point of compliance would be established as close to the contaminant source as possible as provided for in National Contingency Plan and the Washington State Model Toxics Control Act. The areal extent of the plumes would be shrunk as close to the point of compliance as technically feasible. Volatile organic contamination would be removed by recirculating the Aquifer 2 water back through the Main Gravel Pit Lake or an equivalent on-Site surface water body. Should the extracted water contain volatile organic contamination which is above drinking water strippers standards, then the water would be treated via air strippers to meet those standards.

Contaminant levels in Aquifer 1 outside of the IRM area are expected to decrease to regulatory standards within 5 years after completion of the vertical barrier around the IRM. However, if Aquifer 1 levels do not decrease, then Aquifer 1 ground water would also be extracted and treated to meet regulatory standards. Treated Aquifer 1 and Aquifer 2 water would be discharged to the Main Gravel Pit Lake. The institutional controls and long term ground-water

monitoring which are described in Alternative 2, are included in this alternative.

The present worth costs of this alternative are estimated to be \$43,000,000. The estimated time to construct this alternative is 3 years.

Potential ARARs for this alternative would include all the ARARs identified in IRM Alternative 3 in addition to the CWA Disposal of Dredged Material Guidelines, 40 C.F.R. Part 230.

IRM Alternative 5: Vertical barrier, dewatering and treatment of Aquifer 1 within the IRM, contingent extraction and treatment of Aquifer 1 outside of the IRM, recovery and off-site incineration of LNAPL, venting of IRM soils, extraction and contingent treatment of Aquifer 2, institutional controls and ground-water monitoring.

This alternative is the same as IRM Alternative 4, except that it would include removal of some of the mobile contaminants via venting of the IRM soils. This alternative was analyzed in order to evaluate the feasibility of providing an additional measure of protection at a minimal cost.

A series of vent wells may be installed in the IRM cap. The vents would be designed and installed in a manner which prevents rainfall from entering the IRM cap. These vents will provide an oxygen source which should promote the aerobic biodegradation of the PAHs and xylenes within the soils. In addition, the vents should promote the removal of volatile and semi-volatile contaminants in the unsaturated soils. Heavy metals and PCB contaminants can not be degraded or removed using this technology, and would still remain in place. However, heavy metal and PCB contaminants are generally not mobile, and should not migrate from soils to ground water. The vents will be monitored for off-gases which may enter the atmosphere as a result of the breakdown and/or removal of contaminants within the soils. If necessary, best available technology will be utilized to treat the gases emitted from the vents prior to entering the atmosphere.

Prior to installing the vents, treatability studies will be performed to determine if the IRM soils are suitable for treatment utilizing this technology. The treatability studies will determine the contaminant removal efficiency of the vents, and will aid in determining the number of vents which will be necessary to optimize contaminant removal.

The institutional controls and long term ground-water monitoring which are described in Alternative 2, are included in this alternative.

For purposes of estimating costs, it was assumed that 10 vents would be installed. The present worth cost of this alternative is estimated to be \$44,525,000. The estimated time to construct this alternative is 3 years.

Potential ARARs for this alternative would be the same as those identified for IRM Alternative 4.

IRM Alternative 6: Temporary vertical barrier, soil vapor extraction, dewatering and treatment of Aquifer 1 within the IRM, contingent extraction and treatment of Aquifer 1 ground water outside of the IRM, recovery and off-site incineration of LNAPL, extraction and contingent treatment of Aquifer 2 ground water, institutional controls, and ground-water monitoring.

Soil vapor extraction (SVE) is a remedial technology which removes volatile organic compounds from the unsaturated zone. SVE involves drilling a system of extraction wells through the IRM cap and construction of a vacuum system to remove the soil air and the mass of volatile organics contained in the soil air. The removal of the volatile organics from the soil air results in the mass transfer of more volatile organics from the soil water and from the LNAPL. In addition, PAHs may be removed from LNAPL along with the volatile organics. The extracted soil air is then treated to remove the volatile organics and the PAHs. SVE technology is not effective for removing metals and PCBs, so these contaminants would remain in the IRM soils.

In order to optimize the effectiveness of SVE technology for treatment of the IRM soils, a temporary vertical barrier may need to be installed to prevent infiltration of ground water into the IRM area. In addition, the water level of the portion of Aquifer 1 that lies within the IRM area would need to be lowered. This may involve the construction of a ground-water extraction system to remove and treat Aquifer 1 ground water both within and outside the IRM area. Extraction of Aquifer 1 water outside the IRM area is necessary to contain ground-water flow and gradients within the IRM. The Aquifer 1 ground-water treatment system would be the same as that described for IRM Alternative 3. The treated water would most likely be discharged to a POTW.

As in IRM Alternative 3, oil from the LNAPL would be recovered and incinerated, and institutional controls and ground-water monitoring would be implemented. In addition, the Aquifer 2 contaminant plume would be contained and a point of compliance established as described for IRM Alternative 4. Extracted ground water would most likely be discharged on Site to the Main Gravel Pit Lake.

The institutional controls and long term ground-water monitoring which are described in Alternative 2, are included in this alternative.

The present worth costs of this alternative are estimated to be \$54,000,000. The estimated time to construct this alternative is 3 years.

Potential ARARs for this alternative would be the same as those identified for IRM Alternative 4.

IRM Alternative 7: Excavation of the IRM cap, recovery and on-site incineration of LNAPL, dewatering and treatment of Aquifer 1 within the IRM, excavation and on-site incineration of IRM soils, extraction and treatment of Aquifer 2 ground water, and ground-water monitoring.

With this alternative, the IRM cap would be removed. Prior to removal of the cap, the LNAPL would be recovered and incinerated on-site. The IRM would be dewatered and the contaminated water treated and discharged to a POTW. The contaminated soils within the IRM would be excavated. Debris from the multi-layered cap would be sampled to determine if they are contaminated and need to be incinerated. A mobile incinerator would be placed on-site to incinerate the contaminated soils, LNAPL and, if necessary, cap debris.

Soil left in place would meet cleanup levels established under the Model Toxics Control Act. The IRM area would be backfilled with clean soil. Aquifer 2 water would be extracted and, if necessary, treated to meet regulatory levels. Extracted Aquifer 2 ground water would be discharged on-site to the Main Gravel Pit Lake or to an equivalent on-site surface water body. Ground-water monitoring would be required to ensure that health-based levels are maintained.

The present worth cost of this alternative is approximately \$293,000,000 to set up and treat an estimated 280,000 cubic yards of contaminated soils. The time required for implementation of this alternative is estimated to be 5 years, largely due to the complexity of excavating the IRM cap, and pretreatment requirements prior to incineration. However, operation and maintenance of the IRM area would not be required.

Potential ARARs which have been identified for this alternative include the RCRA Standards for Hazardous Waste Incinerators, 40 C.F.R. 264, Subpart O, the RCRA Land Disposal Restrictions, 40 C.F.R. 260, Subpart D; the TSCA PCB Disposal and Incineration Standards, 40 C.F.R. 761.60 and 761.70; the SDWA MCLs and MCLGs, 40 C.F.R. 171; the Clean Air Act, National Air Ambient Quality Standards, 40

C.F.R. Subpart 50; the Model Toxics Control Act Cleanup Standards, WAC 173-340; and Washington State Air Pollution Regulations, WAC 173-400 through 490. The TSCA PCB Spill Cleanup Policy is considered a TBC.

8.2 Buried Drum Area

Four remedial alternatives, including "no action", were considered for their effectiveness in cleanup of contaminated soils and debris associated with the BDA.

BDA Alternative 1: No Action

This alternative is the same as the "no action" alternative described for IRM Alternative 1. Removal activities have already taken place in the BDA, and under this alternative, no further action would be taken.

BDA Alternative 2: BDA Capping

A multilayered cap would be constructed to cover the BDA. The cap would have the same design as the existing IRM cap, and could be united with the existing IRM cap. Approximately 30,000 ft² of cap would be necessary for isolation of the BDA. The cap would prevent direct contact with contaminants, control generation of dust, and prevent surface water infiltration through the BDA. Prevention of surface water infiltration would eliminate potential leaching of contaminants to Aquifer 1. A surface water drainage system would be constructed to divert rainfall from the cap area to Queen City Lake.

The present worth cost of this alternative is estimated to be \$725,000. The estimated time to implement this alternative is 1 year.

Potential action-specific ARARs which would be triggered for this capping alternative are the TSCA Chemical Waste Landfill requirements, 40 C.F.R. Part 761.75; and RCRA Hazardous Waste Landfill Closure/Postclosure requirements, 40 C.F.R. Part 264. Washington State regulations which are potential ARARs include, the Minimum Functional Standards for Solid Waste Handling, WAC 173-304, and the Model Toxics Control Act Cleanup Standards, WAC 173-340. The TSCA PCB Spill Cleanup Policy is a TBC regulation.

BDA Alternative 3: Excavation, off-site treatment of debris and consolidation of soil with low levels of contamination below an expansion of the existing IRM cap.

Approximately 10,000 cubic yards of soil and debris would be excavated. About 100 cubic yards of this material consists of buried drum debris and associated soils which

are contaminated with metals and organics. This drum debris and soil would be separated and transported off-site for treatment and disposal at a permitted hazardous waste facility. The debris may need to be treated to meet regulatory requirements prior to off-site disposal. Approximately 4,000 cubic yards of soil have low levels of metal and organic contamination. This soil would be consolidated on-site below an expansion of the existing IRM cap. The remaining 6,000 cubic yards of clean soil would be used as backfill material on Site.

The present worth cost of this alternative is estimated to be \$2,040,000. The estimated time to implement this alternative is 2 years.

Potential ARARs which would be triggered by this alternative include all the ARARs identified for BDA Alternative 2, in addition to, RCRA Land Disposal Restrictions, 40 C.F.R. Part 268, and the Washington State Hazardous Waste Management Act, RCW 70.105.

BDA Alternative 4: Excavation, off-site treatment of debris, on-site treatment of low level contaminated soil and consolidation of the treated soil below an expansion of the existing IRM cap.

This alternative is the same as BDA Alternative 3, except that the 4,000 cubic yards of soil with low levels of contamination would be treated on-site by thermal desorption. Thermal desorption is a process by which contaminated soils are heated in a kiln to temperatures between 500 and 800 degrees Fahrenheit to remove the organic contaminants from the soil. Process equipment for this technology is readily available. Offgas treatment processes may need to include carbon adsorption, wet scrubbing, and after-burning. The treated soil may contain low concentrations of metals, so if necessary, the soil would be stabilized with Portland cement prior to placement below the extension of the IRM cap.

The present worth cost of this alternative is estimated to be \$5,960,000. The estimated time to implement this alternative is 3 years.

Potential ARARs which would be triggered by this alternative include all the ARARs identified for BDA Alternatives 2 and 3, in addition to, Clean Air Act, National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50, National Emissions Standards for Hazardous Air Pollutants, 40 C.F.R. Part 60; Washington Clean Air Act, General Regulations, WAC 173-400, Volatile Emissions Standards, WAC 173-460, Controls for New Sources, WAC 173-490, and Puget Sound Air Pollution Control Agency (PSAPCA) Regulation III.

8.3 4-Tek

Two remedial alternatives, including "no action", were considered for the cleanup of the 4-Tek Industries portion of the Site.

4-Tek Alternative 1: No Action

This alternative is the same as the "no action" alternative described for IRM Alternative 1. Removal activities have already taken place at 4-Tek, and under this alternative, no further action would be taken.

4-Tek Alternative 2: Ground-water monitoring with contingent extraction and treatment.

Removal of contaminated soil at the 4-Tek facility has eliminated a source of contamination. However, a shallow water table zone at the 4-Tek facility is contaminated with volatile organics. This water table zone is not used for potable water but it is considered a potential source of contamination to Aquifer 2. Currently, no Aquifer 2 monitoring wells exist at the 4-Tek facility. With this alternative ground water from Aquifer 2 would be monitored at least twice per year for a period of five years. Post removal monitoring will also consist of sampling and characterization of possible additional sources and the perched water table zone. If a contaminant plume is detected in Aquifer 2, with contaminant levels above MCLs, then the plume will be contained, and if necessary, reduced via ground-water extraction and treatment.

Treatment would probably involve the placement of air strippers on the extraction wells. The treated ground water will be discharged on Site to the Main Gravel Pit Lake or to an equivalent on site surface water body. The costs listed here include the costs for the monitoring and extraction wells and the treatment system.

The present worth cost of this alternative is estimated to be \$3,500,000. This estimated cost includes a ground-water extraction and treatment system, as well as long-term monitoring costs. The estimated time to construct this alternative is 3 months to install the ground-water monitoring wells, and 1 year to install a ground-water extraction and treatment system.

Potential ARARs which would be triggered by this alternative include, the SDWA MCLs and non-zero MCLGs, 40 C.F.R. Part 141; the Clean Air Act National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50, National Emissions Standards for Hazardous Air Pollutants, 40 C.F.R. Part 60; the Model Toxics Control Act Cleanup Standards, WAC 173-340; Washington Clean Air Act, General

Regulations, WAC 173-400, Volatile Emissions Standards, WAC 173-460, Controls for New Sources, WAC 173-490; and Puget Sound Air Pollution Control Agency (PSAPCA) Regulation III. The SDWA Secondary MCLs, 40 C.F.R. Part 143, Proposed MCLs and Health Advisories for Drinking Water are TBC.

9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires that each remedial alternative analyzed in detail in the Feasibility Study be evaluated according to specific criteria. The purpose of this evaluation is to promote consistent identification of the relative advantages and disadvantages of each alternative, thereby guiding selection of remedies offering the most effective and efficient means of achieving site cleanup goals. There are nine criteria by which feasible remedial alternatives are evaluated. While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they describe a required level of performance (threshold criteria), provide for consideration of technical or socioeconomic merits (primary balancing criteria), or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria). The nine criteria are summarized in Table 16.

9.1 Threshold Criteria

The remedial alternatives were first evaluated by comparison with the threshold criteria: overall protection of human health and the environment and compliance with ARARs. The threshold criteria must be fully satisfied by candidate alternatives before the alternatives can be given further consideration in remedy selection.

9.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether the remedial actions provide adequate protection, and describes the mechanism for controlling risks for the different exposure pathways.

The treatment alternatives (IRM Alternatives 5 through 7, BDA Alternatives 3 and 4, and 4-Tek Alternative 2) are all protective of human health and the environment. These alternatives are more protective because they employ treatment to reduce the principal threats associated with volatile organic contamination in ground water; remove volatile, semi-volatile, and hydrocarbon contaminants from the IRM and BDA soils; and reduce the likelihood of ground-water or surface water contamination migrating off-site into drinking water wells or nearby streams. SVE (IRM Alternative 6), incineration (IRM Alternative 7), and thermal desorption (BDA Alternative 4), would be more protective of human health and the environment, because these alternatives would destroy or remove the principal contaminants found at the Site.

IRM Alternatives 3 through 7 are protective because they include the removal of LNAPL. If left in place, the

Table 16
Glossary of Evaluation Criteria

EPA ranks the alternatives considered against the following nine evaluation criteria:

Threshold Criteria:

1. Overall protection of human health and the environment - How well does the alternative protect human health and the environment, both during and after construction?

2. Compliance with applicable or relevant and appropriate standards (ARARs) - Does the alternative meet all applicable or relevant and appropriate state and federal laws?

Balancing Criteria:

3. Long-term effectiveness and permanence - How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the site?

4. Reduction of toxicity, mobility and volume through treatment - Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility and volume of the hazardous substance?

5. Short-term effectiveness - Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How fast does the alternative reach the cleanup goals?

6. Implementability - Is the alternative both technically and administratively feasible? Has the technology been used successfully on other similar sites?

7. Cost - What are the estimated costs of the alternative? How do costs of the alternative being evaluated compare with costs of the other alternatives?

Modifying Criteria:

8. State acceptance - What are the state's comments or concerns about the alternatives considered and about EPA's preferred alternative? Does the state support or oppose the preferred alternative?

9. Community acceptance - What are the community's comments or concerns about the preferred alternative? Does the community generally support or oppose the preferred alternative?

LNAPL would slowly dissolve, supplying potentially significant concentrations of contaminants to ground water over very long time periods.

SVE (IRM Alternative 6), and venting of IRM soils (IRM Alternative 5), would directly treat or remove the mobile contaminants which contribute most to human health risks.

Ground-water extraction (IRM Alternatives 3 through 7, and 4-Tek Alternative 2) is a proven technology for containment of ground-water contamination. Ground-water extraction along with source reduction or removal (IRM Alternatives 5 through 7) would be more protective of human health and the environment.

The containment alternatives (IRM Alternatives 3 and 4, and BDA Alternative 2), are not as protective, because containment alone without treatment may make it possible for contaminants to migrate below the IRM and BDA into the underlying aquifers.

The "no-action" alternatives (IRM Alternative 1, BDA Alternative 1, and 4-Tek Alternative 1), and the alternative requiring only monitoring (IRM Alternative 2), are not protective of human health and the environment, because the main contaminant sources to ground water, surface water, and soil would still remain uncontrolled.

9.1.2 Compliance with ARARs

The purpose of this analysis is to evaluate the alternatives for compliance with the major ARARs. Grounds for invoking waivers of ARARs are included in this analysis where appropriate.

CERCLA requires that remedial actions satisfy all identified ARARs. These laws may include among others, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act, and state laws, such as the Model Toxics Control Act with promulgated standards more stringent than the corresponding federal law.

An "applicable" requirement directly and fully addresses the situation at the site. It would legally apply to the response action if that action were undertaken independently from any CERCLA authority. A "relevant and appropriate" requirement is one that is designed to apply to problems which are sufficiently similar to the problem being addressed at the site, that it's use is well suited to the particular site.

All of the combination source treatment/containment alternatives (IRM Alternatives 4 through 6, and BDA

Alternatives 3 and 4) can meet all identified ARARs. Additional offgas treatment systems may be required for the SVE and venting alternatives to ensure compliance with federal and state air regulations.

Ground-water extraction and treatment alternatives (IRM Alternatives 4 through 7, and 4-Tek Alternative 1) may qualify for an ARAR waiver in the future if cleanup standards are not achievable within the required time frame, provided the following two conditions are met:

- a) There is a demonstration that it is technically impracticable to meet the cleanup standards from an engineering perspective, and this demonstration is made to the satisfaction of EPA. EPA will make its determination as to whether aquifer restoration to cleanup standards is technically impracticable based upon EPA-approved data, supporting analysis, and site characterization.
- b) EPA determines the alternative remedial action objectives.

The source containment alternatives (IRM Alternative 3 and BDA Alternative 2) may not comply with chemical-specific ARARs because these alternative rely on natural dilution of ground water to achieve SDWA MCLs and Model Toxics Control Act Cleanup Standards once the containment barrier is in place. It is not known how long natural dilution will take, or if dilution will be effective, to reduce the ground-water contamination to health-based levels.

The "no action" and monitoring only alternatives (IRM Alternative 1 and 2, BDA Alternative 1, 4-Tek Alternative 1) do not comply with chemical-specific ARARs because soil and ground-water contamination would remain above state soil cleanup standards and federal SDWA MCLs.

The "no action" alternatives (IRM Alternative 1, BDA Alternative 1 and 4-Tek Alternative 1) will not be considered further, as they do not meet the threshold criteria.

9.2 Primary Balancing Criteria

For those alternatives satisfying the threshold criteria, five primary balancing criteria are used to evaluate other aspects of the potential remedies. No single alternative will necessarily receive the highest evaluation for every balancing criterion. This phase of the comparative analysis is useful in refining the relative merits of candidate alternatives for site cleanup. The five primary balancing criteria are: long-term effectiveness and permanence, reduction of toxicity, mobility, or

volume through treatment, short-term effectiveness, implementability, and cost.

9.2.1 Long-Term Effectiveness and Permanence

This criterion evaluates the ability of a remedial alternative to maintain reliable protection of human health and the environment over time, once cleanup goals have been achieved.

LNAPL recovery, venting, SVE, incineration (IRM Alternatives 4 through 7), and off-site disposal and thermal desorption (BDA Alternatives 3 and 4), are all effective over the long term because they would destroy or remove contaminants, thereby eliminating the potential for exposure to contaminated soils and ground water.

A vertical barrier wall and cap around the IRM and BDA, without source treatment (IRM Alternative 3 and BDA Alternative 2), would reduce the mobility of contaminants, but high concentrations of contaminants would still persist on-site. The potential for future migration of contaminants due to failure of the barrier wall, or long-term fluctuations of the water levels within Aquifer 1, would still remain.

Institutional controls and monitoring, as described in IRM Alternative 2, are not permanent, because they do nothing to reduce the levels of contaminants remaining on site. It is not known how long it would take natural attenuation to reduce ground-water contamination to health-based cleanup levels.

9.2.2 Reduction of Toxicity, Mobility and Volume Through Treatment

This criterion evaluates the anticipated performance of the various treatment technologies and addresses the statutory preference for selecting remedial actions that employ treatment technologies which permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reductions in contaminant mobility, or reductions in the total volume of contaminated media.

IRM Alternatives 5 (venting) and 6 (SVE), and BDA Alternative 4 (thermal desorption) employ a combination of treatment and containment of contaminated soils and ground water to significantly reduce contaminant toxicity, mobility, and volume. SVE and venting would reduce the contaminant volume of the more mobile contaminants within the IRM soils. On-site incineration (IRM Alternative 7)

would permanently reduce the toxicity and volume of all of the contaminants in the IRM soils.

LNAPL removal and incineration (IRM Alternatives 3 through 7) would permanently reduce the toxicity and volume of contaminants within Aquifer 1 ground water.

Ground-water extraction and treatment (IRM Alternatives 4 through 7, and 4-Tek Alternative 2) would reduce the volume and mobility of contaminants in ground water.

Off-site disposal (BDA Alternative 3), containment (BDA Alternative 2), and monitoring (IRM Alternative 2), do not employ treatment as a principal component of the remedy. With each of these alternatives, toxicity, mobility, and volume of the contaminants remain unchanged.

9.2.3 Short-Term Effectiveness

The short-term effectiveness criterion focuses on the period of time needed to achieve protection of human health and the environment, and adverse impacts which may occur during remedial construction and remedial action, until cleanup goals are achieved.

All of the IRM and BDA alternatives, with the exception of IRM Alternative 2 (monitoring and institutional controls), and the "no action" alternatives, would create some level of short-term risk during construction of the vertical barrier system and cap expansion. The estimated time of construction for the vertical barrier system and cap expansion is 3 years. The short-term risks are primarily those associated with dust and air emissions resulting from excavated soil, debris handling, and off-site disposal. Short term risks, such as those from dust emissions, will be mitigated to the maximum extent practicable, using best available technology.

IRM Alternative 7 (excavation of IRM cap and incineration of IRM soils) would have the greatest short-term risks associated with volatilization and particulate emissions during the excavation of highly contaminated soils from the IRM. Installation of SVE (IRM Alternative 6) extraction wells, vents, and ground-water extraction and treatment systems, would have some short-term risks from air emissions during construction and testing of the extraction, treatment and disposal systems. These risks could be minimized by controlling air emissions during construction and operation of the treatment systems.

9.2.4 Implementability

This evaluation addresses the technical and administrative feasibility of implementing the alternatives,

including the availability of materials and services required to construct the remedy.

All of the alternatives can be implemented with varying degrees of difficulty. Excavation, incineration, and off-site disposal would require extensive materials handling. On-site incineration is an established technology; however, there may not be an incinerator readily available to handle the waste. Therefore, delays may be encountered due to problems in scheduling a mobile incinerator. In addition, metal and construction debris in the IRM soils may present difficulties in controlling the quality of the feed to the unit, resulting in a potential for excessive slagging, volatile metals emissions, and variable destruction and removal efficiencies. Trial burns would be necessary to establish operating parameters and optimize the process equipment.

Venting and soil vapor extraction of IRM contaminants would require treatability testing prior to implementation. Equipment and services are readily available. In-field modifications of equipment and/or operational procedures are likely to be required prior to start-up in order to design a system to maximize the amount of contaminants which can be removed from the IRM soils.

Ground-water extraction, treatment, and monitoring systems are readily implementable. Ground-water extraction is a proven technology and process services and equipment are readily available. Ground-water discharge to a POTW will require permitting prior to implementation. Treatability studies may need to be performed on extracted ground water prior to discharge to an on-site surface water body, such as the Main Gravel Pit Lake.

LNAPL recovery would require pilot testing to determine the amount of oil which can be removed from the IRM area. It may be difficult to recover LNAPL from extraction wells if much adsorption to subsurface soil particles has occurred within the unsaturated zone.

Construction of the vertical barrier wall would be complex, and take approximately two years to complete. The vertical barrier wall would completely enclose the IRM area. Difficulties might be encountered when attempting to key the slurry wall into the Aquifer 1 aquitard which may not be continuous around the IRM. In addition, the sloping terrain of the IRM area requires that the depth of the slurry wall vary between 30 and 70 feet. This variability in depth may present difficulties during cutting and filling of the slurry wall materials.

Long-term dewatering of Aquifer 1, as required by IRM Alternatives 3 through 6, may be difficult to accomplish

because of the large amount of infiltration into the Aquifer during the wet seasons. Piezometric heads within Aquifer 1 will need to be carefully monitored in order to ensure that excessive pressure does not cause a breakdown of the IRM slurry wall.

9.2.5 Projected Costs

Present worth costs are used to evaluate and compare the estimated monetary value of each remedial alternative. Present worth costs are determined by summing the estimated capital costs and estimates of the discounted operation and maintenance (O&M) costs over the projected lifetime of the remedial alternative. Estimated present worth costs are based on a 30-year life of the remedial alternative using a discount rate of 5 percent. Table 17 gives a summary of costs for each of the evaluated alternatives.

The estimated capital costs for the IRM alternatives range from \$30,000 (monitoring only) to \$288,000,000 (excavation and incineration). The capital cost differential for the combination containment/treatment alternatives (IRM Alternatives 4 through 6) is only \$780,000.

The estimated capital costs for the BDA alternatives range from \$610,000 to \$5,960,000. The containment alternative has the lowest capital costs, and the treatment alternatives have the highest capital costs.

The estimated capital cost for the treatment alternative at the 4-Tek facility is \$1,300,000.

Alternatives that completely treat and/or destroy contaminants have the lowest O&M costs (IRM Alternative 7 and BDA Alternative 4). Alternatives that include groundwater monitoring and maintenance of containment features have the highest O&M costs.

9.3 Modifying Criteria

The modifying criteria are used in the final analysis of remedial alternatives and are generally considered in altering an otherwise viable alternative rather than deciding between very different alternatives. The two modifying criteria are state and community acceptance.

9.3.1 State Acceptance

Ecology has been involved with the development and review of the Remedial Investigation, Feasibility Study and Proposed Plan for the Site. Ecology's comments have resulted in substantive changes to these documents. Ecology has also been integrally involved in determining

TABLE 17
ESTIMATED COSTS FOR EVALUATED ALTERNATIVES

IRM AREA ALTERNATIVES

IRM Alternative 2

Capital cost	\$30,000
Operation and Maintenance (O & M)	\$640,000
Present Worth	\$9,900,000

IRM Alternative 3

Capital Cost	\$13,000,000
O & M	\$1,200,000
Present Worth	\$31,000,000

IRM Alternative 4

Capital Cost	\$16,120,000
O & M	\$1,800,000
Present Worth	\$43,000,000

IRM Alternative 5

Capital Cost	\$16,700,000
O & M	\$1,850,000
Present Worth	\$44,525,000

IRM Alternative 6

Capital Cost	\$24,800,000
O & M	\$1,760,000
Present Worth	\$54,230,000

IRM Alternative 7

Capital Cost	\$288,000,000
O & M	\$200,000
Present Worth	\$293,000,000

BDA ALTERNATIVES

BDA Alternative 2

Capital Cost	\$610,000
O & M	\$4,000
Present Worth	\$725,000

BDA Alternative 3

Capital Cost	\$2,040,000
O & M	0
Present Worth	\$2,040,000

BDA Alternative 4

Capital Cost	\$5,960,000
O & M	0
Present Worth	\$5,960,000

4-TEK ALTERNATIVE 2

Capital Cost	\$1,300,000
O & M	\$180,000
Present Worth	\$3,446,000

which cleanup standards will apply to contaminated soils and ground water under the Model Toxics Control Act. The state has commented that the Proposed Plan is acceptable given that the pump and treat element for Aquifer 2 remediation is contingent upon documentation that levels of contaminants decline once source control measures are in place. Ecology has also stated that treatability studies should be conducted on IRM soils to determine the effectiveness of vent wells.

9.3.2 Community Acceptance

EPA has carefully considered all comments submitted during the public comment period, and has taken them into account during the selection of the remedy for the QCF Site.

Members of the community are concerned about their ground-water quality, and the threat of Site-related contamination migrating into drinking water supplies. Community members are also concerned about the effect dust emissions, which may be created during remedial action construction activities, might have on the health and safety of the surrounding community.

EPA responses to comments received during the public comment period are included in the attached Responsiveness Summary.

10.0 SELECTED REMEDY

Based on CERCLA, the NCP, the administrative record, and the comparative analysis of alternatives, EPA has selected a comprehensive Site-wide remedy which combines the elements of IRM Alternative 5, BDA Alternative 3, and 4-Tek Alternative 2. The selected remedy includes the following:

For the IRM Area and Associated Ground-Water Contamination:

- Isolation of contaminated soils by construction of a vertical barrier system/slurry wall around the IRM.
- Dewatering, treatment and off-site discharge of the water within the IRM.
- Contingent extraction of Aquifer 1 ground water outside the IRM. Treatment, and on-site discharge of treated ground water to the Main Gravel Pit Lake or equivalent surface water body.
- Removal and off-site incineration of LNAPL from within, and adjacent to, the IRM.
- Contingent venting of IRM soils. The effectiveness of venting will be determined by treatability studies to be conducted during remedial design..
- Contingent extraction of contaminated Aquifer 2 ground water in order to remove volatile organic contamination. Volatiles would most likely be removed by recirculation through the Main Gravel Pit Lake, or equivalent surface water body. Should the extracted volatile organic contamination exceed action levels, then the ground water may be treated via air stripping, or best available technology, prior to discharge to the Main Gravel Pit Lake or equivalent surface water body.

For the BDA:

- Excavation of approximately 10,000 cubic yards of soil and debris from the BDA. Off-site treatment and disposal of the soils with high levels of contamination at a permitted hazardous waste landfill. On-site or off-site treatment of debris prior to recycling, or disposal of debris at an off-site solid waste or hazardous waste landfill. Placement of soil with low levels of contamination below an extension of the existing IRM cap. Backfilling of the uncontaminated soil.
- Construction of a surface water diversion system, to prevent infiltration of water into the IRM/BDA cap.

For 4-Tek Industries:

- Sampling and analysis of the shallow ground-water zone, and Aquifer 2, at the 4-Tek facility twice per year for 5 years. Should contamination be found above cleanup levels, then the ground water may be extracted and treated on site. Treated ground water would be discharged to the Main Gravel Pit Lake or equivalent on-site surface water body.

Site-Wide Actions:

- Deed restrictions and institutional controls on land and ground-water use.
- Long-term ground-water and surface water monitoring.

Off-Site Areas

- Long-term monitoring of private drinking water wells, with a contingency for providing an alternative water supply, should site-related contaminants exceed action levels.
- Continued long-term monitoring of surface water and ground-water in the southern portion of the Cedar Hills Landfill.

10.1 IRM AREA AND ASSOCIATED GROUND-WATER CONTAMINATION

10.1.1 VERTICAL BARRIER SYSTEM

A vertical barrier system, such as a slurry wall, will be installed on a circumferential alignment that will enclose the IRM area. The primary objective of the barrier wall shall be to contain the contaminated soils within the IRM for a minimum of thirty years. The following performance standards shall apply to the design and construction of the barrier wall:

- The barrier wall will be designed and constructed to have a maximum permeability of 1×10^{-7} cm/sec.
- The barrier wall shall be stable and resistant to degradation from hydraulic permeation of the wall and from adjacent ground-water movement. The barrier wall should remain effective in preventing ground-water flow from accumulating within the barrier for a minimum of 30 years.
- The barrier wall shall maintain integrity and be physically stable under environmental loading conditions, such as settlement during seismic loading, and/or dewatering of the interior formation.

- The barrier wall shall retain long-term physical integrity during possible chemical alteration resulting from the quality of permeating ground water, and chemical constituents in the soil, and ground water which is incorporated into the backfill material.

10.1.2 DEWATERING OF IRM

Extraction of ground water from within the IRM area barrier system will be implemented upon completion of construction of the slurry/bentonite wall. The objective of the dewatering will be to prevent the eventual discharge of the IRM ground water through the Aquifer 1 aquitard system into Aquifer 2.

Short-term dewatering via extraction wells will be implemented immediately upon completion of construction of the barrier wall to remove and treat the ground water contained within the barrier system. The most efficient pumping rates for the extraction wells shall be determined based on an evaluation of aquifer response to actual pumping conditions. Treatment of ground water from short-term dewatering shall be accomplished using an on-site ground-water treatment system which may consist of oil/water separation, filtration, air stripping, and carbon adsorption. Offgas treatment of treatment residuals will be conducted, if necessary.

Long-term dewatering shall be implemented via extraction wells to further control the mobility of residual contaminants within the barrier system through recovery of any leakage into the system. Extracted water will be treated on-site and probably discharged to a POTW, or treated to meet Washington State water quality discharge standards prior to being discharged to surface water. Ground water treatment will be accomplished using a permanent on-site ground-water treatment system which may consist of oil/water separation, precipitation, filtration, and carbon adsorption.

Performance standards for the ground-water treatment systems will be established during remedial design in coordination with the POTW and will comply with current pretreatment standards and requirements. Air stripper offgas will be treated, if necessary, to meet federal and state ambient air discharge requirements.

10.1.3 CONTINGENT EXTRACTION AND TREATMENT OF AQUIFER 1 GROUND WATER OUTSIDE BARRIER SYSTEM

Established cleanup levels for Aquifer 1 are shown in Table 18. Aquifer 1 samples taken from outside the IRM area, have revealed only volatile organic contamination (VOC) above these established cleanup levels. While the RME cancer and non-cancer risks for the future residential scenario are above EPA's acceptable risk range for inhalation of volatile organics from Aquifer 1, it is not expected that Aquifer 1 will ever be used as a potable water source, due to it's limited volume and areal

TABLE 18
CLEANUP LEVELS FOR AQUIFER 1 GROUND WATER

The following cleanup levels have been established for Aquifer 1 ground water outside the IRM vertical barrier system. Aquifer 1 is not a drinking water source, however these established concentrations will be protective of Aquifer 2. These cleanup levels will also apply to the shallow ground-water zone at the 4-Tek facility.

<u>HAZARDOUS SUBSTANCE</u>	<u>CONCENTRATION ($\mu\text{g/l}$)</u>	<u>RISK LEVEL</u>
Chromium (total)	80	HI = 1. (non-cancer)
PCBs (total)	.01 ^a	1 X 10 ⁻⁶ (cancer)
Carcinogenic PAHs	.01 ^a	1 X 10 ⁻⁶
Tetrachloroethylene (PCE, PERC)	1	1 X 10 ⁻⁶ (cancer)
1,1-Trichloroethene (TCE)	5	1 X 10 ⁻⁶ (cancer)
1,2-Dichloroethene (cis) (DCE)	70	HI = 0.2 (non-cancer)
1,2-Dichloroethene (trans) (DCE)	100	HI = 0.1 (non-cancer)
Vinyl chloride	.02 ^a	1 X 10 ⁻⁶ (cancer)

For all other hazardous substances detected in Aquifer 1 and in the 4-Tek shallow ground-water zone, the cumulative cancer risks must not exceed 1 X 10⁻⁵, and the non-cancer risks must not exceed a HI = 1.0.

NOTE: Aquifer 1 will be dewatered inside the vertical barrier system.

$\mu\text{g/l}$ = micrograms per liter
HI = Hazard Index

a = These levels may be below the Practical Quantitation Limit. The decision to terminate remediation of Aquifer 1 will be made by EPA in consultation with Ecology and will depend on (1) expert knowledge of the ground water system at the QCF Site; (2) an understanding of how the method of treatment affects ground water flows and contamination levels at the Site; and (3) statistical results from monitoring wells from which levels of contamination can be extrapolated.

extent. However, Aquifer 1 recharges Aquifer 2, which is used off-site as a potable water source.

Once the barrier wall is constructed, it is expected that the source of contamination to Aquifer 1 will be isolated. Based on the conceptual hydrogeologic model of the QCF Site, the Aquifer 1 ground water, which is outside of the barrier wall, is expected to discharge to springs along the gravel pit face in the central portion of the Site, or to Aquifer 2. Due to isolation of the contaminant source, and volatilization of contaminants through springs, it is expected that VOC contaminant levels in Aquifer 1 will decrease to below cleanup levels within 5 years after completion of the IRM vertical barrier system.

Aquifer 1 contaminant levels will be monitored on a quarterly basis. Three years after completion of the IRM barrier wall system, a statistical trend analysis will be performed on the quarterly monitoring data. If this analysis reveals that the trend in contaminant concentrations within Aquifer 1 will not achieve the risk-based goal within 5 years after construction of the IRM vertical barrier system, then extraction and treatment of Aquifer 1 ground water may be implemented. The remedial action risk-based goal for Aquifer 1 is a total risk not to exceed 1×10^{-5} for carcinogens, and a hazard index not to exceed 1.0 for non-carcinogens. This risk-based goal for Aquifer 1 is the same as the risk-based goal for Aquifer 2, and therefore, it will be protective of Aquifer 2.

Extraction, if needed, will occur at the locations and rates which will be appropriate to achieve the remedial action goal. Extracted ground water will be treated on-site using air stripping or the best available technology. Air stripper offgas treatment such as thermal oxidation will be implemented, if necessary, to meet federal and state ambient air discharge requirements. Treated ground water will be discharged on-site to the Main Gravel Pit Lake, or to an equivalent on-site surface water body that directly recharges Aquifer 2.

10.1.4 LNAPL RECOVERY/REMOVAL

LNAPL currently serves as a source of contamination to soils and ground water at the QCF Site. The remedial action goal of this element of the remedy is the immobilization of the LNAPL source.

LNAPL removal measures will begin prior to construction of the barrier system. Selection of the appropriate options and implementation program for LNAPL removal will be made during remedial design. Additional Site characterization and pilot testing during remedial design will determine the estimate of recoverable LNAPL, recovery rates, and duration of recovery. LNAPL removal measures will continue until LNAPL within the barrier system is sufficiently controlled to limit or prevent

downward contaminant migration through the Aquifer 1 aquitard system, once ground water is withdrawn from within the barrier system.

10.1.5 VENTING OF IRM SOILS

The remedial action objective of this element of the remedy is volume reduction of the mobile contaminants within the IRM soils. This element of the selected remedy, if implemented, should provide an additional measure of protection at a minimal cost. Upon completion of the barrier system, on-site treatability tests will be performed to determine if the IRM soils are suitable for contaminant removal via venting. If feasible, vent wells will be drilled through the IRM cap to the unsaturated soils. The wells will be designed such that precipitation will be prevented from entering the vents. The vents will be monitored for offgas, and if necessary, the offgas will be treated to meet federal and state ambient air quality requirements. If venting of IRM soils is not feasible, the additional IRM source control, source removal, and treatment measures outlined in the selected remedy should be adequately protective.

10.1.6 AQUIFER 2 EXTRACTION AND TREATMENT

The primary remedial action objective of this element of the remedy is the on-site containment of the Aquifer 2 TCE and DCE plume. The short-term remedial action objective for this element is a reduction in the size of the Aquifer 2 plume. A long-term goal of the remedial action is restoration of Aquifer 2 to its beneficial use.

The boundary of the Aquifer 2 TCE and DCE contaminant plume reaches as close as 200 feet from the Site boundary to the south, and may extend across the northern Site boundary on to the Cedar Hills Landfill. Aquifer 2 serves as a drinking water source for residences south and southwest of the QCF Site. Future on-site residential and occupational cancer risks associated with ingestion of Aquifer 2 ground water were within EPA's acceptable risk range; however, future on-site residential risks associated with inhalation of Aquifer 2 ground-water are at the 1×10^{-4} risk level for the RME case. The Washington State Model Toxics Control Act defines the maximum acceptable excess cancer risk under state law as a total risk of 1×10^{-5} .

The Washington State Model Toxics Control Act, WAC 173-340, allows establishment of a "point of compliance" where established ground-water cleanup levels must be attained, WAC 173-340-720. Established cleanup levels for Aquifer 2 are shown in Table 19. The ground-water cleanup levels must be attained in all ground waters from the point of compliance to the outer boundary of the plume. Where hazardous substances remain on-site as part of the clean-up action, a "conditional point of compliance" can be

TABLE 19
CLEANUP LEVELS FOR AQUIFER 2 GROUND WATER

The following long-term cleanup levels have been established for Aquifer 2 ground water throughout the QCF Site. These cleanup levels have been established in order to achieve the cleanup goal of restoration of Aquifer 2 for future use. They are either the more stringent of levels established under the MTCA Method B or the MCLs and non-zero MCLGs.

HAZARDOUS SUBSTANCE	CONCENTRATION $\mu\text{g/l}$	BASIS	RISK LEVEL
Tetrachloroethene (PCE, PERC)	1.0	MTCA	1×10^{-6}
Trichloroethene (TCE)	5.0	MCL	2×10^{-6}
1,2-Dichloroethene (cis)	70	MCLG	HI = 0.2
1,2-Dichloroethene (trans)	100	MCLG	HI = 0.1
Vinyl chloride	0.02 ^a	MTCA	1×10^{-6}

$\mu\text{g/l}$ = micrograms per liter
HI = Hazard Index

a = These levels may be below the Practical Quantitation Limit. The decision to terminate remediation of Aquifer 1 will be made by EPA in consultation with Ecology and will depend on (1) expert knowledge of the ground water system at the QCF Site; (2) an understanding of how the method of treatment affects ground water flows and contamination levels at the Site; and (3) statistical results from monitoring wells from which levels of contamination can be extrapolated.

established which must be as close as practicable to the source of the contamination. For Aquifer 2 ground-water at the QCF Site the conditional point of compliance will be no greater than the circumference defined by the boundaries of the IRM vertical barrier system (Figure 17). Cleanup levels from the conditional point of compliance to the outer boundary of the plume shall be 5.0 $\mu\text{g/l}$ for TCE and 70 $\mu\text{g/l}$ for cis-1,2-DCE. These cleanup levels are the Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act, 40 C.F.R. 141, and are acceptable cleanup levels under the Model Toxics Control Act Method B, WAC 173-340-720.

In order to achieve the cleanup objectives established for Aquifer 2 ground water, the following contingent remedial action will be implemented:

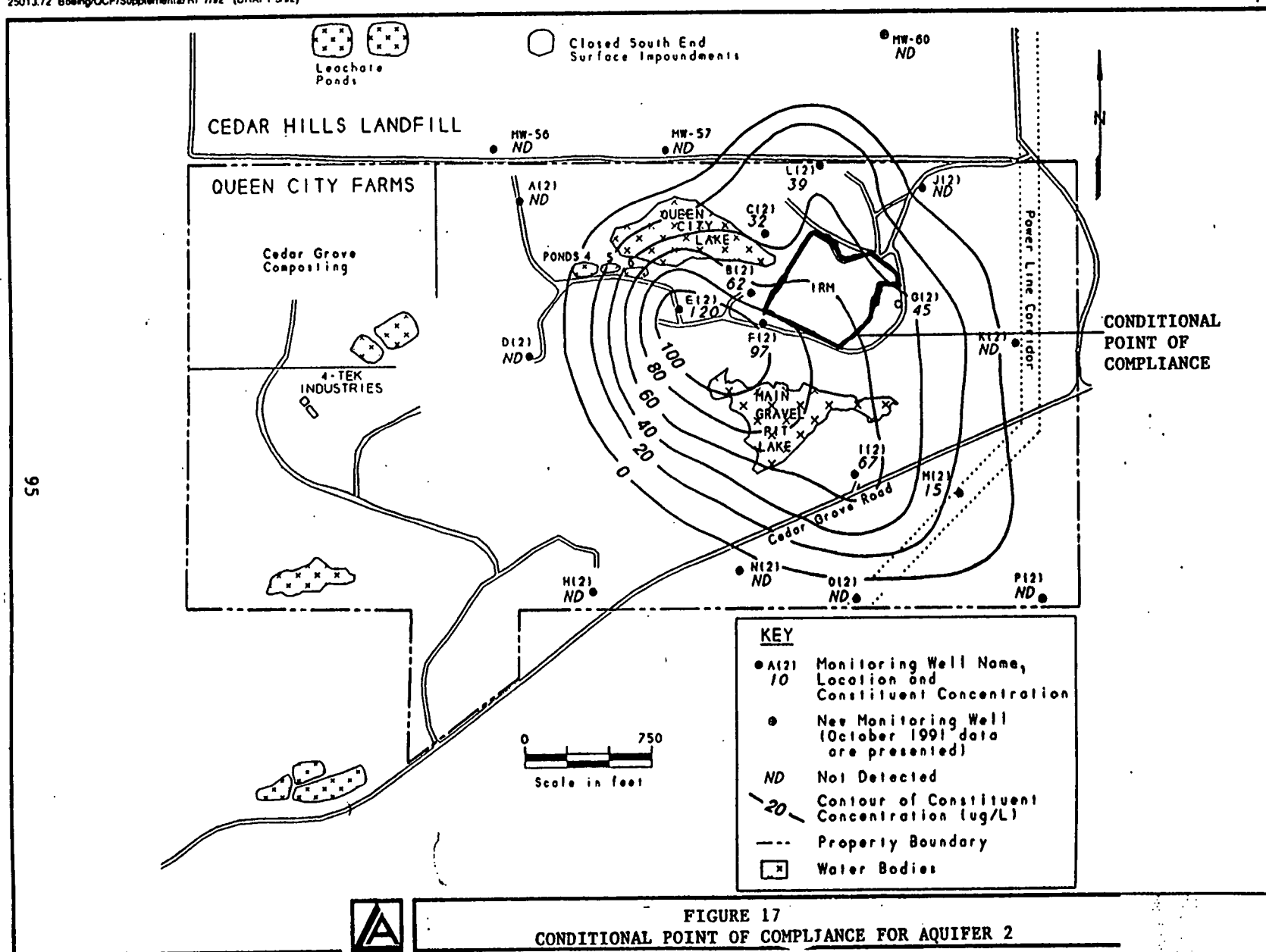
Three years after construction of the IRM vertical barrier system, an historical and statistical analysis of Aquifer 2 contaminant concentrations will be conducted. If this analysis indicates that contaminant concentrations in Aquifer 2 are not likely to decline to cleanup levels within 10 years after construction of the vertical barrier system, ground-water extraction shall be implemented. The determination as to whether Aquifer 2 cleanup levels are achievable within the required time frame will be made by EPA, in consultation with Ecology.

If at any time in the future plume expansion is detected, ground water extraction will be implemented immediately to reduce the size of the plume. The determination of plume expansion will be made by EPA, in consultation with Ecology, and will depend on, (1) expert knowledge of the ground water system at the QCF Site, and (2) statistical results from monitoring wells from which levels of contamination can be measured.

To reduce the time needed to install a ground-water extraction system, the needed technical data and information shall be gathered, and the design plan drafted, during the general site remedial design phase.

Ground-water extraction, if necessary, will occur for an estimated period of 10 years, during which time the extraction system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications to the ground-water extraction system may include any or all of the following:

- a) at individual wells where cleanup goals have been attained, pumping may be discontinued;
- b) alternating pumping at wells to eliminate stagnation points,



c) pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into ground water; and,

d) installation of additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

To ensure maintenance of cleanup levels, Aquifer 2 will be monitored yearly, for a minimum period of 30 years, at those wells where pumping has ceased.

Treatability studies will be conducted to determine if the extracted ground-water is suitable for treatment via air stripping or using best available technology. If the ground water is suitable for treatment, then treatment via air stripping or best available technology will be implemented. Extracted and treated Aquifer 2 ground water will be discharged on-site to the Main Gravel Pit Lake, or to an equivalent surface water body. Contaminant levels in ground water which will be discharged shall not exceed cleanup levels. The requirement for treatability studies prior to implementation will be consistent with the Model Toxics Control Act requirement to provide "all known available and reasonable methods of treatment" (AKART) prior to discharge to state waters.

10.2 BURIED DRUM AREA

10.2.1 BDA EXCAVATION/OFFSITE TREATMENT/DISPOSAL/ONSITE CONSOLIDATION

The remedial action objectives of this element of the remedy are to permanently remove and treat the BDA debris, and permanently control the mobility of any residual contaminants remaining after excavation and removal of the primary debris source.

The Remedial Investigation has identified a discrete layer of drum debris and directly associated soil materials which may have contaminant levels above the State of Washington Dangerous Waste Designation levels, WAC 173-303-70 et. seq., set under the Washington State Hazardous Waste Management Act, RCW 70.105. This layer is variable in thickness and is located within 10-12 ft of the existing surface grade. This material, estimated to be about 100 yd³, will be removed and segregated for subsequent off-site treatment. An estimated 6,000 yd³ of clean soil located above the drum debris, will be excavated and stockpiled on Site. Approximately 4,000 yd³ of soil associated with, and directly below the drum debris layer, may have contaminant concentrations below State Dangerous Waste designation levels, but above cleanup levels established under the Washington State Model Toxics Control Act Method B, WAC 173-340-740 (Table 20). This soil will

TABLE 20
CLEANUP LEVELS FOR BDA SOIL LEFT IN PLACE

Hazardous substances in BDA soils which are left in place must be below the following concentrations levels. These concentrations are based upon the MTCA Human Health Risk Based Formula Values, October 7, 1992:

HAZARDOUS SUBSTANCE	CONCENTRATION (mg/kg)
Arsenic	20 ^{a1}
Cadmium	40
Chromium	400
Lead	250 ^{a2}
PCBs (total)	1.0 ^{a3}
PAHs (carcinogenic)	1.0 ^{a3}

a = Taken from Method A cleanup levels as described in "Model Toxics Control Act Cleanup Regulation, Chapter 173-340-WAC".

- 1 = background
- 2 = no Method B value available
- 3 = practical quantitation limit

be consolidated on-site beneath an integral IRM area cap and incorporated within the boundary of the barrier wall. Prior to backfilling, confirmatory soil samples will be taken. The 6,000 yd³ of excavated clean soil will be placed into the excavation as backfill, and additional clean soil/fill added as needed, to match the surrounding topography.

Fugitive dust or volatile emissions during excavation activities are not anticipated to be above health-based levels, because of the limited volatility of the contaminants in the BDA, and the anticipated moist nature of the soil. Worker protection requirements will be developed during remedial design.

The drum debris and directly associated contaminated soil will be treated prior to disposal. After treatment, the contaminated soil and drum debris will be disposed at an off-site solid waste or hazardous waste landfill. If feasible, the drum debris may be recycled.

A test burn may be necessary to verify acceptability of the excavated material for the incineration facility. This requirement will be identified during remedial design.

10.2.2 IRM/BDA SURFACE WATER DRAINAGE SYSTEM

The existing surface water drainage system will be extended to convey direct precipitation and upgradient surface runoff from the IRM/BDA cap expansion area. This runoff will be directed to Queen City Lake, as is the runoff from the existing cap.

10.3 4-TEK INDUSTRIES

A previous removal action has removed the suspected source of VOC contamination at the 4-Tek facility. However, residual VOC contamination above cleanup levels has been detected in shallow ground water. The goal of this element of the remedial action is to confirm that residual contamination from 4-Tek has not migrated and contaminated Aquifer 2; and to ensure that if any 4-Tek-related contamination has reached Aquifer 2, it is remediated to cleanup levels.

The shallow ground-water zone, in addition to Aquifer 2 at the 4-Tek facility will be monitored at least twice per year for a minimum of 5 years. If VOC contamination is detected above cleanup levels, and if EPA, in consultation with Ecology, determines that the number of detections are statistically significant, an extraction and treatment remedy may be implemented to contain and, if necessary, reduce the VOC plume. The cleanup levels for this element of the remedy are shown in Table 18.

Ground-water monitoring will commence during remedial design. The ground-water extraction system will be designed as

expeditiously as possible, once it is determined that extraction and treatment are necessary.

10.4 SITE-WIDE ACTIONS

10.4.1 DEED RESTRICTIONS AND INSTITUTIONAL CONTROLS

The existing deed restriction required by an EPA Consent Order (Docket No. 1085-10-12-106), will be maintained. This deed restriction is intended to notify any potential purchaser of the IRM area property that the land has been used to manage hazardous waste and that its use is restricted.

The deed restrictions will be expanded to require ground-water use restrictions, and maintenance and protection of the ground-water monitoring facilities. Use of on-site untreated ground water from Aquifers 1 and 2 will be restricted until cleanup goals for the QCF Site are achieved.

The deed restricting Site use will be amended further to restrict land use in the remainder of the IRM area which would include the portion of this area outside of the existing fence line. The security fence currently surrounding the IRM cap area will be extended to include the expanded IRM area and the BDA. Surface water springs, whose water source is Aquifer 1, will be fenced where feasible. The fenced areas will be posted with warning signs. The fence and signs will be maintained during the life of the remedy.

10.4.2 LONG-TERM MONITORING

Long-term on-site surface water and ground-water monitoring shall be implemented to provide an ongoing assessment of water quality. A surface water and ground-water monitoring plan shall be submitted for EPA and Ecology approval during remedial design. At a minimum, the monitoring program shall include, semi-annual sampling of Aquifer 1, Aquifer 2, and Aquifer 3 wells, surface water springs whose source is Aquifer 1, and all on-site surface water lakes and streams which flow off Site.

The monitoring program shall be conducted for a minimum of 30 years after cleanup goals are achieved.

10.4.3 CERCLA FIVE YEAR REVIEW

CERCLA mandates a 5-Year Review for remedial actions that leave contaminants at the site. This review is required at least once every five years to ensure protection of human health and the environment. The five-year review is necessary for all of the above elements of the selected remedy.

10.5 OFF-SITE AREAS

10.5.1 MONITORING OF OFF-SITE DRINKING WATER WELLS

Off-site drinking water wells will be monitored at least annually, for a minimum of 15 years. The off-site drinking water well monitoring program will be a voluntary program for community residents adjacent to the QCF Site. The goal of this element of the remedy is to ensure that site-related contaminants are not migrating into drinking water supplies.

If Site-related contamination above cleanup levels is detected in off-site drinking water wells, an alternate source of water supply may need to be provided for those affected community residents. EPA in cooperation with Ecology and SKCDPH will determine whether an alternate water supply is warranted based upon an analysis of historical on-site and off-site sampling data.

10.5.2 MONITORING OF CEDAR HILLS LANDFILL

A CERCLA Section 106, 42 U.S.C. §9606, Consent Order (EPA Docket No. 1088-01-05-106-A) agreed upon by EPA and King County, requires continual long-term surface water and ground-water monitoring of the southern portion of Cedar Hills Landfill. The goal of this monitoring program is to ensure that surface water and ground-water quality and flows from the Cedar Hills Landfill do not impact the remedial action at the QCF Site. In addition, ground-water quality is being monitored at the Cedar Hills Landfill to ensure that Site-related contaminants are not migrating to the landfill.

11.0 REMEDIAL ACTION OBJECTIVES

Risks due to the QCF Site will be managed or mitigated through a number of source control, removal, and treatment methods. In addition, long-term monitoring and institutional controls will be implemented to prevent exposure to on-site contaminated media.

The remedial action goals for the QCF Site are:

For soils:

- Prevention of exposure to contaminated surface and subsurface soils.
- Prevention of migration of contaminants in subsurface IRM and Buried Drum Area soils to ground water.
- Reduction of contaminant concentrations in subsurface IRM and Buried Drum Area soils.

For ground water:

- Prevention of exposure to contaminated ground water.
- Prevention of migration of the contaminant plume.
- Restoration of ground water for future use.

The following source control actions should achieve the remedial action goals for soils and ground water:

- Construction of a vertical barrier system around the IRM should prevent migration of contaminants in subsurface soil to ground water. In addition, the vertical barrier system should aid in the restoration of Aquifer 1 outside the slurry wall by minimizing migration of contamination from within the IRM.
- Placement of BDA soils with low-levels of contamination below an expansion of the existing IRM cap should prevent exposure to contaminated surface and subsurface soils. Cleanup levels for BDA soils remaining in-place are shown in Table 18. These cleanup levels are based on the MTCA Method B and are protective of ground water.

The following removal and treatment methods will achieve the established remedial action goals for soils and ground water:

For the IRM area:

- Removal of LNAPL will mitigate a source of ground water contamination and therefore help prevent migration of contaminants to Aquifer 2.
- Dewatering and treatment of Aquifer 1 within the IRM will minimize an additional source of contamination to Aquifer 2. Cleanup levels for Aquifer 1 outside the vertical barrier system are shown in Table 18. These cleanup levels are protective of Aquifer 2.

- Venting of IRM soils, if implemented, will remove mobile contaminants and reduce the concentrations of contaminants remaining in the IRM soils.

For the BDA:

- Removal and off-site treatment of soil and debris will prevent on-site exposure to contaminated soils, and reduce the levels of soil contaminants remaining on-site.

For Aquifer 1 and the shallow ground-water zone at 4-Tek:

- Contaminants within Aquifer 1 outside the IRM vertical barrier system are expected to decrease, once the source control measures are in place. Contingent extraction and treatment will ensure reduction of the levels of contaminants in the shallower ground water, and therefore prevent migration of contaminants to Aquifer 2. The cleanup levels shown in Table 18 pertain to shallow ground water throughout the Site, which is not used for drinking water. These cleanup levels will be protective of Aquifer 2.

For Aquifer 2:

- Contaminants within Aquifer 2 are also expected to decrease, once the source control measures are in place. Contingent extraction and treatment will ensure containment of potential future migration of contaminants, and aid in the restoration of Aquifer 2 for future use. Cleanup levels for Aquifer 2 are shown in Table 19. Aquifer 2 is used off-site as a source of drinking water. The cleanup levels are protective of drinking water.

Institutional controls and long-term monitoring of surface water, shallow ground water, and Aquifers 1, 2, and 3 will ensure prevention of future exposure to contaminated media remaining on-site.

12.0 STATUTORY DETERMINATIONS

Under CERCLA, EPA's primary responsibility is to ensure remedial actions are undertaken which protect human health, welfare, and the environment. In addition, Section 121 of CERCLA, 42 U.S.C. §9621, establishes cleanup standards which require that the selected remedial action complies with all ARARs established under federal and state environmental law, unless such requirements are waived by EPA in accordance with established criteria. The selected remedy must also be cost-effective and must utilize permanent solutions, alternative treatment technologies, or resource recovery technologies to the maximum extent practicable. Finally, CERCLA regulations include a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous waste. The following sections discuss how the selected remedy for the QCF Site meets these CERCLA requirements.

12.1 Protection of Human Health and the Environment

The selected remedy combines a number of containment, treatment and monitoring measures which are designed to be protective of human health and the environment.

Containment of primary source areas will be accomplished through isolation of the IRM and BDA areas. This measure will minimize or eliminate migration of contaminants to Aquifer 1, as well as migration from Aquifer 1 to surface water, and to Aquifer 2. Much of the primary contaminant source was previously removed during construction of the IRM in 1985 and 1986.

Principal sources of contamination such as LNAPL, contaminated ground water within the IRM area, and contaminated IRM and BDA soil and debris will be reduced or eliminated through a number of remedial actions. LNAPL will be recovered and incinerated off-site. The IRM area will be dewatered, and the extracted water treated and disposed off-site. BDA debris and highly contaminated soil will be removed and treated off-site. Some mobile contaminants in IRM soils may be removed via venting of the soils.

Prevention of migration of contaminants, and restoration of ground water will be accomplished via the source containment and treatment measures described above. In addition there may be short-term and long-term ground-water extraction and treatment, if necessary.

Institutional controls will further the measures described above by protecting the IRM cap, vertical barrier system, ground-water extraction and treatment systems, and controlling land and ground-water uses.

Additional protection will be provided by the long-term surface water and ground-water monitoring programs for the Cedar Hills Landfill and for off-site drinking water wells.

Implementation of the selected remedy will involve extensive excavation of soils, and may result in some potential for air emissions and additional short-term risks. Short-term risks will be minimized to the maximum extent practicable. It is expected that dust emissions from excavation activities can be controlled to acceptable levels through the use of dust suppressants. No adverse cross-media impacts are anticipated.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The selected remedy will comply with all ARARs that have been identified. No waiver of any ARAR is being sought or invoked for any component of the selected remedy. The ARARs identified for the QCF Site include, but are not limited to, the following:

Chemical-Specific ARARs

Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that establish the acceptable amount or concentration of a chemical in the ambient environment. Following are the chemical-specific requirements for the QCF Site:

1. Washington State Model Toxics Control Act, RCW 70.105D, (MTCA) Method B Soil Cleanup Standards, WAC 173-340-740.

These regulations are applicable for soils which will remain in the BDA.

2. SDWA MCLs and MCLGs, 40 C.F.R. Part 141; SDWA Secondary MCLs, 40 C.F.R. Part 143.

Applicable for off-property drinking water supplies, if these wells are community wells that serve more than two residences. Relevant and appropriate for remedial action goals for Aquifer 2 extraction and treatment, and for all other off-site drinking water wells.

3. MTCA Method B Ground Water Cleanup Standards, WAC 173-340-720.

Applicable for remedial action goals for on-site shallow ground water, Aquifer 1 and Aquifer 2.

Location-Specific ARARs

Location-specific requirements are restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of the Site.

1. Executive Order 11988, Statement of Procedures on Floodplain Management and Wetlands Protection, Appendix A to 40 C.F.R. Part 6.

The selected remedy is not expected to have an impact on wetlands at the Site. However, this requirement is **relevant and appropriate** to remedial actions which may affect on-site surface water such as Queen City Lake.

Action-Specific ARARs

Action-specific ARARs are technology- or activity based controls or restrictions on activities related to management of hazardous wastes. These requirements are triggered by the particular remedial activities selected to cleanup the Site.

1. TSCA PCB Disposal regulations, 40 C.F.R. § 761.60; TSCA Chemical Waste Landfill regulations, 40 C.F.R. § 761.75.

These regulations are **applicable** for PCB-contaminated materials that are disposed off-site. **Relevant and appropriate** for PCB contaminated soils and LNAPL from the IRM area and BDA which will be treated and disposed of in a manner consistent with these requirements.

2. RCRA Land Disposal Treatment Standards, 40 C.F.R. Part 268, Subpart D; RCRA Transportation regulations, 40 C.F.R. Part 263.

The LNAPL recovered from the IRM area, and the excavated and treated soils and debris from the BDA, will be analyzed to determine whether or not they exhibit RCRA hazardous waste characteristics. If the LNAPL, soils or debris are RCRA hazardous waste then the above ARARs may be **applicable**.

3. Washington State Hazardous Waste Management Act, RCW 70.105 and WAC 173-303.

These regulations are **relevant and appropriate** for the management of hazardous wastes associated with the IRM, BDA and 4-Tek facility.

4. Washington State Minimum Functional Standards (MFS) for Solid Waste Handling, RCW 70.95 and WAC 173-304.

This is the state statute governing solid waste management. This regulation is relevant and appropriate for capping, surface water controls and ground-water monitoring actions which will be consistent with substantive MFS requirements.

5. CWA Ambient Water Quality Criteria, 40 C.F.R. Part 131; POTW Discharge Requirements 40 C.F.R. Part 403.

WPCA Surface Water Quality Standards, WAC 173-201; WPCA Waste Discharge Program, WAC 173-216; WPCA NPDES Permit Program, WAC 173-220; Construction of Wastewater Facilities, WAC 173-240.

These regulations are applicable for Aquifer 1 and Aquifer 2 ground-water treatment systems which will be designed to meet these requirements. Treated ground-water will be discharged in a manner which complies with the substantive requirements of the above-mentioned ARARs.

6. CAA National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50; CAA National Emissions Standards for Hazardous Air Pollutants, 40 C.F.R. 60; CAA New Source Performance Standards, 40 C.F.R. 61.

WCAA Volatile Emissions Standards, WAC 173-460; WCAA Controls for New Sources, WAC 173-490; Puget Sound Air Pollution Control Agency (PSAPCA) Regulation III.

These regulations are applicable for on-site air emissions from ground-water and soils treatment systems. PSAPCA is a regional agency which was created by the Washington Clean Air Act. Regulation III controls and regulates new sources of air emissions. Coordination with PSAPCA will ensure compliance with above ARARs.

7. Occupational Safety and Health Act (OSHA), 29 U.S.C. 651; the implementing regulations under OSHA, 20 C.F.R. Parts 1910 and 1926; and the Washington Industrial Safety and Health Act, RCW 49.17.

These regulations are applicable for all construction activities related to the selected remedy.

Policy, Guidance and Regulations To-Be-Considered

- Additional policies, guidance and other laws and regulations to be considered for source control and remedial actions

include, but are not necessarily limited to the TSCA PCB Spill Cleanup Policy, 40 C.F.R. 761.120; the Guidance on Selecting Remedies at Superfund sites with PCB Contamination; the Washington State Water Well Construction Minimum Standards for Construction, RCW 18.104 and WAC 173-160; and, EPA's Off-Site Disposal Policy.

The PCB Spill Cleanup Policy provides guidance on recommended cleanup levels under certain access scenarios. The Superfund PCB Guidance recommends cap designs which are consistent with RCRA guidance, as well as specifying long-term management controls.

The Washington State Water Well Construction regulations specify minimal requirements for the design and construction of ground-water wells.

EPA's Off-Site Disposal Policy describes procedures that should be implemented when a response action under CERCLA involves off-site storage, treatment or disposal of hazardous substances.

12.3 Cost Effectiveness

EPA believes that the combination of remedial actions identified as the selected remedy will reduce or eliminate the risks to human health and the environment in a cost-effective manner. A potentially costly element of the selected remedy is extraction and treatment of Aquifer 2 ground water. However, this element won't be required unless less aggressive measures are not effective. The level of protectiveness afforded by this element of the selected remedy justifies any potential increase in cost. Performance of this element of the selected remedy will be monitored, and costs can be controlled by the measures outlined in Section 10.1.6 of the ROD.

By tailoring the remedy so that removal and any necessary treatment are applied to major source areas and ground water, and containment is used for large volumes of contaminated soils, the selected remedy provides an appropriate level of protection for each area of the Site, and for potential off-site receptors.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Among the alternatives which are protective of human health and comply with ARARs, the selected remedy provides the best balance of long-term effectiveness and permanence; reduction of toxicity, mobility, volume and persistence; short-term effectiveness; implementability; and cost. The selected

remedy considers the statutory preference for treatment as a principal element, and considers state and community acceptance.

Excavation and incineration of IRM soils would be fully protective and comply with ARARs; however, the short-term risks, difficulties with implementation, and the cost associated with excavation of the highly contaminated soils and LNAPL do not justify selection of this alternative. Soil vapor extraction (SVE) is an innovative technology which may not be an appropriate technology for the soil types at the QCF Site. SVE would be difficult to implement because of the nature of the contaminated soils and ground water associated with the IRM.

All of the evaluated alternatives, with the exception of IRM monitoring and institutional controls, would create some level of short-term risk during the period in which construction occurs. The short-term risks are primarily those associated with dust and air emissions resulting from excavated soil, debris handling and off-site disposal. Ground-water extraction and treatment would have minimal short-term risks from air emissions during construction and testing of the extraction, treatment and disposal systems. These risks will be minimized by control of air emissions during construction and operation of the treatment systems.

Institutional controls and monitoring alone are not permanent remedies, because they do nothing to reduce the levels of contaminants remaining on the Site. It is not known how long it would take natural dilution to reduce ground-water contamination to cleanup levels.

A vertical barrier wall and cap around the IRM and BDA, without treatment, would reduce the mobility of contaminants, but high concentrations of contaminants would still persist. The potential for future migration of contaminants due to failure of the barrier wall, or long-term fluctuations of the water levels would still remain.

All of the alternatives can be implemented with varying degrees of difficulty. Excavation, incineration and off-site disposal would require extensive materials handling. Treatability testing would be necessary before a venting or soil vapor extraction system could be designed which would effectively remove contaminants from the IRM soils. Before LNAPL removal could be implemented, pilot testing would be necessary to determine the most cost effective method to remove the oily layer. Construction of the vertical barrier wall would be complex, because it requires extensive coordination of construction activities.

The selected remedy employs a combination of treatment and containment of soils and ground water in a cost-effective manner to reduce contaminant volume, mobility, and toxicity.

12.5 Preference for Treatment as a Principal Element

Treatment of LNAPL, BDA soils, and Aquifer 1 and contingent treatment of Aquifer 2 water will satisfy the CERCLA preference for treatment of principal threats.. The selected remedy incorporates a number of treatment elements which are designed to reduce or eliminate the major sources of ground-water contamination at the QCF Site.

13.0 DOCUMENTATION OF SIGNIFICANT DIFFERENCES

Subsequent to issuing the Proposed Plan, EPA reviewed public comments. In response, EPA clarified the remedial action (cleanup) goals for soils; clarified the proposed venting of IRM soils; re-evaluated the ground-water extraction and treatment remedial element for Aquifer 2; and, provided more detail for the remedial actions to be conducted at the 4-Tek facility. In addition, EPA provided more detail on the on-site ground water discharge option, and added a contingency for providing an alternate off-site private drinking water supply.

Some of the changes are significant changes. However, all these changes are logical outgrowths of the information available to the public in the Proposed Plan and the RI/FS reports. Additional public notice or public comment period was determined not to be necessary.

The following sections discuss in more detail the changes that have been incorporated into the selected remedy.

13.1 Cleanup Goals for Soils at the QCF Site

The Proposed Plan described one of the three cleanup goals for soils at the Site as "prevention of exposure to contaminated surface soils". The selected remedy incorporates source control, in addition to LNAPL and soil removal measures which are also designed to prevent exposure to contaminated subsurface soils. Construction of a vertical barrier system, and removal of highly contaminated soils with expansion of the IRM cap to incorporate the BDA, should prevent exposure to subsurface contamination in the IRM and BDA. Therefore, the cleanup goals for soils at the QCF Site are as follows:

- Prevention of exposure to contaminated surface and subsurface soils.
- Prevention of migration of contaminants in subsurface IRM and BDA soils to ground water.
- Reduction of contaminant concentrations in subsurface IRM and BDA soils.

13.2 Venting of IRM Soils

The Proposed Plan included bioventing of IRM soils as a component of the preferred alternative. Bioventing is a technology which is employed to enhance the biodegradation of contaminants by injection of an oxygen source and/or a supply of microorganisms into the subsurface soils through vent wells. This technology has been proven to be effective at some sites with characteristics similar to the QCF Site. However, there is some uncertainty as to whether bioventing would be effective at the QCF Site because of the complex nature of the Site geology,

and the presence of contaminants which are not degradable, such as metals.

In addition to metals and PCBs, the IRM soils are contaminated with volatile and semi-volatile compounds. These compounds are mobile in the environment, and may lend themselves to passive techniques such as venting. The vent wells would be installed to promote movement of volatile and semi-volatile compounds to the surface. Venting would be a cost-effective technique which, if effective, would require minimal operation and maintenance. The complex geology of the Site may limit the removal efficiency of vent wells, therefore, treatability studies will be conducted on the IRM soils prior to making the decision to install the wells.

13.3 Aquifer 2 Extraction and Treatment

The Proposed Plan included an element for extraction of Aquifer 2 ground water and removal of volatile organic contamination by treatment or recirculation through the Main Gravel Pit Lake. The selected remedy adds conditions before implementation of this element of the cleanup would occur. Either one of these conditions may trigger extraction of ground water. These conditions are as follows:

1. Three years after construction of the IRM vertical barrier system, an historical and statistical analysis of Aquifer 2 contaminant concentrations will be conducted. If this analysis indicates that contaminant concentrations in Aquifer 2 are not likely to decline to cleanup levels within 10 years after construction of the vertical barrier system, ground-water extraction shall be implemented. The determination as to whether Aquifer 2 cleanup levels are achievable within the required time frame will be made by EPA, in consultation with Ecology.
2. If, at any time in the future plume expansion is detected, ground water extraction will be implemented immediately to reduce the size of the plume.

The IRM source control, LNAPL removal, and IRM dewatering measures outlined in the selected remedy should remove and contain the contaminants in the IRM, and in Aquifer 1, which currently serve as a source of contamination to Aquifer 2. The Aquifer 2 contaminant plume should not expand once these measures are implemented. Contamination above cleanup levels has not reached beyond the QCF Site boundary. Perimeter wells will be installed along the Site boundary to monitor for plume expansion. If the contaminant plume expands to the perimeter wells, ground-water extraction will be implemented immediately to contain the plume.

Restoration of ground water for future use is a cleanup goal for the QCF Site. In order to help achieve this cleanup goal

within a reasonable time frame, ground-water extraction may be implemented to reduce the size and concentrations of the contaminant plume.

13.4 4-Tek Industries

The Proposed Plan called for monitoring of Aquifer 2, and provided a contingency for ground-water extraction and treatment should contamination be detected. The selected remedy includes characterization of the contamination within the shallow ground-water zone, in addition to monitoring of Aquifer 2. The previous soil removal action removed a source of potential contamination to ground water. However, the contamination which has been detected in the shallow ground-water zone could potentially serve as a source of contamination to deeper ground water.

The remedial action, selected for the 4-Tek facility, in addition to the other elements of the selected remedy, will ensure that a comprehensive cleanup remedy is provided for the entire Site.

13.5 On-Site Surface Water Discharge of Extracted Ground Water

Discharge of extracted ground water from Aquifer 1 outside the IRM, and Aquifer 2, if necessary, would be to the Main Gravel Pit Lake. The Main Gravel Pit Lake directly recharges to Aquifer 2. The discharged ground water would be below cleanup levels and would serve as an additional source of clean water to Aquifer 2. However, should physical conditions change at the Site, which would preclude discharge to the Main Gravel Pit Lake, an equivalent on-site surface water body would be used. In order to help maintain steady-state surface water and ground-water flow conditions at the Site, this equivalent surface water body must directly recharge Aquifer 2.

13.6 Off-Site Drinking Water Wells

The Proposed Plan included a provision for the continued monitoring of off-site drinking water wells. The selected remedy includes a contingency for the provision of an alternate source of water supply should site-related contamination above cleanup levels be detected in the off-site wells.