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APPENDICES A - F
OF THE ENDANGERMENT ASSESSMENT
FOR THE WELLS G & H SITE
WOBURN, MASSACHUSETTS

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TABLE OF CONTENTS

Page

A.0 CHEMICALS OF POTENTIAL CONCERN A-1
REFERENCES A-10

B.0 ENVIRONMENTAL FATE AND TRANSPORT B-1
B.1 Site Environmental Factors B-1
B.1.1 Geologic/Hydrogeologic Setting B-1
B.1.2 Hydrology B-3
B.1.3 Climatic Conditions B-4
B.2 Waste Characteristics B-4
B.3 Physical and Chemical Properties of the Chemicals of Concern B-5
B.4 Mechanisms of Migration B-8
B.4.1 Migration into Air B-9
B.4.2 Percolation into Groundwater B-10
B.4.3 Migration into Surface Water B-11
B.4.4 Biodegradation and Biotransformation Processes. B-12
B.4.5 Bioaccumulation of Compounds Released from Surface Water and Sediments B-14
REFERENCES B-17

C.0 EXPOSURE AND RISK CHARACTERIZATION METHODOLOGY C-1
C.1 Ingestion of Groundwater C-1
C.2 Shower Model C-2
C.3 Direct Contact with Contaminated Soils, Sludges and Sediments C-7
C.4 Exposure to Contaminats Released from Soils and Sludges Via Inhalation C-14
C.4.1 Particle Emissions Model for Vehicular Traffic. C-19
C.4.2 Soil Volatilization Emissions Model C-21
C.4.3 Box Models for Air Dispersion C-27
C.4.3.1 Box Model for Air Dispersion of Fugitive Dusts C-30
C.4.3.2 Box Model for Air Dispersion of Volatile Organic Compounds C-32
C.5 Exposure to Contaminants Released through Groundwater Use in Production Processes C-40
C.5.1 Surface Water Volatilization Model C-40
C.5.2 Indoor Air Dispersion Model C-42
REFERENCES C-46

D.0 HAZARD IDENTIFICATION D-1
D.1 Acetone D-9
D.1.1 Human Health Effects D-9
D.1.2 Toxicity to Wildlife D-10
D.2 Aldrin D-10
D.2.1 Human Health Effects D-10
D.2.2 Toxicity to Wildlife D-11

TABLE OF CONTENTS

		Page
D.3	Aluminum	D-13
	D.3.1 Human Health Effects	D-13
	D.3.2 Toxicity to Wildlife	D-14
D.4	Antimony	D-15
	D.4.1 Human Health Effects	D-16
	D.4.2 Toxicity to Wildlife	D-16
D.5	Aroclor 1260	D-16
	D.5.1 Human Health Effects	D-16
	D.5.2 Toxicity to Wildlife	D-17
D.6	Arsenic	D-19
	D.6.1 Human Health Effects	D-19
	D.6.2 Toxicity to Wildlife	D-20
D.7	Barium	D-21
	D.7.1 Human Health Effects	D-21
	D.7.2 Toxicity to Wildlife	D-22
D.8	Bis(2-ethylhexyl)phthalate	D-22
	D.8.1 Human Health Effects	D-22
	D.8.2 Toxicity to Wildlife	D-23
D.9	Cadmium	D-24
	D.9.1 Human Health Effects	D-24
	D.9.2 Toxicity to Wildlife	D-25
D.10	Chlordane	D-26
	D.10.1 Human Health Effects	D-26
	D.10.2 Toxicity to Wildlife	D-27
D.11	Chloroform	D-28
	D.11.1 Human Health Effects	D-28
	D.11.2 Toxicity to Wildlife	D-29
D.12	Chromium	D-29
	D.12.1 Human Health Effects	D-29
	D.12.2 Toxicity to Wildlife	D-30
D.13	Copper	D-31
	D.13.1 Human Health Effects	D-31
	D.13.2 Toxicity to Wildlife	D-32
D.14	4,4'-DDT	D-33
	D.14.1 Human Health Effects	D-33
	D.14.2 Toxicity to Wildlife	D-34
D.15	1,2-Dichlorobenzene	D-35
	D.15.1 Human Health Effects	D-35
	D.15.2 Toxicity to Wildlife	D-35
D.16	1,1-Dichloroethane	D-36
	D.16.1 Human Health Effects	D-36
	D.16.2 Toxicity to Wildlife	D-37
D.17	1,2-Dichloroethane	D-37
	D.17.1 Human Health Effects	D-37
	D.17.2 Toxicity to Wildlife	D-38
D.18	1,1-Dichloroethene	D-39
	D.18.1 Human Health Effects	D-39
	D.18.2 Toxicity to Wildlife	D-39

TABLE OF CONTENTS

	Page
D.19 trans-1,2-Dichloroethene	D-40
D.19.1 Human Health Effects	D-40
D.19.2 Toxicity to Wildlife	D-40
D.20 Iron	D-41
D.20.1 Human Health Effects	D-41
D.20.2 Toxicity to Wildlife	D-42
D.21 Lead	D-44
D.21.1 Human Health Effects	D-44
D.21.2 Toxicity to Wildlife	D-45
D.22 Manganese	D-46
D.22.1 Human Health Effects	D-46
D.22.2 Toxicity to Wildlife	D-47
D.23 Mercury	D-47
D.23.1 Human Health Effects	D-47
D.23.2 Toxicity to Wildlife	D-49
D.24 Methylene Chloride	D-50
D.24.1 Human Health Effects	D-50
D.24.2 Toxicity to Wildlife	D-50
D.25 Nickel	D-51
D.25.1 Human Health Effects	D-51
D.25.2 Toxicity to Wildlife	D-52
D.26 Pentachlorophenol	D-53
D.26.1 Human Health Effects	D-53
D.26.2 Toxicity to Wildlife	D-54
D.27 Phenol	D-56
D.27.1 Human Health Effects	D-56
D.27.2 Toxicity to Wildlife	D-56
D.28 Polycyclic Aromatic Hydrocarbons	D-57
D.28.1 Human Health Effects	D-57
D.28.2 Toxicity to Wildlife	D-58
D.29 Radionuclides	D-59
D.29.1 Human Health Effects	D-59
D.30 Tetrachloroethene	D-61
D.30.1 Human Health Effects	D-61
D.30.2 Toxicity to Wildlife	D-61
D.31 Toluene	D-62
D.31.1 Human Health Effects	D-62
D.32.2 Toxicity to Wildlife	D-63
D.32 1,1,1-Trichloroethane	D-64
D.32.1 Human Health Effects	D-64
D.32.2 Toxicity to Wildlife	D-65
D.33 Trichloroethene	D-65
D.33.1 Human Health Effects	D-65
D.33.2 Toxicity to Wildlife	D-65
D.34 Vinyl Chloride	D-66
D.34.1 Human Health Effects	D-66
D.34.2 Toxicity to Wildlife	D-66

TABLE OF CONTENTS

Page

D.35 Xylenes D-67
D.35.1 Human Health Effects D-67
D.35.2 Toxicity to Wildlife D-68
D.36 Zinc D-68
D.36.1 Human Health Effects D-68
D.36.2 Toxicity to Wildlife D-69
REFERENCES D-70

E.0 ANALYTICAL DATA SUMMARY TABLES E-1
W.R. Grace Company E-1
New England Plastics Corporation E-11
Olympia Nominee Trust E-16
Unifirst Corporation E-30
Wildwood Conservation Corporation E-42
Central Area E-59

F.0 SPECIES OBSERVED AND SPECIES THAT MAY BE FOUND AT THE WELLS G & H SITE F-1
REFERENCES F-8

APPENDIX A
CHEMICALS OF POTENTIAL CONCERN

A.0 CHEMICALS OF POTENTIAL CONCERN

During the site investigations conducted for EPA by the NUS Field Investigation Team (NUS 1986, Alliance 1986) and Ebasco for the supplemental RI/FS (Ebasco 1988), and studies conducted by the primarily responsible parties (PRPs), the soil, groundwater, surface water, and sediments at the Wells G & H site have been found to be contaminated by a large number of organic and inorganic compounds. In order to focus this endangerment assessment, the chemicals associated with the greatest potential risk were selected for further evaluation at this site.

The selection of chemicals of potential concern used the validated analytical data collected during the various site investigations and the methodology presented in the Superfund Public Health Evaluation (PHE) manual (EPA 1986a). The selection process was performed on an environmental medium specific basis for each source area to ensure that the threat to public health, welfare, and the environment would be evaluated with respect to compounds associated only with each individual source area at the site. The criteria that may be considered in selecting chemicals of potential concern include the presence of the chemical in background (i.e., uncontaminated or upgradient samples) samples for naturally occurring inorganic chemicals and in blanks, the extent and magnitude of chemical contamination, chemical and physical properties affecting fate and transport of the chemical in the environment, and chemical toxicity.

All chemicals detected in each medium sampled at each area will be evaluated in the selection process. Chemicals of potential concern initially were screened based on a comparison to blanks and to background concentrations. Following this initial screening process, chemicals were considered for removal from further evaluation based on their frequency of detection and toxicity. This procedure was applied to data from samples collected during the 1985 remedial investigation (NUS 1986, Alliance 1986), the 1987 remedial investigation and supplemental groundwater samples collected in 1988 (Ebasco 1988), and by the Unifirst Corporation. (The last group of samples was used to supplement the U.S. EPA data base to make it more inclusive. A large data

base of U.S. EPA collected data was available for the other properties at the Wells G & H site.)

Chemicals detected in samples at similar concentrations to those detected in laboratory, field, or trip blanks associated with the sample will not be selected for detailed evaluation. This includes chemicals that may have been introduced during RI activities such as casing lubricants used during well installation. Chemicals detected in samples at significantly higher levels than blanks will be considered in the selection process after careful review of the site-relatedness of the reported chemical concentrations.

Concentrations of inorganic chemicals can be compared to background concentrations to determine if they may be present at naturally occurring concentrations, or if they have been elevated due to site activities. Appropriate background samples would be located in areas where site-related chemicals are not expected to occur, that is off-site and sufficiently upgradient or distant to ensure that site-related contamination will not be present but in similar terrain. The Wells G & H site is located in a semi-industrialized area for which is impossible to obtain background concentrations which have not been impacted by human activities. As a result, regional background soil concentrations were obtained from the literature to use as a basis for comparison. If the maximum concentration of a constituent was detected at a level less than twice the maximum background then the constituent was determined to be present at background levels and was, therefore, not selected as a chemical of potential concern. The value of two times the maximum background concentration was selected to account for natural variations. The soil concentrations are summarized in Table A-1. Because there are very few naturally occurring organic chemicals a comparison to background will not be grounds for elimination of those chemicals from further consideration.

Inorganic compounds can be present in groundwater from natural sources. Local background or upgradient data were not available and the data summarized in Table A-2 were obtained from Walton (1985) and EPA (1986b). Walton (1985) categorizes dissolved inorganic chemicals into major, minor, and trace

Table A-1

Typical Concentrations of Inorganic Constituents in Soil
(mg/kg)

Compound	Concentration Range	
	Regional Soils[a]	Eastern United States[b]
Aluminum	30,000-70,000	7,000-100,000<
Antimony	<1-10	<150-500
Arsenic	6.5-65	<0.73-73
Barium	15-300	15-1,000
Beryllium	1-1.5	<1-7
Cadmium	NR	<1-1
Calcium	7,900-28,000	<1,000-160,000
Chromium	30-70	1-100
Cobalt	7-70	<3-70
Copper	15-30	<1-150
Iron	15,000-30,000	100-100,000<
Lead	NR	<10-70
Magnesium	5,000-50,000	50-50,000
Manganese	400-2,000	<2-7,000
Mercury	0.2-2	0.01-3.4
Nickel	8-25	<3-700
Potassium	11,000-20,000	50-37,000
Selenium	0.3-5	<0.1-1.4
Silver	<0.5-5	<0.5-5[c]
Sodium	10,000	<200-15,000
Thallium	NR	0.1-0.8[d]
Tin	1.5-7	<10-15
Vanadium	70-500	<5-300
Zinc	20-60	<5-400

NR = Not Reported

[a] Surface Soils in Massachusetts. Shacklette and Boerngen 1984.
[b] Cultivated and Uncultivated Soils, B Horison. Connor and Shacklette 1975.
[c] Cultivated and Uncultivated Soils, B horizon, Western United States (only data available in this source). Connor and Shacklette 1975.
[d] Bowen 1979.

TABLE A-2

BACKGROUND CONCENTRATIONS GENERALLY PRESENT IN GROUNDWATER

Compound	Background Concentration[a] ug/liter
Aluminum	100
Antimony	100
Arsenic	10[b]
Barium	100
Beryllium	100
Cadmium	5[b]
Calcium	1,000,000
Chromium	100
Cobalt	100
Copper	100
Iron	10,000
Lead	10[b]
Magnesium	1,000,000
Manganese	100
Mercury	0.5[b]
Nickel	100
Potassium	10,000
Selenium	5[b]
Silver	1
Sodium	1,000,000
Thallium	1
Tin	100
Vanadium	100
Zinc	100

[a]Background concentrations obtained from Walton (1985) except where noted.

[b]Background concentrations obtained from EPA (1986b).

categories. EPA (1986b) presents background concentrations of inorganic chemicals obtained from EPA's Storet data base. Since it is known that, in some parts of the country, naturally occurring levels are above drinking water standards, the background concentrations reported in these two sources were first compared to maximum contaminant levels (MCLs). If both sources reported background concentrations that exceeded MCLs, neither concentration was used to represent background. If both sources reported background concentrations below the MCL, the background concentrations reported by Walton (1985) were used preferentially because this was the more complete source. The background concentration reported for mercury by EPA (1986b) was used because this chemical was not presented in the classification system presented by Walton (1985).

Background samples were collected in the Alberjona River. In both site investigations (Alliance 1986, Ebasco 1988), upstream samples for surface water and sediments were collected. These data were used as background ranges to select chemicals of potential concern for surface water and sediments. As with the comparison to background for the soil chemicals of potential concern, twice the upstream or background concentration was used to screen out constituents detected in during sampling.

The frequency of detection of chemicals remaining after the above initial screening were evaluated to determine if any additional chemicals could be screened out due to their infrequent presence, i.e., if the chemical was detected in approximately 5% or less of the samples in only one or possibly two environmental media. The chemicals screened out based on frequency were further evaluated to ensure that their limited frequency was not due to their presence at potential hot spots or that these chemicals were not considered to be present at concentrations of potential concern based on their toxicity or that these chemicals were present in other media at high concentrations or at a high frequency and could migrate into another medium under consideration.

Chemicals for which U.S. EPA has not established toxicity criteria for human health and for which available information indicates low toxicity, were also considered for elimination from further consideration in the endangerment

assessment. Chemicals for which U.S. EPA has not established human health toxicity criteria but which may not have low toxicity were addressed in a discussion of uncertainty. These chemicals were, however, eliminated from quantitative evaluation in the assessments. The environmental effects of these chemicals were also considered before they were eliminated from evaluation in the ecological risk assessment.

Several of the inorganic chemicals detected in the samples are considered to be essential nutrients for humans. Calcium, magnesium, and potassium are essential nutrients in the human diet (recommended daily allowances for adults are 800, 300-500, and 1875-5600 mg/day, respectively) and, in general, more attention has been given to problems of deficiency rather than toxicity. These minerals are typically obtained through food and drinking water (and sometimes mineral supplements), and the body generally has adequate physiological mechanisms to maintain a proper equilibrium over a wide range of intake levels. For this reason, these three elements are not selected as chemicals of potential concern.

Cobalt, copper, iron, manganese, selenium, and zinc are essential metals with potential for toxicity. Each of these metals has three levels of biologic activity, trace levels required for optimum growth, storage levels, and toxic levels. For these metals, environmental accumulations are generally less important routes of excess exposure than accidents or occupational exposures (Klaassen et al. 1986). Therefore, in the selection process, these chemicals are selected as chemicals of potential concern only if concentrations are greatly elevated (i.e., at least 10 times) above background concentrations.

Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDDS/PCDFs) were sampled for at six locations at the Wells G & H site. Heptachloro-dibenzo-p-dioxin (HpCDD) and octachlorodibenzo-p-dioxin (OCDD) were detected at several locations. These two compounds are members of the PCDD family of compounds, the most biologically active of which is 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) which was not detected at the Wells G & H site. Additionally, the most biologically active congeners tend to be chlorinated at the 2,3,7,8 position. For regulatory purposes, the relative

potencies of the other PCDDs are often based on a comparison with 2,3,7,8-TCDD.

Although a considerable amount of data is available on 2,3,7,8-TCDD, less information is available on other PCDDs. For this reason, EPA (Bellin and Barnes 1986) has established interim procedures for estimating risks associated with exposure to PCDDs, based on their potency relative to that of 2,3,7,8-TCDD. The toxicity equivalence factors (TEFs) derived using a comparison of relative potencies for the two PCDDs found at the Olympia Nominee Trust property are 0.001 for 2,3,7,8-HpCDD, 0.0001 for the other HpCDDs, and 0 for the OCDDs. To estimate the potency of the HpCDD and OCDD mixture, the concentrations of the congeners in each group are multiplied by an appropriate TEF. Thus, to derive an equivalent concentration of the HpCDD and OCDDs detected here, their concentrations are multiplied by the TEF. Therefore, the if the HpCDD concentration is 1.2 ug/kg then the 2,3,7,8-TCDD equivalent concentration would be 0.0012 ug/kg conservatively assuming all the HpCDD is 2,3,7,8-HpCDD. Similarly, if the OCDD concentration is 16.5 ug/kg then the 2,3,7,8-TCDD equivalent concentration would be 0 ug/kg. The total 2,3,7,8-TCDD equivalent concentration is 0.0012 ug/kg which is well below the 1 ug/kg typical soil action levels for this class of compounds (Kimbrough 1984, EPA 1988). Thus, these two compounds were not selected as chemicals of potential concern.

The analytical chemistry data are summarized using the representative concentration and the maximum detected concentration. The representative concentration of each chemical at the Wells G & H site is considered to be the geometric mean of the positive detections and in samples with non-detects, one-half the U.S. EPA contract laboratory program (CLP) detection limit or, when available, the sample detection limit. In the cases where the detection limit for a specific chemical is unusually high, use of half of this high detection limit would bias the mean, particularly when several samples have high detection limits. Hence, samples in which half of the detection limit exceeds the largest measured concentration of that chemical in that medium will not be used in calculating the mean. The geometric mean was used rather than the arithmetic mean because environmental data generally are log-normally

distributed (Dean 1981; Ott 1988). Analytical chemistry samples with a "J" data qualifier, indicating that the chemical was detected but that the reported levels were estimated, were included in the geometric mean calculations. Although the use of these results adds an additional degree of uncertainty to the concentration levels (i.e., may overestimate or underestimate actual values), they have been taken at face value in this assessment. However, if one of these values is seen to play an important role in determining risk, the uncertainty will be noted at that time. If a duplicate sample was collected and analyzed, reported concentrations are first averaged and the average of the two samples is used in calculating geometric means.

To summarize, the following criteria for identifying chemicals of potential concern were used:

- Frequency of detection. Chemicals that are detected only once in only one of the media sampled (e.g., soil, ground water, or surface water/sediment) are eliminated from further consideration. In addition, chemicals which are detected in approximately 5% or less of the samples in only one or possibly two environmental media were also eliminated from further consideration.

- Comparison of naturally occurring inorganic chemicals with background concentrations. Chemicals are considered to be elevated above background if maximum levels detected in site samples are greater than the maximum background level.

- Essential nutrients. Calcium, magnesium, and potassium are essential nutrients in the human diet and, in general, more attention has been given to problems of deficiency rather than toxicity. These minerals are typically obtained through food and drinking water (and sometimes mineral supplements), and the body generally has adequate physiological mechanisms to maintain a proper equilibrium over a wide range of intake levels. For this reason, these three elements will not be selected as chemicals of potential concern.

  Cobalt, copper, iron, manganese, selenium, and zinc are essential metals with potential for toxicity. Each of these metals has three levels of biologic activity, trace levels required for optimum growth, storage levels, and toxic levels. For these metals, environmental accumulations are generally less important routes of excess exposure than accidents or occupational exposures (Klaassen et al. 1986). Thus, these chemicals will be selected as chemicals

of potential concern only if concentrations are greatly elevated (i.e., at least 10 times) above background concentrations.

- Toxicity. Chemicals for which available information indicates low toxicity and are present in low concentrations will not be selected as chemicals of potential concern. Chemicals for which U.S. EPA has not established toxicity criteria for human health but which may not have low toxicity will not be selected as chemicals of concern but will be discussed in the uncertainty section of the main part of the report.

A specific discussion of the extent of contamination and the reasons for selecting the chemicals of potential concern for each medium are presented in the main body of the text.

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APPENDIX B
ENVIRONMENTAL FATE AND TRANSPORT

B.0 ENVIRONMENTAL FATE AND TRANSPORT

An evaluation of the environmental fate and transport of the site-related contaminants present in the study area of the Wells G & H site is important in determining the potential for migration through the study area and in assessing the potential for exposure to the contaminants. The migration of contaminants that have been released in the past and may be released in the future from the site are influenced by (1) site environmental factors, (2) waste characteristics, and (3) the physical and chemical properties of the chemicals of concern. Each of these factors is addressed below. These factors together influence the migration potential of the chemicals of concern; this is addressed in Section B.4.

B.1 SITE ENVIRONMENTAL FACTORS

B.1.1 GEOLOGIC/HYDROGEOLOGIC SETTING

Surficial Geology

Glacial outwash deposits and recent alluvial sediments are deposited over bedrock within the Aberjona River valley. Glacial till is found primarily in the uplands on either side of the Aberjona River valley. A thin, discontinuous layer of highly compacted basal till (or lodgement till) directly overlying the bedrock has been observed in several of the well borings near the Wells G & H site. Stratified drift deposits up to 140 feet thick are found directly overlying the till and bedrock. These stratified sand and gravel deposits form the most important aquifer in the study area. The unconsolidated valley fill deposits can be divided into three units. The uppermost unit is the sand, silt, clay, and peat layer which underlies the entire wetland. A peat layer ranging in thickness of 2 to 30 feet (average 2 to 7 feet) overlies the stratified drift in the immediate vicinity of the wetlands. In test boring well S89, it was 30 feet thick. The peat layer is underlain by a 10 to 50 foot layer of coarse sands, which in turn is underlain by a unit consisting of coarse sands and gravels. This lower unit ranges from

20 to 50 feet in thickness.

Bedrock Geology

The Aberjona River valley is underlain by intrusive igneous rocks of Ordovician and Precambrian Ages. The lowland areas are generally underlain by Salem Gabbrodiorite while the uplands are composed of the more resistant Dedham Grandiorite. The Salem Gabbrodiorite is a medium to coarse grained, bluish-gray gabbrodiorite composed of hornblende, quartz, and feldspar. The highly fractured nature of this rock makes it less resistant to weathering and therefore provides a preferential pathway for erosive forces. The Dedham Granodiorite is Precambrian in age and is a coarse-grained, grayish-pink, biotite-hornblende granodiorite. Bedrock cores from the area indicate that this rock is slightly to moderately fractured (NUS 1986).

The depth to bedrock ranges from 0 feet where it outcrops at the surface to 128 feet below the surface at well S76, which is located immediately west of the railroad tracks. A north-northwest/south-southeast trending bedrock valley is located under the wetlands. The present location of the Aberjona River valley generally mimics the deepest depression in the bedrock surface.

Groundwater

The local hydrogeology has been characterized through data collected from the nearly 210 observation wells installed in the Wells G & H study area. Groundwater recharge is largely from precipitation which infiltrates the stratified drift and underlying bedrock in the upland areas. Piezometric head data obtained from nested wells indicate that a vertically downward component to flow exists in the uplands on the east side of the Aberjona River, and a vertically upward component to flow exists in the vicinity of the wetlands. That is, groundwater being recharged in the uplands migrates through the bedrock and stratified drift, ultimately discharging into the wetlands and Aberjona River through the shallow peat layer. A small portion of groundwater migrates laterally down the river valley in a southerly direction.

The elevation of the water table ranges from approximately 40 feet above the National Geodetic Verbal Datum (NGVD) of 1929 at the Aberjona River to over 94 feet NGVD of 1929 in the vicinity of the W.R. Grace site in the northeastern portion of the study area. The depth to the water table ranges from 0 feet in the wetland areas to 10 to 15 feet in the hilly areas along the east and west boundaries of the study area. The water table gradients are relatively steep in the eastern part of the study area near Washington Street and relatively gentle in the wetland near the middle of the site (Myette et al. 1986).

Production wells such as Wells G & H and the industrial wells located in the southwest portion of the study area can have a significant influence on local groundwater flow patterns at the site. Long-term pumping of the industrial well in the southwest quadrant has produced a localized groundwater divide in the southwest portion of the wetlands (Myette et al. 1986). In addition, during pumping of these wells, groundwater gradients between the river and Wells G & H are reversed, resulting in flow from the river toward Wells G & H. In the area southwest of Well G the river acts as a groundwater boundary or mound which marks the extent of the zone of influence of Wells G & H. In the deeper strata, the groundwater divide discussed above shifts to increase the zone of influence of the two wells. As a result, groundwater in the deeper strata may flow under the Aberjona River towards Wells G & H.

B.1.2 HYDROLOGY

The study area lies within the Aberjona River basin which is a subbasin of the Mystic River watershed. One of the major wetland areas in the Mystic River watershed is the wetland along the Aberjona River in Woburn. This wetland stores excess runoff during flood conditions and gradually releases this water to streams during dry periods (New England River Basins Commission 1975). This wetland was substantially larger at one time; however, extensive development in the area and filling along the edges has obliterated portions of the wetland.

As a result of this development, much of the area has been paved which has increased the total amount of surface water runoff and decreased the amount of

precipitation recharging the groundwater. In addition, significant quantities of oil, grease, and road salt from roads and parking lots probably enter the wetlands during and immediately after rainstorms. A detailed assessment of the wetlands within the Wells G & H study area can be found in the 1987 Wetlands Assessment (Alliance 1987).

B.1.3 CLIMATIC CONDITIONS

The climatology at the Wells G & H site is best described by the meteorological data collected at the National Weather Service Office at General Logan International Airport for the Boston Metropolitan area. The airport is located approximately 10 miles southeast of the Wells G & H site.

Annual mean maximum temperatures range from 36°F in January to 81°F in July. The annual mean minimum temperatures are 22°F in January and 65°F in July. Actual temperatures at the site, which is located about 10 miles northwest of Boston, may be slightly more extreme because of its greater distance from the ocean which acts to temper extremes. Precipitation in this area is evenly distributed throughout the year. The heaviest local rainfall is produced by thunderstorms, which are prevalent between June and September. Total precipitation averages from 40 to 50 inches per year. The prevailing winds in the area are from the west and the average annual wind speed is about 12 miles per hour (NOAA 1985).

B.2 WASTE CHARACTERISTICS

The remedial investigations describe the groundwater (NUS 1986, Ebasco 1988) and soil contamination (Alliance 1986, Ebasco 1988) at the Wells G & H site study area. Most of the contaminants are present at the site because of past waste handling or disposal practices which resulted from disposal of drums or bulk solids on soil surfaces or burial of these wastes in existing pits or trenches. Additional contaminant releases are thought to be the result of leaking underground storage tanks or fuel spills; the gasoline or fuel related spills are not within the scope of this endangerment assessment or remedial investigation.

The site history has been summarized in Section 1.2 of the main body of the endangerment assessment. As was mentioned previously, a number of the drums have been removed. Depending on the chemical composition of the contaminants and the surrounding environment, some may have been adsorbed to the soil while others have been transported downward through soil via rainwater infiltration. When the contaminants are present on the surface soils, they may be volatilized to the air or may be released to air as fugitive dust if adsorbed to soil particles in an area that is unvegetated.

B.3 PHYSICAL AND CHEMICAL PROPERTIES OF THE CHEMICALS OF CONCERN

The environmental fate and transport of contaminants is dependent on the physical and chemical properties of the compounds, the environmental transformation processes affecting them, and the media through which they are migrating. Physical and chemical properties of the organic chemicals of concern are summarized in Table B-1.

The water solubility of a substance is a critical property affecting environmental fate: Highly soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities range from less than 1 mg/liter to totally miscible with most common organic chemicals falling between 1 mg/liter and 1,000,000 mg/liter (Lyman et al. 1982). The solubility of chemicals which are not readily soluble in water may become enhanced in the presence of organic solvents which themselves are more soluble in water.

Volatilization of a compound will depend on its vapor pressure, water solubility, and diffusion coefficient. Highly water soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of

TABLE B-1

PHYSICAL-CHEMICAL PROPERTIES OF CHEMICALS OF CONCERN
AT THE WELLS G & H SITE

CHEMICAL	MOLECULAR WEIGHT (g/mol)	DIFFUSIVITY (cm2/sec)	WATER SOLUBILTY (mg/l)	VAPOR PRESSURE (mm HG)	HENRY'S LAW CONSTANT (atm-m3/mol)	Koc	Log Kow
Halogenated Aliphatics							
Chloroform	119	0.08868	8.20E+03	1.51E+02	3.80E-03	3.10E+01	1.97
1,1-Dichloroethane	99	0.09590	5.50E+03	1.82E+02	5.70E-03	3.00E+01	1.79
1,2-Dichloroethane	99	0.09451	8.52E+03	6.40E+01	1.10E-03	1.40E+01	1.48
1,1-Dichloroethene	97	0.10077	2.25E+03	6.00E+02	1.54E-01	6.50E+01	2.13
1,2-Dichloroethene (trans)	97	0.09980	6.30E+03	3.24E+02	6.56E-03	5.90E+01	2.09
Methylene Chloride	85	0.08580	2.00E+04	3.62E+02	2.60E-03	8.80E+00	1.30
Tetrachloroethene	166	0.07404	1.50E+02	1.78E+01	2.30E-02	3.64E+02	2.60
1,1,1-Trichloroethane	133	0.07965	1.50E+03	1.23E+02	2.80E-02	1.52E+02	2.50
Trichloroethene	131	0.08116	1.10E+03	5.79E+01	8.90E-03	1.26E+02	2.38
Vinyl Chloride	63	0.10726	2.67E+03	2.66E+03	6.90E-01	5.70E+01	1.38
Ketones							
Acetone	58	0.11498	1.00E+06	2.70E+02	3.67E-05	2.20E+00	-0.24
Monocyclic Aromatics							
1,2-Dichlorobenzene	147	0.07113	1.00E+02	1.00E+00	1.93E-03	1.70E+03	3.60
Pentachlorophenol	266	0.05528	1.40E+01	1.10E-04	2.75E-06	5.30E+04	5.00
Phenol	94	0.08924	9.30E+04	3.41E-01	4.54E-07	1.42E+01	1.46
Toluene	92	0.07828	5.35E+02	2.81E+01	6.60E-03	3.00E+02	2.73
Xylene (total)	106	0.07164	1.98E+02	1.00E+01	7.04E-03	2.40E+02	3.26
Pesticides							
Aldrin	365	0.04399	1.80E-01	6.00E-06	1.60E-05	9.60E+04	5.30
Chlordane	410	0.04500	6.00E-03	2.50E-05	1.90E-03	9.50E+03	4.78
4,4'-DDD	320	0.04742	1.00E-01	1.89E-06	7.96E-06	7.70E+05	6.20
4,4'-DDE	318	0.05336	4.00E-02	6.50E-06	6.80E-05	4.40E+06	7.00
4,4'-DDT	354	0.04467	5.00E-03	5.50E-06	5.13E-04	2.43E+05	6.19
Phthalate Esters							
Bis(2-ethylhexyl)phthalate	391	0.03542	4.00E-01	2.00E-07	4.40E-07	8.71E+04	5.11
Polychlorinated Biphenyls (PCBs)							
Aroclor 1254	328	0.05251	4.30E-02	2.20E-05	1.90E-04	5.30E+05	6.04
Aroclor 1260	376	0.04909	1.44E-02	6.31E-06	1.70E-04	6.70E+06	7.15
Polychlorinated Biphenyls (total)	328	0.05254	3.10E-02	7.70E-05	1.07E-03	5.30E+05	6.04
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	154	0.05951	3.42E+00	1.55E-03	9.20E-05	4.60E+03	4.00
Acenaphthylene	152	0.06703	3.93E+00	2.90E-02	1.48E-03	2.50E+03	3.70
Anthracene	178	0.05904	4.50E-02	1.95E-04	1.01E-03	1.40E+04	4.45
Benz(a)anthracene	228	0.04654	5.70E-03	2.20E-08	1.16E-06	1.38E+06	5.61
Benzo(b)fluoranthene	252	0.04392	1.40E-02	5.00E-07	1.19E-05	5.50E+05	6.06
Benzo(k)fluoranthene	252	0.04392	4.30E-03	5.10E-07	3.94E-05	5.50E+05	6.06
Benzo(g,h,i)perylene	276	0.04197	7.00E-04	1.03E-10	5.34E-08	1.60E+06	6.51
Benzo(a)pyrene	252	0.04653	3.80E-03	5.60E-09	1.55E-06	5.50E+06	6.06
Chrysene	228	0.04531	2.00E-03	6.30E-09	9.46E-07	2.00E+05	5.61
Dibenzo(a,h)anthracene	278	0.05707	1.40E-02	1.00E-10	2.61E-09	3.30E+06	5.61
Dibenzo(a,e)pyrene	302	0.05475	9.35E-03	4.86E-11	2.27E-09	1.22E+07	7.30
Dibenzo(a,h)pyrene	302	0.05475	6.96E-05	4.32E-15	2.72E-11	1.22E+07	7.30
Dibenzo(a,i)pyrene	302	0.05475	9.91E-01	4.30E-11	4.70E-12	2.57E+06	6.62
Fluoranthene	202	0.04944	2.60E-01	1.00E-05	1.02E-05	3.80E+04	5.33
Fluorene	276	0.05710	1.98E+00	7.10E-04	6.42E-05	7.30E+03	4.18
Indeno(1,2,3-cd)pyrene	276	0.05728	5.30E-04	1.00E-10	6.86E-08	1.60E+06	6.50
Naphthalene	128	0.08205	3.20E+01	8.70E-02	4.60E-04	9.40E+02	3.23
Phenanthrene	178	0.05430	1.29E+00	6.80E-04	1.59E-04	1.40E+04	4.46
Pyrene	202	0.05039	1.32E-01	2.50E-06	5.04E-06	3.80E+04	5.32

Sources: Callahan et al. 1979; Lyman et al. 1982; Mabey et al. 1982; Mackay and Shiu 1981; and Verschuren 1983.

chemicals in their pure state, ranges from 10^{-3} to 760 mm Hg for liquids, with solids ranging down to less than 10^{-10} (EPA 1986). The Henry's law constant, which combines vapor pressure with solubility and molecular weight, is more appropriate for estimating releases from water to air. Compounds with Henry's law constants in the range of 10^{-3} and larger can be expected to readily volatilize from water; those with values ranging from 10^{-3} to 10^{-5} are associated with possibly significant but not facile volatilization, while compounds with values less than 10^{-5} will only volatilize from water to a limited extent (Lyman et al. 1982). The diffusion coefficient can also be used as a means to predict the rate at which a compound moves through the environment. Molecular diffusion is determined by both molecular properties (e.g., size and weight) and by the presence of a concentration gradient which causes the molecules to migrate to areas without molecules of that compound.

The octanol-water partition coefficient (K_{ow}) is often used to estimate the extent to which a chemical will partition from water into lipophilic parts of organisms, for example, animal fat. Similarly the organic carbon partition coefficient (K_{oc}) reflects the propensity of a compound to sorb to the organic matter found in soil. The normal range of K_{oc} values is from 1 to 10^7, with higher values indicating greater sorption potential.

The inorganic chemicals of potential concern selected for this study are antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. Antimony is an amphoteric element, exhibiting both metallic and non-metallic behavior. Arsenic, chromium, and iron can be present in either of two positively charged forms depending on the nature of the system. The other metals are generally found as the divalent cation. In the soil, metals are generally quite immobile, particularly under neutral or alkaline conditions. In addition, inorganic metal ions are not volatile. Metals in the soil tend to adsorb to soil particles, but may be desorbed when the conditions (mainly changes in pH and oxidation-reduction potential) of the water moving through the soil are appropriate. Rain water is generally mildly acidic due to the presence of carbon dioxide. Thus the potential exists for these compounds to be leached into the groundwater, or to be carried to the Aberjona river or wetlands.

Once in water, the inorganic constituent may be removed form the dissolved phase through reactions with ions of an opposite charge. Since inorganic elements do not degrade, the loss mechanisms are limited by the chemical interactions described above.

As indicated in Table B-1, the organic chemicals of concern can be classified into categories according to their similarity in chemical structure and/or physicochemical properties (factors which would influence mobility in the environment). The organic chemical categories and the chemicals of concern within each category as well as the inorganics are listed below:

- Volatile halogenated aliphatics: chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, methylene chloride, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride.
- Volatile monocyclic aromatics: 1,2-dichlorobenzene, pentachlorophenol, phenol, toluene, and total xylenes.
- Chlorinated pesticides: aldrin, chlordane, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE.
- Ketones: acetone.
- Phthalate esters: bis(2-ethylhexyl)phthalate.
- Polynuclear aromatic hydrocarbons (PAHs): acenaphthylene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indene(1,2,3-c,d)perylene, naphthalene, phenanthrene, and pyrene.
- Polychlorinated biphenyls (PCBs): Aroclor 1254 and Aroclor 1260.
- Inorganics: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc.

B.4 MECHANISMS OF MIGRATION

There are several mechanisms by which contaminants may migrate from the Wells G & H site. The contaminated soils at the site can act as a source of contaminants to the other environmental media. Migration into the air can

occur via volatilization or fugitive dust emissions; transport into the wetlands and/or the Aberjona River can occur via surface runoff and groundwater discharge; and migration into groundwater can occur by percolation of infiltrating rainwater with subsequent leaching and transport. One other process that will influence migration is the biotransformation of certain organic compounds. The potential for the chemicals of concern to be influenced by and migrate via these mechanisms is described in the following subsections.

B.4.1 MIGRATION INTO AIR

The mechanisms of organic volatilization are complex. Volatilization is the mass transfer of an organic compound from a specific medium (e.g., soil, water) to the air. The ability for this transfer or migration to occur will depend on the other competing processes which would hinder this migration. For example, if a chemical is very soluble in water, it will be less likely to volatilize into the air. Environmental factors of importance include temperature, soil porosity, amount of water present in the soil, soil organic carbon content, and depth of contamination (Jury et al. 1983).

Generally, compounds with high vapor pressures or high Henry's law constants are expected to volatilize readily. Of the chemicals of concern at the Wells G & H site, the halogenated aliphatics (chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, methylene chloride, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride) and some of the monocyclic aromatics (1,2-dichlorobenzene, toluene, and total xylenes) have high vapor pressures and Henry's law constants greater than 1×10^{-3} $atm \cdot m^3/mol$ and, therefore, tend to volatilize from contaminated soils and water.

However, while the other chemicals of potential concern such as the pesticides, phthalate esters, PAHs, and PCBs have substantially lower vapor pressures, they also have low water solubilities with the net result being that substantial volatilization can still occur (EPA 1986).

Fugitive dust emissions could occur at the Wells G & H site in areas that are unpaved or unvegetated. The halogenated aliphatics and toluene of the monocyclic aromatics have a relatively low affinity for organic matter in the soil (as described by the organic carbon partition coefficient) and moderate to high solubility in water. These compounds are not expected to remain in the surface soils and would not be emitted in dust generated from the site. The pesticides, PAHs, PCBs, phthalate esters, and most of the monocyclic aromatic hydrocarbons selected here (excluding toluene), on the other hand, have low water solubilities and high organic carbon partition coefficients (K_{oc}) and would be expected to remain in the surface soil and could be transmitted by fugitive dust. The potential for fugitive dust emission is primarily dependent on environmental factors such as percent silt, moisture content, vegetative cover, and wind speed.

The inorganic chemicals of potential concern can form insoluble precipitates with compounds found in soils or sorb onto the soil particles. These processes will result in the inorganic compounds remaining in the soil. As a result, these chemicals of potential concern could be transported by fugitive dust.

B.4.2 PERCOLATION INTO GROUNDWATER

Compounds present in the soils at the Wells G & H site may be leached by precipitation infiltrating into soils. Organic chemicals of concern with high solubilities and low K_{oc}s are particularly susceptible to this phenomenon. The halogenated aliphatics and monocyclic aromatics have aqueous solubilities in the hundreds of milligrams per liter range and are, therefore, expected to be more mobile than the other chemicals of concern. This is observed at the site since the halogenated aliphatics and monocyclic aromatics are detected in the groundwater and at depth in the soils.

In general, the pesticides, PAHs, PCBs, phthalate esters, and most of the monocyclic aromatic hydrocarbons selected here (excluding toluene) detected in the soils are not very mobile. Of these compounds, bis(2-ethylhexyl)phthalate, 1,2-dichlorobenzene, and xylenes were the most mobile.

having been detected in the groundwater.

Once in the groundwater, the compounds with low water solubilities and high organic carbon partition coefficients (K_{oc}) are transported in the direction of the groundwater flow but at a slower rate than the groundwater. This is because compounds moving with the groundwater flow tend to partition or divide themselves between the mobile water or aqueous phase and the stationary soil particles that are in contact with groundwater. The overall effect of this sorption process is a retardation of the rate of a compound's transport. The halogenated aliphatic and monocyclic aromatic chemicals of potential concern have high solubilities and low K_{oc}s which indicates that they are very mobile in groundwater.

The migration of inorganic chemicals through soil to groundwater is influenced by soil characteristics and water movement. Soil parameters that must be considered are cation and anion exchange capacities (that is the interaction between positively and negatively charged ions), fraction of organic matter, pH, oxidation-reduction potential, and porosity. In general, inorganic chemicals with a positive charge (cations) will be retarded by clays exhibiting an overall negative charge, and anions such as chromium (as chromate) or arsenic (as arsenate) will be more mobile in such an environment.

B.4.3 MIGRATION IN SURFACE WATER

The Aberjona River flows through the western side of the site. It is possible that during periods of heavy rainfall contaminated surface soil could be carried into the river and the wetlands via surface runoff. In addition, groundwater discharges into the wetlands and the Aberjona River, under natural conditions, can result in the input of contaminants into these areas. Upon reaching the surface water, the more volatile chemicals of concern are likely to volatilize to the air while those chemicals which have low solubilities and/or K_{oc}s will tend to be deposited in the sediments.

The inorganic chemicals of potential concern in surface water are naturally occurring metals that may have reached increased concentrations in the surface

water through groundwater discharge and/or surface runoff. The behavior of these metals in aquatic systems varies, although common complexing agents are naturally occurring organic materials (fulvic and humic acids, for example). These organic compounds can increase the solubility and hence the mobility of these metals, resulting in their downstream transport. The presence of fulvic acid in groundwater can also act to increase the mobility of metals.

B.4.4 BIODEGRADATION AND BIOTRANSFORMATION PROCESSES

Biological and chemical processes that occur in the soil can be important in determining the ultimate fate of the chlorinated aliphatics found at the Wells G & H site. The extent and rates of these reactions, however, are difficult to predict because of a limited scientific data base. The state of knowledge in this field is summarized below and has been reported in recent reviews (SAIC 1985, Smith and Dragun 1984).

Under anaerobic or oxygen depleted conditions, chlorinated aliphatic chemicals (e.g., tetrachloroethene, trichloroethene) have been found to undergo reductive dechlorination reactions, that is, reactions which remove chlorine from and add hydrogen to the chemical (Bouwer et al. 1981, Kobayashi and Rittman 1982). One exception to this is the aerobic degradation of trichloroethene in the presence of methane (Wilson and Wilson 1984). The transformation is sequential with, for example, tetrachloroethene (an ethene molecule with four chlorines) yielding trichloroethene (an ethene molecule with three chlorines), which in turn yields 1,1-dichloroethene (an ethene molecule with two chlorines) and ultimately vinyl chloride (an ethene molecule with one chlorine) (Parsons et al. 1984, Cline and Viste 1984).

Chloroform has been found to degrade to methylene chloride in laboratory studies (Bouwer 1983). Wilson and coworkers (1981, 1983) did not observe this degradation in field studies and attributed this to the high mobility of chloroform in soils (i.e., it volatilizes or percolates to the groundwater).

The nature and extent of degradation, as well as the type and number of products, appears to be highly dependent on soil conditions. Some

investigators (Wilson et al. 1983, Schwarzenbach et al. 1983) found no transformation in soil, while others (Kleipfer et al. 1985, Parsons et al. 1984) found substantial transformation. It is possible that the vinyl chloride in the groundwater is a result of the transformation of the higher molecular weight chlorinated alkenes. Vinyl chloride is stable toward further biological and/or chemical transformation and is likely to persist unless it has an opportunity to volatilize or leach from soil.

PCBs are metabolized by microorganisms present in the environment. Metabolism of one PCB will sequentially yield PCBs of lower molecular weight and greater solubility. Thus metabolism of PCBs in the environment will increase the mobility of the compound. The nature and extent of degradation, as well as the type and number of products, appears to be highly dependent on soil conditions. Some investigators (Wilson et al. 1983, Schwarzenbach et al. 1983) found no transformation in soil, while others (Kleipfer et al. 1985, Parsons et al. 1984) found substantial transformation.

The PAHs sorbed onto soil can also be biodegraded. Factors which contribute to degree to which biodegradation occurs include biodegradability rates, production of intermediates, and the effects of mixtures. In general, PAHs with 2 or 3 rings (i.e., phenanthrene) were more readily degraded than PAHs with 4 or more rings (i.e., pyrene) (McKenna and Heath 1976).

In most cases, an organic contaminant is not broken down completely to carbon dioxide and water by a bacterium, but is metabolized to an intermediate which is in turn further degraded. The metabolites isolated depend primarily on the time at which the reaction is stopped. In the course of the degradation of phenanthrene to low molecular weight carboxylic acids by soil Pseudomonads (bacteria), a total of 24 different metabolites have been either isolated or proposed as intermediates (Pucknat 1981). All of these intermediates are more water soluble than the parent compound and are therefore more mobile. Many of them are also more toxic.

The last problem associated with biodegradation is that concerned with mixtures. As noted above, some PAHs are more degradable than others. If both

stable and mobile PAHs are present in a mixture, the more degradable materials may be co-metabolized at a rate similar to or faster than the more degradable compounds.

B.4.5 BIOACCUMULATION OF COMPOUNDS RELEASED FROM SURFACE WATER AND SEDIMENTS

As has been discussed above, the concentrations of organic and inorganic compounds in surface water and sediments are governed a partitioning mechanism which regulates the amount of the compound which will be adsorbed by the sediments and the amount remaining in the water. This section discusses the relationship between the presence of contaminants in the surface water and sediments and the uptake of these contaminants by biota. Some of the factors which regulate this transfer have been discussed previously and will be summarized below.

The sediments provide an important role in reducing the amount of a chemical available to the biota by acting as a 'sink' for the chemical. When chemical concentrations in the water column are subsequently reduced, the chemical sinks in the sediments then act as a source of the compound for aquatic exposure by slowly releasing the sorbed compound into the water column. Other processes that may also influence the transfer rates between sediment and water and/or biota are bioturbation, storm events and sedimentation. Bioturbation is best defined as the mixing resulting from movement of the contaminated sediments by infauna or benthic foragers, this movement can either expose or bury the chemicals, and is dependent on the densities of interacting benthic organisms in addition to properties of the sediments.

Sediments and the overlying water column may be viewed as a series of compartments or layers. These layers may be viewed by their availability to exchange, giving a deep or buried layer of sediment, and the active or accessible layer of sediment on top, interfacing with the water column (Reuber et al. 1987). The properties regulating the initial partitioning of contaminants among these compartments are based first on the properties of the chemical. A chemical's solubility and corresponding hydrophobicity (lack of affinity for water) are very important in determining the partitioning of the

compound. For organics compounds, such as PAHs, the less soluble the compound, the more likely it is to sorb to available organic carbon in the sediment or to be taken up by biota such as fish. This is expressed as the ratio of the compound's solubility in octanol (used as a lipid surrogate) to its solubility in water (K_{ow}). The higher the K_{ow}, the less soluble and more hydrophobic the compound and, consequently, the more readily bioaccumulated (Karickhoff 1981). Additionally, the more hydrophobic (high K_{ow}) the compound, the slower it is released (depurated) from the organism. The bioconcentration factor (BCF) is the ratio of concentration of the chemical in the organism to its concentration of the chemical in the water (or other media). The K_{ow} has been positively correlated to the BCF of a compound. MacKay (1982) found this relationship to be BCF=0.048 K_{ow}, although this relationship is not definitive. Several other factors such as steric properties of molecules and pharmacokinetic intercompartmental rate constants also affect uptake and depuration. Thus, K_{ow} should only be used to yield a relative estimate of the bioconcentration potential of a chemical.

A partition coefficient, K_p, may be calculated from the concentration of the compound in the sediment (C_s) and the concentration in the water (C_w). A first order approximation of K_p for PAHs (and other hydrophobic compounds) is governed by the amount of organic carbon in the system and their K_{ow}s. The organic carbon partition coefficient (K_{oc}) has been correlated with the K_{ow} and defines the compound's affinity to sorb to organic carbon, or the concentration in organic carbon/ concentration in water. Thus the K_p of a compound in a system can be determined from the K_{oc}.

Due to their high K_p, most of the hydrophobic organics and metals entering a river quickly become adsorbed to organic and inorganic particulate matter and large amounts of the compounds are deposited in the sediments. This contaminant burden remains relatively near the point sources and concentrations decrease approximately logarithmically with distance from the source. Leaching or biologic activity may return a small portion to the water column, by relative concentrations, metals and hydrophobic contaminants in aquatic systems are generally highest in sediments, intermediate in biota and lowest in water (Neff 1985, Enk and Mathis 1977). Chemical transformation and

degradation of xenobiotics in aquatic environments occurs through photooxidation, chemical oxidation and biological transformation. Most of these pathways require oxygen, which being limited in the sediments, creates a stable environment for contaminant persistance. Metabolism in animals is via enzymatic systems commonly referred to as MFOs (mixed-function oxygenase). Through these enzymatic pathways, phthalates are quickly metabolized and eliminated, thus have little bioaccumulative potential (Callahan et al. 1979). Some PAHs are transformed into intermediates that are highly toxic, mutagenic or carcinogenic to the organism. Organisms which lack MFOs (e.g. coelenterates and ctenophores) lack the ability to transform these compounds and thus may accumulate higher amounts without harm. PAHs have been found in tissues of many fresh- and saltwater organisms. This accumulation occurs from water, sediments and/or ingested food and other items (e.g. sediments).

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APPENDIX C

EXPOSURE AND RISK CHARACTERIZATION METHODOLOGY

C.0 EXPOSURE AND RISK CHARACTERIZATION METHODOLOGY

The purpose of this appendix is to present the methodology, assumptions, and models used to evaluate exposure and risk in the text of the endangerment assessment. An exposure pathway is complete if four elements are present: (1) a source and mechanism of chemical release to the environment, (2) an environmental transport medium (e.g., groundwater, surface water), (3) a point of potential contact with the contaminated medium (the exposure point), and (4) an exposure route at the contact point (e.g., ingestion of groundwater).

In the text, an evaluation of the risks associated with a number of exposure scenarios associated with the various properties and the central area of the Wells G & H site were discussed. A number of the exposure pathways were common to all or most of the areas. These exposure pathways will be discussed first followed by those pathways with limited applicability.

C.1 INGESTION OF GROUNDWATER

The groundwater beneath the Wells G & H site is contaminated with a variety of organic and inorganic compounds. In each area specific evaluation, the concentration of the chemicals of potential concern was used to calculate a chronic daily intake (CDI) which was subsequently used to evaluate risk. The CDI estimates for ingestion of groundwater were calculated as follows:

$$CDI = \frac{(C_w)(I)(YR)}{(BW)(YL)} \qquad (1)$$

where

- CDI = chronic daily intake (mg/kg/d);
- C_w = chemical concentration in groundwater (mg/liter);
- I = amount of water ingested (liter/d);
- YR = years of exposure (year);
- BW = average body weight (kg); and
- YL = years in a lifetime (year).

C.2 SHOWER MODEL

Volatile organic chemicals (VOCs), dissolved in household water supplies can be released into the indoor air as a result of activities such as showering, bathing and dishwashing. Of particular concern to human health is the potential for elevated exposures to occur in the confined space of a shower. The shower model developed by Foster and Chrostowski (1987), was used to assess the possible inhalation exposures to VOCs from ground water at the Wells G & H site. In the shower model inhalation exposures are modeled by estimating the rate of chemical release into the air (generation rate), the buildup (shower on) and decay (shower off) of VOCs in shower room air, and the quantity of airborne VOCs inhaled while the shower is both on and off.

Estimation of the rate of VOC release into the air is based upon Liss and Slater's adaptation of the two-layer film model of gas-liquid mass transfer. The two-film boundary theory provides the basis for estimating the overall mass transfer coefficient (KL) for each VOC of interest according to the following equation:

$$K_L = (1/k_l + RT/Hk_g)^{-1} \qquad (1)$$

where

K_L = overall mass transfer coefficient (cm/hr),

H = Henry's Law Constant (atm-m^3/mol-K)

RT = 2.4×10^{-2} atm-m^3/mole (gas constant of 8.2×10^{-5} atm-m^3/mol-K times absolute temperature of 293 K),

k_g = gas-film mass transfer coefficient (cm/hr), and

k_l = liquid-film mass transfer coefficient (cm/hr).

Equation 1 describes the mass transfer rate of a compound at an air-water interface where diffusion may be limited by both liquid- and gas-phase resistances.

The chemical-specific resistances to mass transport for both the liquid and gas phases were calculated from empirical expressions suggested by Liss and

Slater (1974). Typical values of k_l (20 cm/hr) and k_g (3,000 cm/hr), which have been measured for CO_2 and H_2O, respectively, were used to estimate VOC-specific values for these parameters:

$$k_l = 20*[44/MW]^{1/2} \quad (2)$$

$$k_g = 3000*[18/MW]^{1/2} \quad (3)$$

where:

k_l = liquid-phase mass transfer coefficient (cm/hr);

k_g = gas-phase mass transfer coefficient (cm/hr); and

MW = molecular weight of the chemical.

The mass transfer coefficient, K_L, is adjusted to the shower water temperature, T_s, according to a semi-empirical equation developed to estimate the effect of temperature on oxygen mass-transfer rate:

$$K_{aL} = K_L(T_l m_s/T_s m_l)^{-0.5} \quad (4)$$

where:

K_{aL} = adjusted overall mass transfer coefficient (cm/hr);

T_l = calibration water temperature of K_L (K);

T_s = shower water temperature (K);

m_l = water viscosity at T_l (cp); and

m_s = water viscosity at T_s (cp).

The concentration leaving the shower droplet, C_{wd}, is obtained from an integrated rate equation based on a mass-balance approach:

$$C_{wd} = C_{w0}(1-\exp[-K_{aL}t_s/60d]) \quad (5)$$

where

C_{wd} = concentration leaving shower droplet after time t_s (ug/l);

C_{w0} = shower water concentration (ug/l);

d = shower droplet diameter (mm); and

t_s = shower droplet drop time (sec).

The term $K_{aL}/60d$ combines both the rate transfer and the available interfacial area across which volatilization can occur. The value 1/60d equals the specific interfacial area, 6/d, for a spherical shower droplet of diameter d multiplied by conversion factors (hr/3,600 sec and 10 mm/cm).

The VOC generation rate in the shower room, S, can then be calculated by the equation:

$$S = C_{wd}(FR)/SV \tag{6}$$

where

S = indoor VOC generation rate (ug/m^3-min);

FR = shower water flow rate (l/min); and

SV = shower room air volume (m^3).

A simple one-box indoor air pollution model was used to estimate VOC air concentrations in the shower room. This model can be expressed as a differential equation describing the rate of change of the indoor pollutant concentration with time:

$$dC_a/dt = RC_a + S \tag{7}$$

where

C_a = indoor VOC air concentration (ug/m^3); and

R = air exchange rate (min^{-1}).

When equation 7 is integrated, the time-dependent indoor concentration can be estimated as follows:

$$C_a(t) = (S/R)(1 - \exp[-Rt]) \text{ for } t \leq D_s \tag{8}$$

and

$$C_a(t) = (S/R(\exp[RD_s] - 1)\exp(-Rt) \text{ for } t > D_s \quad (9)$$

where

$C_a(t)$ = indoor air VOC concentration at time t (mg/m^3);

D_s = shower duration (min); and

t = time (min).

The inhalation exposure per shower can then be calculated according to the equation:

$$E_{inh} = [VR/(BW)(10^6)] \int_0^{D_t} C_a(t)dt \quad (10)$$

where

E_{inh} = inhalation exposure per shower (mg/kg/shower);

VR = ventilation rate (l/min);

BM = body weight (kg); and

D_t = total duration in shower room (min).

This equation can be solved as:

$$E_{inh} = [(VR)(S)/[(BW)(R)(10^6)] [D_s - 1/R + \exp(-RD_s)/R] \quad (11)$$

for the duration of the shower, and as:

$$E_{inh} = [(VR)(S)/[(BW)(R)(10^6)] \times [D_s + \exp(-RD_t)/R - \exp[R(D_s - D_t)]/R] \quad (12)$$

for both the duration of the shower and the duration in the room after the shower is turned off.

Table C-1 lists the input parameters to the shower model.

TABLE C-1

INPUT PARAMETERS TO THE SHOWER MODEL

Parameter	Value
Inhalation Factor	0.46
Shower Water Temperature	318 K
Water Viscocity at Shower Temperature	0.596 cp
Shower Droplet Drop Time	2 sec
Shower Droplet Diameter	1 mm
Shower Water Flow Rate	10 liter/min
Air Flow Rate	0 m^3/min
Air Exchange Rate in Shower Room	0.5 hr^{-1}
Ventilization Rate	15 liter/min
Shower Duration	10 min
Duration in Shower Room After Shower Stops	5 min
Body Weight	70 kg

C.3 DIRECT CONTACT WITH CONTAMINATED SOILS, SLUDGES, AND SEDIMENTS

Direct contact with contaminated soil is considered most likely to occur by several mechanisms: young adults using the area for recreational purposes, industrial workers using the area, or future onsite residents of the areas. Direct contact with sediments could occur while an adult or child was wading in the Abejona River. In each case, direct contact with the contaminated soils, sludges, and sediments could lead to dermal contact and absorption of contaminants through the skin, as well as inadvertent ingestion of the compounds.

Tables C-2, C-3, C-4, and C-5 present the assumptions used in assessing exposure via these pathways. These assumptions were based on the exposure pathway analysis presented in the text and the best currently available information. EPA standard assumptions for average lifetime (70 years) and body weights for children, young adults and adults (27 kg, 45 kg, 70 kg, respectively) were used (Anderson et al. 1985). The future residential scenario body weight of 70 kg is based upon a lifetime average body weight.

Average and plausible maximum incidental soil ingestion rates for young adults are 50 and 100 mg/visit, respectively, and are 25 and 100 mg/visit, respectively, for adults. The future residential scenario ingestion rates of 54 mg/day and 145 mg/day are based upon lifetime averages. The derivation of these rates was based primarily on the work of LaGoy (1987). Incidental ingestion of the sediments was assumed not to occur.

Values of 400 mg/day and 990 mg/day are used as the average and plausible maximum estimates of soil contact rates for dermal exposure for the current land-use scenarios. The soil contact rates for the future residential exposure are based upon lifetime average exposures which result in contact rates of 790 mg/day and 5,400 mg/day for the average and plausible maximum cases, respectively. The sediment contact rates for adults were 420 mg/d for the average case and 1,260 mg/d for the plausible maximum case and for children were 300 mg/d and 1,000 mg/d for the average and plausible maximum cases, respectively. These values are contact rates for each exposure event

TABLE C-2

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR DIRECT CONTACT BY WORKERS WITH SOIL AT THE NEW ENGLAND PLASTICS CORPORATION PROPERTY AND THE OLYMPIA NOMINEE TRUST PROPERTY

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	48 days	100 days
Duration of Exposure	10 yr	10 yr
Average Weight	70 kg	70 kg
Incidental Ingestion Rate	25 mg/day	100 mg/day
Percent of Phthalates Absorbed from Ingested Soils	15%	45%
Percent Other Organic Compounds Absorbed from Ingested Soil	100%	100%
Soil Contact Rate	400 mg/day	990 mg/day
Percent Phthalates Absorbed Dermally from Skin	0.3%	3%
Percent Other Organic Compounds Absorbed Dermally from Skin	1%	10%
Average Lifetime	70 years	70 years

TABLE C-3

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR DIRECT CONTACT BY YOUNG ADULTS WITH SOIL SLUDGES AT THE OLYMPIA NOMINEE TRUST AND WILDWOOD CONSERVATION CORPORATION PROPERTIES

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	100 d/yr	168 d/yr
Duration of Exposure	6 yr	6 yr
Average Weight	45 kg	45 kg
Average Lifetime	70 yr	70 yr
Incidental Ingestion Rate	50 mg/d	100 mg/d
Percent PAHs, Pesticides, PCBs, Phthalates Absorbed from Ingested Soils	15%	45%
Percent Other Organic Compounds Absorbed from Ingested Soils	100%	100%
Percent Inorganic Compounds Absorbed from Ingested Soils	100%	100%
Soil Contact Rate	400 mg/day	990 mg/day
Percent PAHs, Pesticides, PCBs, Phthalates Absorbed Dermally from Skin	0.3%	3%
Percent Other Organic Compounds Absorbed Dermally from Skin	1%	10%
Percent Inorganic Compounds Absorbed Dermally from Skin	Negligible	Negligible

TABLE C-4

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR DIRECT CONTACT BY FUTURE RESIDENTS WITH SOIL AND SLUDGES AT THE WELLS G & H SITE

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	100 d/yr	168 d/yr
Duration of Exposure	70 yr	70 yr
Average Weight[a]	70 kg	70 kg
Incidental Ingestion Rate[a]	54 mg/d	145 mg/d
Percent Phthalates, PAHs, PCBs, Pesticides Absorbed from Ingested Soils	15%	45%
Percent Other Organic Compounds Absorbed from Ingested Soils	100%	100%
Percent Inorganic Compounds Absorbed from Ingested Soils	100%	100%
Soil Contact Rate[a]	0.79 g/d	5.4 g/d
Percent Phthalates, PAHs, PCBs, Pesticides Absorbed Dermally from Skin	0.3%	3%
Percent Other Organic Compounds Absorbed Dermally from Skin	1%	10%
Percent Inorganic Compounds Absorbed Dermally from Skin	Negligible	Negligible
Average Lifetime	70 years	70 years

[a] Based on lifetime averages.

TABLE C-5

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR DIRECT CONTACT WITH SEDIMENTS BY INDIVIDUALS AT THE CENTRAL AREA

Parameters	Average Exposure	Plausible Maximum Exposure
General		
Frequency of Exposure	16 days/year	32 days/year
Percent Phthalates, PAHs, PCBs, Pesticides Absorbed Dermally	0.3%	3%
Percent Other Organic Compounds Absorbed Dermally	1%	10%
Adults		
Sediment Contact Rate	420 mg/day	1,260 mg/day
Duration of Exposure	5 years	30 years
Average Body Weight	70 kg	70 kg
Children		
Sediment Contact Rate	300 mg/day	900 mg/day
Duration of Exposure	5 years	5 years
Average Body Weight	27 kg	27 kg

and are based on a consideration of contact rates in mg soil/cm^2 skin (0.5-1.5 mg/cm^2) from Schaum (1984), surface area of parts of the body that are likely to be in contact with soil (e.g., approximately 250 cm^2 for the palms of the hands) from Anderson et al. (1985), and of certain subjective factors (i.e., children have less surface area than adults but are more likely to play in soil). These are reasonable values, but they are another source of uncertainty in the risk calculation.

Poiger and Schlatter (1980) noted that approximately 5% of the TCDD was absorbed from a soil and water paste applied to rat skin; Feldmann and Maibach (1974) reported that 8% of the aldrin, dieldrin, or lindane applied to human skin in acetone was absorbed. Analogy to the Poiger and Schlatter study probably overestimates absorption for the following reasons: Rodent skin is much more permeable than human skin (Feldmann and Maibach 1974); absorption is likely to be higher from a soil and water paste than from drier soil; and TCDD was added to the paste only 10-15 hours before application and therefore was not fully adsorbed. Similarly, dermal absorption of soil-incorporated chemicals of potential concern is likely to be lower than absorption of pesticides dissolved in acetone. Based on a consideration of the available data and the bioavailability of the chemicals of potential concern from soil, a value of 10% will be used as the plausible maximum dermal absorption and a value of 1% will be used as the average dermal absorption rate for organic chemicals. Dermal absorbtion rates of 0.3% and 3% were used for the phthalate esters, PCBs, PAHs, and pesticides. These values are likely to be accurate within an order of magnitude. Significant exposure via dermal absorption to the inorganic chemicals of potential concern is not expected considering the very low permeability of skin to metal ions [as reviewed by Schaefer et al. (1983)].

Exposure to site-related chemicals may occur as a result of inadvertent ingestion of soil during recreational or work-related activities at the Wells G & H site. Kimbrough et al. (1984) estimated that adults and children older than 11 years of age may incidentally ingest as much as 100 mg of soil per day. This value is used in this assessment as a maximum intake estimate for young adults and adults. Based on the work of LaGoy (1987), a value of 50

mg/day is used to estimate an average soil intake for exposed young adults. An average intake of 25 mg/day may be a more reasonable estimate for adults who do not exhibit frequent hand-to-mouth contact (e.g., many nonsmokers), and this value was used for adult workers.

Pesticides, phthalates, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) present in soil are likely to be strongly sorbed to soil, and consequently may be less bioavailable than these same chemicals in drinking water or in animal feed (typical media in animal studies used to derive toxicity criteria). Values of 15% and 45% were used for these compounds to reflect this diminished bioavailability based on physicochemical properties and analogy to studies by Poiger and Schlatter (1980) and Umbreit et al. (1986) with TCDD. For the other organic chemicals of potential concern, an oral absorbtion factor of 100% was used. The inorganic chemicals of potential concern are assumed to become bioavailable upon ingestion, and a value of 100% absorption was used for these compounds.

Using these assumptions, chronic daily intake (CDI) estimates for incidental soil ingestion for children and adults are calculated as follows:

$$CDI = \frac{(Cs)(I)(AI)(E)(YR)(X)}{(BW)(DY)(YL)} \qquad (2)$$

where:

CDI = chronic daily intake (mg/kg/day)

Cs = chemical concentration in soil (mg/kg);

I = amount of soil ingested (mg/visit);

AI = differential absorption factor;

E = frequency of exposure events (visits/yr);

YR = years of exposure (years);

X = conversion factor (kg/10^6 mg);

BW = average body weight (kg);

DY = days in a year (365 days/year); and

YL = years in lifetime or in the period over which risk is being estimated (70 year lifetime for carcinogens, period of exposure for noncarcinogens).

CDIs for dermal absorption of chemical contaminants for children and adults are calculated as follows:

$$CDI = \frac{(Cs)(CD)(E)(YR)(Z)(ABS)}{(BW)(DY)(YL)} \qquad (3)$$

where:

CDI = chronic daily intake (mg/kg/day);

Cs = chemical concentration in soil (mg/kg);

CD = contact rate for soil (g/visit);

E = frequency of exposure events (visits/year)

YR = years of exposure;

Z = conversion factor (kg/1,000g); and

ABS = dermal absorption factor;

BW = average body weight (kg);

DY = days in year (365 days/year);

YL = years in lifetime or in the period over which risk is being estimated (70 year lifetime for carcinogens, period of exposure for noncarcinogens).

The total CDI associated with direct contact with soils is the sum of the CDIs from incidental ingestion and dermal absorption. The total CDI associated with direct contact with sediments is the CDI from dermal absorption.

C.4 EXPOSURE TO CONTAMINANTS RELEASED FROM SOILS AND SLUDGES VIA INHALATION

The soil and sludges in some of the areas of the Wells G & H site are a source of contaminants which can be transferred to the air. Several volatile organic compounds detected in soils can volatilize and be released to the air. There unpaved paths at the Olympia and Wildwood properties and dirt bikes are known to drive along the former and could, in the absence of the fence, drive along the latter. Dirt bikes driving along these paths will release dust and hence the compounds adsorbed to the soil. The equation used to calculate the

chronic daily intake is presented below. Detailed descriptions of the equations used to calculate the emission rates and the resulting air concentrations are also found in the sections that follow.

Young adults using the Wells G & H site for recreational purposes or workers at the New England Plastics Corporation property may be exposed via inhalation to contaminated air under current conditions at the site. Future residents at the Wells G & H site could also inhale contaminated air. Exposure to air contaminants may occur through inhalation of chemicals volatilized from soil (at Wildwood and New England Plastics) or through inhalation of vehicle-generated dust (at Olympia and Wildwood). Tables C-6 and C-7 present the assumptions used in assessing inhalation exposure under current conditions. Table C-8 summarizes the assumptions used to assess future residential exposure. These exposures were based upon the exposure pathway analysis presented in the main text. EPA standard assumptions for body weight, inhalation rates and average lifetime were used (Anderson et al. 1985).

CDIs of inhaled airborne contaminants for exposed populations on site were derived using the assumed frequencies and durations, respiration rates, and body weights listed in Tables C-6, C-7, and C-8. In the absence of definitive toxicokinetic data, 100% absorption of inhaled contaminants was assumed. For chemicals considered to be potentially carcinogenic by inhalation, the total cumulative exposure over the exposure period (for current exposures) was prorated over a 70 year lifetime to derive an average daily intake in mg/kg/day. For chemicals which may cause noncarcinogenic effects by inhalation, the average daily exposure over the exposure period was calculated. The equation used to estimate the CDI is:

$$CDI = \frac{(C_a)(V)(HR)(E)(YR)}{(BW)(DY)(LT)} \qquad (4)$$

where

CDI = chronic daily intake (mg/kg/d);

C_a = ambient air concentration (mg/m^3);

TABLE C-6

ASSUMPTIONS FOR USE IN THE RISK ASSESSMENT FOR INHALATION OF CONTAMINATED AIR AT THE OLYMPIA NOMINEE TRUST COMPANY PROPERTY AND THE WILDWOOD CONSERVATION CORPROATION PROPERTY

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	100 days/year	168 days/year
Duration of Exposure	6 years	6 years
Inhalation Rate	2.8 m^3/hr	2.8 m^3/hr
Length of Visit	1 hour	2 hours
Average Weight Over Period of Exposure	45 kg	45 kg
Average Lifetime	70 years	70 years

TABLE C-7

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR OUTDOOR INHALATION EXPOSURE OF INDUSTRIAL WORKERS AT THE NEW ENGLAND PLASTICS CORPORATION PROPERTY

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	1 hr/d	1 hr/d
Duration of Exposure	48 d/yr	100 d/yr
Length of Employment	10 yr	20 yr
Inhalation Rate	2.6 m^3/hr	2.6 m^3/hr
Average Body Weight	70 kg	70 kg
Average Lifetime	70 yr	70 yr

TABLE C-8

ASSUMPTIONS FOR USE IN RISK ASSESSMENT FOR OUTDOOR INHALATION EXPOSURE BY FUTURE RESIDENTS AT THE NEW ENGLAND PLASTICS CORPORATION PROPERTY AND THE WILDWOOD CONSERVATION CORPORATION PROPERTY

Parameters	Average Exposure	Plausible Maximum Exposure
Frequency of Exposure	1 hr/day	3 hr/day
Duration of Exposure	100 d/yr	168 d/yr
Inhalation Rate[a]	2.1 m^3/hr	2.1 m^3/hr
Average Weight	70 kg	70 kg
Average Lifetime	70 yr	70 yr

[a] Based on a lifetime average.

V = ventilation rate (m3/hr);

HR = length of exposure (hr);

E = number of exposure events (d/yr);

YR = years of exposure (yr);

BW = body weight (kg);

DY = days in a year (365 d/yr); and

YL = years in lifetime or in the period over which risk is being assessed (70 year lifetime for carcinogens, less than lifetime for noncarcinogens).

C.4.1 PARTICLE EMISSIONS MODEL FOR VEHICULAR TRAFFIC

Vehicle traffic on unpaved roads is a source of PM_{10} emission as the turbulent wake behind the vehicle entrains dust particles. In this exposure scenario, vehicles are assumed to travel over a portion of the inactive site area being used for temporary storage. An empirical expression presented by Cowherd et al. (1984) was used to estimate the PM_{10} emissions associated with vehicle traffic.

Estimation of the PM_{10} emission rate for vehicle traffic required specification of several variables which characterize the road surface, the vehicles on the road, and the distance traveled on the road. The silt content of the road surface material was assumed to be 25 % based on the soil type at the site. Moisture in the road surface will eliminate emissions associated with vehicle traffic. The emission rate equation includes a term to reduce the calculated annual emission rate to account for the number of days with at least 0.254 mm (0.01 in.) of precipitation per year. Based on National Weather Service records collected at Stapleton Airport in Boston, MA, the number of days with rain greater than 0.254 mm was set at 128.

Assumptions concerning the vehicles traveling on the unpaved roads and the distances traveled were made based on the size and purpose of the hypothetical storage area within the Inactive site area. The average vehicle was

characterized as having 2 wheels and a weight of 9.1×10^{-2} Mg (~200 lbs). The mean vehicle speed was estimated to be approximately 40 km/hr (25 mph).

The emission rate of PM_{10} due to vehicle traffic is the product of the emission factor and the source extent. Having specified values for the required parameters, the emission factor was determined by:

$$e_{10v} = (0.85)\left[\frac{s}{10}\right]\left[\frac{S}{24}\right]^{0.80}\left[\frac{W}{7}\right]^{0.3}\left[\frac{w}{6}\right]^{1.2}\left[\frac{365 - p}{365}\right] \qquad (5)$$

where

e_{10v}	=	PM_{10} emission factor per vehicle-kilometer of travel, VKT, (kg/VKT)
s	=	silt content of soils (%).
S	=	mean vehicle speed (km/hour).
W	=	mean vehicle weight (Mg).
w	=	mean number of wheels.
p	=	number of days with at least 0.254 mm of precipitation per year.

Table C-9 lists the parameter values used to calculate the emission factor.

The source extent term used in the emission rate equation describes the vehicle kilometers traveled on the unpaved surfaces. It is the product of the distance traveled per vehicle and the number of vehicles per day. For this assessment it was assumed that 4 vehicles made 20 round trips per day. The distance traveled was determined by assuming the vehicles would travel along the unpaved paths of the Olympia or Wildwood properties, a distance of 275 m and 366 m, respectively. The vehicle distance traveled, T_v, was calculated using the following expression:

$$T_v = \frac{\text{\# of round trips}}{\text{1 Day}} \times \frac{\text{\# of vehicles}}{\text{round trip}} \times \frac{\text{distance traveled}}{\text{vehicle}} \times \frac{\text{1 Day}}{\text{86,400 s}} \qquad (6)$$

Table C-9 lists the calculated value for T_v.

TABLE C-9

INPUT PARAMETERS TO VEHICLE TRAFFIC
EMISSION RATE EQUATION

s	16.3%
S	40 mg/hr
W	0.091 Mg
w	2 wheels
P	128 days
e_{10v}	0.0984 kg/VKT
Olympia T_v	2.55×10^{-4} VKT/s
Wildwood T_v	3.39×10^{-4} VKT/s
Olympia E_{10v}	2.52×10^{-5} kg/s
Wildwood E_{10v}	3.34×10^{-5} kg/s

Using the emission factor and the source extents calculated above, the PM_{10} mission rate for vehicle traffic over an unpaved surface was calculated by:

$$R_{10} = W\ e_{10v}\ T_v\ X = WE_{10v} \qquad (7)$$

where:

R_{10} = average contaminant emission rate [g/s].

W = mass fraction of contaminant in soil [g/g].

T_v = vehicle distance traveled, [VKT/s]

X = Conversion factor, 10^3 g/kg.

WE_{10v} = PM_{10} emission rate [g/s]

The on-site ambient concentrations associated with vehicle traffic emissions were found by using the appropriate R_{10} value in the box model. The values for W and R_{10} are listed in Table C-10.

C.4.2 SOIL VOLATILIZATION EMISSIONS MODEL

Mathematical models have been developed to predict volatilization rates of organic chemicals when the chemical concentration in the soil is known. One such model proposed by Karimi et al. (1987) was used to calculate the emissions of volatile organic compounds due to soil volatilization at the New England Plastics Corporation property and the Wildwood Conservation Corporation Property at the Wells G & H site.

In the soil matrix a chemical can exist in the following three phases: adsorbed to soil particles; as a liquid in the soil pore spaces; or as a vapor also in the soil pore spaces. In the Karimi model the flux rate of chemicals from the soil into the air is a result of Fickian diffusion of chemical vapors up through the soil matrix. Thus it was necessary to determine the concentration of vapors in the soil pore spaces associated with the reported concentrations of chemicals adsorbed to soil particles at the Inactive area site. By assuming an equilibrium partitioning between the adsorbed, liquid and gas phases of a chemical in the soil matrix, it was possible to determine the chemical concentration in each phase.

TABLE C-10

MASS FRACTIONS AND EMISSION RATES FOR
VEHICULAR TRAFFIC EMISSION RATE EQUATION

COMPOUND	W (g/g) GEOMETRIC MEAN	W (g/g) MAXIMUM	R10 (mg/s) AVERAGE	R10 (mg/s) PLAUSIBLE MAXIMUM
OLYMPIA				
Chromium	2.03E-05	9.24E-04	5.10E+02	2.32E+04
4,4'-DDT	2.95E-08	3.66E-07	7.40E-01	9.19E+00
Lead	2.38E-05	4.24E-04	5.97E+02	1.06E+04
cPAHs (a)	3.13E-08	3.41E-06	7.86E-01	8.56E+01
nPAHs (b)	1.69E-08	2.62E-06	4.24E-01	6.58E+01
WILDWOOD SOILS				
Acetone	8.14E-08	1.20E-06	2.72E-06	4.01E-05
Bis(2-ethylhexyl)-phthalate	4.07E-07	9.35E-06	1.36E-05	3.12E-04
Cadmium	7.20E-07	2.72E-05	2.40E-05	9.08E-04
Chlordane	6.81E-08	2.30E-05	2.27E-06	7.68E-04
Chromium	4.55E-05	3.06E-03	1.52E-03	1.02E-01
4,4'-DDT	4.15E-08	1.02E-06	1.39E-06	3.41E-05
trans-1,2-Dichloro-ethene	4.07E-09	8.90E-08	1.36E-07	2.97E-06
Lead	3.10E-05	6.83E-04	1.04E-03	2.28E-02
Methylene chloride	2.21E-08	6.70E-07	7.38E-07	2.24E-05
cPAHs (a)	1.10E-06	6.09E-06	3.67E-05	2.03E-04
nPAHs (b)	7.13E-07	3.83E-06	2.38E-05	1.28E-04
PCBs (c)	3.86E-07	1.30E-04	1.29E-05	4.34E-03
Tetrachloroethene	7.44E-09	2.00E-06	2.48E-07	6.68E-05
Toluene	6.21E-09	4.96E-08	2.07E-07	1.66E-06
Trichloroethene	8.18E-08	1.20E-05	2.73E-06	3.99E-04
WILDWOOD NORTHERN SLUDGES				
Bis(2-ethylhexyl)-phthalate	NA	3.70E-05	--	1.24E-03
Cadmium	3.46E-06	1.30E-05	1.16E-04	4.34E-04
Chlordane	6.62E-06	8.10E-05	2.21E-04	2.71E-03
Chloroform	NA	3.15E-06	--	1.05E-04
Chromium	2.70E-04	8.02E-04	9.02E-03	2.68E-02
4,4'-DDT	NA	1.97E-05	--	6.58E-04
Lead	8.19E-04	6.18E-03	2.74E-02	2.06E-01
cPAHs (a)	1.46E-05	5.92E-05	4.88E-04	1.98E-03
nPAHs (b)	2.59E-04	9.66E-04	8.65E-03	3.23E-02
Pentachlorophenol	NA	6.40E-06	--	2.14E-04
Phenol	NA	9.80E-06	--	3.27E-04
Xylenes	NA	6.10E-05	--	2.04E-03

NA = Not applicable; geometric mean not calculated with only one positive detection.
(a) Carcinogenic polynuclear aromatic hydrocarbons.
(b) Noncarcinogenic polynuclear aromatic hydrocarbons.
(c) Polychlorinated biphenyls.
NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

TABLE C-10 CONTINUED

MASS FRACTIONS AND EMISSION RATES FOR
VEHICULAR TRAFFIC EMISSION RATE EQUATION

COMPOUND	W (g/g) GEOMETRIC MEAN	W (g/g) MAXIMUM	R10 (mg/s) AVERAGE	R10 (mg/s) PLAUSIBLE MAXIMUM
WILDWOOD SOUTHERN SLUDGES				
Bis(2-ethylhexyl)-phthalate	1.26E-06	1.50E-04	4.21E-05	5.01E-03
Cadmium	7.00E-07	1.80E-05	2.34E-05	6.01E-04
Chlordane	NA	2.00E-05	--	6.68E-04
Chromium	4.16E-05	4.10E-04	1.39E-03	1.37E-02
4,4'-DDT	6.44E-07	3.20E-04	2.15E-05	1.07E-02
trans-1,2-Dichloro-ethene	NA	1.20E-07	--	4.01E-06
Lead	6.38E-04	1.00E-02	2.13E-02	3.34E-01
cPAHs (a)	2.25E-06	1.00E-05	7.53E-05	3.35E-04
nPAHs (b)	6.05E-06	3.80E-05	2.02E-04	1.27E-03
Pentachlorophenol	NA	1.10E-04	--	3.67E-03
Tetrachloroethene	NA	8.60E-05	--	2.87E-03
Toluene	NA	1.50E-06	--	5.01E-05
1,1,1-Trichloroethane	NA	1.10E-05	--	3.67E-04
Trichloroethene	1.33E-08	1.50E-05	4.44E-07	5.01E-04

NA = Not applicable; geometric mean not calculated with only one positive detection.
(a) Carcinogenic polynuclear aromatic hydrocarbons.
(b) Noncarcinogenic polynuclear aromatic hydrocarbons.
(c) Polychlorinated biphenyls.
NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

The phase partitioning between the adsorbed and liquid phases is a function of the fraction of organic carbon (f_{oc}) in the soil and the tendency for the compound to be adsorbed by the organic matter. The value for f_{oc} for soils at the Wells G & H site (i.e., at all properties considered) was assumed to be 1%. The tendency for a chemical to be adsorbed to organic matter in the soil can be described by the organic carbon partition coefficient (K_{oc}). The equilibrium concentration of a chemical in solution was determined by:

$$C_l = \frac{C_s}{K_{oc}\ f_{oc}} \tag{8}$$

where:

C_l = concentration of chemical in solution, [g/ml]

C_s = concentration of chemical adsorbed to soil, [g/g].

The concentration of a chemical in solution was used with the liquid-vapor partition coefficient to determine the equilibrium vapor-phase concentration. The liquid-vapor partition coefficient is generally represented by the chemical-specific Henry's Law constant. Thus the vapor-phase concentration of a chemical in the soil pore spaces was determined by:

$$C_g = \frac{C_l\ H}{R\ \ T} \tag{9}$$

where:

C_g = concentration of chemical in the vapor phase, [g/cm^3]

H = Henry's Law constant, [atm-m^3/mol],

R = universal gas constant, [8.19x10^{-5} atm-m^3/mol-K]

T = soil temperature, [293 K].

The soil column was assumed to be isothermal with a constant temperature of 20°C. This assumption will yield an average estimate of the annual volatilization flux since periods of lower soil temperatures at the Inactive area site could retard or even halt the volatilization process. While higher temperatures could accelerate the process.

Once the chemicals are in a vapor phase they will diffuse up through the soil column driven by the concentration gradient in the soil column. The diffusion

of vapors in the soil is affected by the soil porosity and geometry. The effect of the soil character on vapor phase diffusion was accounted for by using an empirical model suggested by Millington and Quirk (1961). Using the Millington-Quirk model an effective diffusion coefficient for vapor phase diffusion in the soils was calculated as:

$$D_s = \frac{D_o \ (P_a)^{10/3}}{(P_t)^2} \qquad (10)$$

where:

D_s = effective vapor phase diffusion coefficient in soil, [cm^2/s]

D_o = vapor phase diffusion coefficient in air, [cm^2/s]

P_a = air-filled porosity, [m^3/m^3]

P_t = total porosity, [m^3/m^3].

For this assessment it was assumed that the soils would be dry for the entire year. Thus the soil air-filled porosity was set equal to the total porosity. The total porosity of the soil was assumed to be 0.5.

Having determined values for the input parameters used in the Karimi model, it was possible to determine the steady-state flux rate of volatile organic chemicals by:

$$J = \frac{-D_s(C_2 - C_g)X}{L} \qquad (11)$$

where:

J = flux rate of vapors through the soil, [g/m^2-s]

D_s = effective vapor phase diffusion coefficient in soil, [cm^2/s]

C_2 = vapor-phase concentration at the soil surface, [g/cm^3]

C_g = vapor-phase concentration in the soil at depth L, [g/cm^3]

L = depth of volatile organic chemicals, [cm]

X = conversion factor, [10^4 cm^2/m^2].

This equation was simplified as suggested by Karimi et al. (1987) by assuming that C_2 is zero. This assumption is valid since compared to C_g the value of

C_2 is very small. Additionally, this assumption leads to a conservative flux rate since any value for C_2 greater than zero will result in a lower concentration gradient in the soil column and a lower flux rate. The value for the depth of volatile organic chemicals was assumed to be 30.5 cm (1 foot). This corresponds to the depth of most soil samples which were used to calculate the values of C_g.

The chemical-specific values for the input parameters and the resulting flux rate are listed in Tables C-11 and C-12 for the New England Plastics and Wildwood Conservation Corporation Properties, respectively. The calculated flux rates were used in combination with air dispersion modeling results to determine the on-site ambient air concentrations associated with the soil volatilization of organic chemicals.

C.4.3 BOX MODELS FOR AIR DISPERSION

For this study, a box model was used to determine the ambient contaminant concentrations at the source. The box model assumes steady and spatially uniform conditions of dispersion so that the emissions from an area source are uniformly distributed throughout a box defined by the area of the source and the mixing height. Because of the differences in source characteristics at the properties evaluated for outdoor air exposure, two different box models were used to calculate the air concentrations associated with each site.

The application of the box model for air dispersion requires steady-state emission rates, a constant wind vector, and also that the crosswind distance of the area source is large in comparison to the downwind distance of the receptor. To meet these requirements, all emission rates were calculated for steady state, the wind speed was chosen to be the annual average wind speed for Boston, MA., and the receptor location was the site of the area source. The only condition left to determine was the height of the box. Box models used on an urban scale often use the height of the daytime mixing layer, ($\approx$500m), as the height of the box. For that definition to be appropriate, a downstream fetch on the order of tens of kilometers is required. The mean vertical displacement of emissions as a function of stability and downwind

TABLE C-11

AIR FLUXES AND VOLATILIZATION RATES FOR VOLATILIZATION
AT THE NEW ENGLAND PLASTICS CORPORATION PROPERTY

CHEMICAL	Flux Rate [g/cm^2-s] Mean	Flux Rate [g/cm^2-s] Maximum	Emission Rate [g/s] Mean	Emission Rate [g/s] Maximum
Acetone	9.56E-13	3.15E-09	1.47E-09	4.80E-06
Bis(2-ethylhexyl)phthalate	4.73E-17	1.08E-14	7.21E-14	1.64E-11
Methylene chloride	1.88E-11	3.26E-09	2.86E-08	4.96E-06
Tetrachloroethene	2.31E-11	7.67E-08	3.52E-08	1.17E-04
1,1,1-Trichloroethane	3.89E-12	2.61E-09	5.93E-09	3.97E-06
Trichloroethene	4.44E-12	8.62E-09	6.76E-09	1.31E-05

NOTES:

(1) Inorganic chemicals of potential concern are not included in the table since they are not volatile.

(2) Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places (i.e., the magnitude of the number). A negative expoenent indicates the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

TABLE C-12

AIR FLUXES AND EMISSION RATES FOR VOLATILIZATION
AT THE WILDWOOD CONSERVATION CORPORATION PROPERTY

CHEMICAL	FLUX RATE [g/cm^2-s] Mean	FLUX RATE [g/cm^2-s] Maximum	EMISSION RATE [g/s] Mean	EMISSION RATE [g/s] Maximum
SURFACE SOILS				
Acetone	8.47E-12	1.25E-10	2.57E-13	3.79E-02
Bis(2-ethylhexyl)phthalate	3.95E-18	9.07E-17	1.20E-09	2.76E-08
Chlordane	3.32E-14	1.12E-11	1.01E-05	3.41E-03
4,4'-DDT	2.12E-16	5.22E-15	6.45E-08	1.59E-06
trans-1,2-Dichloroethene	2.45E-12	5.35E-11	7.44E-04	1.63E-02
Methylene chloride	3.04E-11	9.21E-10	9.32E-03	2.80E-01
cPAHs[a]	7.82E-19	4.33E-18	2.38E-10	1.32E-09
nPAHs[b]	1.55E-12	8.34E-12	4.72E-04	2.53E-03
PCBs[c]	2.22E-15	7.48E-13	6.75E-07	2.27E-03
Tetrachloroethene	1.89E-12	5.07E-10	5.74E-04	1.54E-01
Toluene	5.80E-13	4.63E-12	7.76E-04	1.41E-03
Trichloroethene	2.54E-10	3.73E-09	7.73E-03	1.13E+00
NORTHERN SLUDGES				
Bis(2-ethylhexyl)phthalate	NA	3.59E-16	NA	4.67E-09
Chlordane	3.23E-12	3.95E-11	4.20E-05	5.14E-04
Chloroform	NA	1.86E-08	NA	2.41E-01
4,4'-DDT	NA	1.01E-13	NA	1.31E-05
cPAHs[a]	1.04E-17	4.21E-17	1.35E-10	5.47E-10
nPAHs[b]	5.64E-10	2.10E-09	7.33E-03	2.73E-02
Pentachlorophenol	NA	9.95E-16	NA	1.29E-08
Phenol	NA	1.52E-11	NA	1.97E-05
Xylenes	NA	6.95E-09	NA	9.04E-02
SOUTHERN SLUDGES				
Bis(2-ethylhexyl)phthalate	1.22E-17	1.46E-15	4.89E-10	5.82E-08
Chlordane	NA	9.76E-12	NA	3.90E-04
4,4'-DDT	6.55E-16	1.64E-12	2.62E-08	6.57E-05
trans-1,2-Dichloroethene	NA	7.22E-11	NA	2.89E-03
cPAHs[a]	2.97E-18	6.45E-18	1.19E-10	2.62E-10
nPAHs[b]	1.32E-11	8.27E-11	5.27E-04	3.31E-03
Pentachlorophenol	NA	1.71E-14	NA	6.84E-07
Tetrachloroethene	NA	2.18E-08	NA	8.75E-01
Toluene	NA	1.40E-10	NA	5.60E-03
1,1,1-Trichloroethane	NA	8.75E-09	NA	3.50E-01
Trichloroethene	4.13E-12	4.66E-09	1.65E-04	1.87E-01

NA = Not applicable; geometric mean not calculated for only one positive detection.

[a] Carcinogenic polynuclear aromatic hydrocarbons.
[b] Noncarcinogenic polynuclear aromatic hydrocarbons.
[c] Polychlorinated biphenyls.

NOTES:

(1) Inorganic chemicals of potential concern not included in table since they are not volatile.
(2) Scientific notation (such as 2E-06) is a short hand way of indicating decimal places (i.e., the magnitude of the number). A negative exponent indicates the decimal should be move the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

distance should provide a reasonable analogy to the mixing height used in larger scale box models. The height of the box was determined using the following equation presented by Pasquill (1975):

$$X = 6.25\ Z_0\ [(H/Z_0)\ \ln\ (H/Z_0) - 1.58(H/Z_0) + 1.58))] \qquad (12)$$

This expression is for a D or neutral atmospheric stability class and should provide a conservative estimate of ambient concentrations. The majority of the time that the trespassers are on site, the air would be unstable which would effectively raise the height of the box, and allow greater vertical mixing and subsequent lowering of the ambient concentrations. The value for Z_0, the roughness height was chosen to be 10.0 cm based on the value recommended in a technical memorandum prepared published by the Meteorology Division of NOAA (NOAA 1983) for the surface characteristics at the Wells G & H site. The downwind distance X was determined on a property specific basis.

The following two sections describe each of the box models used and list the input parameters and calculated air concentrations.

C.4.3.1 Box Model for Air Dispersion of Fugitive Dusts

The emissions of fugitive dusts at both the Olympia Nominee Trust and Wildwood Conservation Corporation Properties were generated by vehicular traffic. The vehicles were dirt bikes which were assumed to traverse the contaminated soils. The emission rates for fugitive dusts associated with the dirt bikes were calculated as described in an earlier section. These emissions were then assumed to mix uniformly in a small box or volume of air. The air concentrations to which individuals could be exposed were calculated based on the dimensions of the box and the calculated emission rates.

Because the dirt bikes ride across a narrow path the fugitive dust emissions occur across a small area. The greatest potential exposures would be to individuals at or near the source of emissions. For this reason air

concentrations were calculated for the volume of air located within the area the dirt bike travels

The area the dirt bikes travel was determined using the assumptions in Section C.4.1. The distance traveled was assumed to be 275 m and 366 m for the Olympian Nominee Trust and Wildwood Conservation Corporation properties, respectively. It was then assumed that the dirt bikes traveled over a square area, thus the downstream and width of the boxes would be equal and were calculated to be 68.8 m and 91.5 m for the Olympia Nominee Trust and Wildwood Conservation Corporation properties, respectively. The heights of the boxes were determined using equation 12 and are summarized in Table C-13. The length of the box was described by the average wind speed at the site. In this way the units of time in the emission rate are cancelled by the units of time in the wind speed and the box model yields an air concentration in terms of mass per unit volume (ie. mg/m^3). The average wind speed for the site was determined to be 5.4 m/s from National Weather Service records for General Logan International Airport in Boston, MA. The air concentrations within the box are then given by:

$$C_i = \frac{(R_{10v})_i}{(H)(W)(U)} \qquad (13)$$

where:

C_i = Air concentration for $i^{\underline{th}}$ chemical, $[mg/m^3]$;
R_{10v} = Emission rate of $i^{\underline{th}}$ chemical, [mg/s];
H = Height of the Box [m];
W = Width of the box [m]; and
V = Wind speed in the box [m/s].

Because the air concentration calculated using the box model is the ratio of the emission rate and the volume of the box, using a larger volume to mix the emissions in would result in a lower air concentration. By assuming that this exposure occurs in a small volume located over the emission source, the calculated risks should result in a conservative estimate. Table C-13 lists

TABLE C-13

INPUT PARAMETRS FOR BOX MODEL USED
FOR DISPERSION OF VEHICULAR TRAFFIC EMISSIONS

OLYMPIA

Height (H) = 2.4 m

Width (W) = 68.8 m

Average Wind Speed (U) = 5.4 m/s

WILDWOOD

Height (H) = 2.5 m

Width (W) = 91.5 m

Average Wind Speed (U) = 5.4 m/s

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the parameters used in the box model for air dispersion of fugitive dust emissions from dirt bikes. Table C-14 lists the emission rates from both the Olympia and Wildwood sites and the associated air concentrations.

C.4.3.2 Box Model for Air Dispersion of Volatile Organic Compounds

A second source of airborne contaminants were the gaseous emissions associated with the volatilization of organic chemicals from contaminated soils and sludges at the New England Plastics Corporation and Wildwood Conservation Corporation properties. In this case at Wildwood, the emissions will occur across a much larger area than in the previous case resulting in a larger area over which an individual may be exposed. Once again at Wildwood the emissions were assumed to mix uniformly in a box located above the emission source, however, this volume will also be much larger than in the previous case. The source of the emissions at the New England Plastics Corporation property is a small area of unvegetated, contaminated soil. Here, the box was assumed to include all areas of the property an individual might encounter while outdoors.

The box model used to evaluate the soil volatilization scenario differs from that used in Section C.4.3.1 (equation 13) in that the emissions come form an area on the property rather than a vehicle traveling around the property. For each property, the downstream (or downwind) distances were chosen to be 94.8m and 175m which are the distances across the New England Plastics Corporation and Wildwood Conservation Corporation properties, respectively. Equation 12 was used to calculate H. At the New England Plastics Corporation property, the average box height H was determined to be 3.0 m while at the Wildwood Conservation Corporation, H was determined to be 4.7 m. The concentration on-site was determined using:

$$C_i = \frac{Q_{vi}\ A}{HWU} \qquad (14)$$

TABLE C-14

EMISSION RATES AND ASSOCIATED AIR CONCENTRATIONS FOR VEHICULAR TRAFFIC EMISSIONS AT THE OLYMPIA NOMINEE TRUST AND WILDWOOD CONSERVATION CORPORATION PROPERTIES

COMPOUND	EMISSION RATE (mg/s) AVERAGE	EMISSION RATE (mg/s) PLAUSIBLE MAXIMUM	AIR CONCENTRATION (mg/m3) AVERAGE	AIR CONCENTRATION (mg/m3) PLAUSIBLE MAXIMUM
OLYMPIA				
Chromium	5.10E+02	2.32E+04	5.72E-01	2.60E+01
4,4'-DDT	7.40E-01	9.19E+00	8.31E-04	1.03E-02
Lead	5.97E+02	1.06E+04	6.70E-01	1.19E+01
cPAHs (a)	7.86E-01	8.56E+01	8.82E-04	9.61E-02
nPAHs (b)	4.24E-01	6.58E+01	4.76E-04	7.38E-02
WILDWOOD SOILS				
Acetone	2.72E-06	4.01E-05	2.20E-09	3.24E-08
Bis(2-ethylhexyl)phthalate	1.36E-05	3.12E-04	1.10E-08	2.53E-07
Cadmium	2.40E-05	9.08E-04	1.95E-08	7.35E-07
Chlordane	2.27E-06	7.68E-04	1.84E-09	6.22E-07
Chromium	1.52E-03	1.02E-01	1.23E-06	8.27E-05
4,4'-DDT	1.39E-06	3.41E-05	1.12E-09	2.76E-08
trans-1,2-Dichloroethene	1.36E-07	2.97E-06	1.10E-10	2.41E-09
Lead	1.04E-03	2.28E-02	8.38E-07	1.85E-05
Methylene chloride	7.38E-07	2.24E-05	5.98E-10	1.81E-08
cPAHs (a)	3.67E-05	2.03E-04	2.97E-08	1.65E-07
nPAHs (b)	2.38E-05	1.28E-04	1.93E-08	1.04E-07
PCBs (c)	1.29E-05	4.34E-03	1.04E-08	3.52E-06
Tetrachloroethene	2.48E-07	6.68E-05	2.01E-10	5.41E-08
Toluene	2.07E-07	1.66E-06	1.68E-10	1.34E-09
Trichloroethene	2.73E-06	3.99E-04	2.21E-09	3.23E-07
WILDWOOD NORTHERN SLUDGES				
Bis(2-ethylhexyl)phthalate	NA	1.24E-03	--	1.00E-06
Cadmium	1.16E-04	4.34E-04	9.36E-08	3.52E-07
Chlordane	2.21E-04	2.71E-03	1.79E-07	2.19E-06
Chloroform	NA	1.05E-04	--	8.51E-08
Chromium	2.26E-07	2.68E-02	1.83E-10	2.17E-05
4,4'-DDT	NA	6.58E-04	--	5.33E-07
Lead	6.87E-07	2.06E-01	5.56E-10	1.67E-04
cPAHs (a)	1.22E-08	1.98E-03	9.91E-12	1.60E-06
nPAHs (b)	2.17E-07	3.23E-02	1.76E-10	2.61E-05
Pentachlorophenol	NA	2.14E-04	--	1.73E-07
Phenol	NA	3.27E-04	--	2.65E-07
Xylenes	NA	2.04E-03	--	1.65E-06

NA = Not applicable; geometric mean not calculated with only one positive detection.
(a) Carcinogenic polynuclear aromatic hydrocarbons.
(b) Noncarcinogenic polynuclear aromatic hydrocarbons.
(c) Polychlorinated biphenyls.
NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

TABLE C-14 CONTINUED

EMISSION RATES AND ASSOCIATED AIR CONCENTRATIONS FOR VEHICULAR TRAFFIC EMISSIONS AT THE OLYMPIA NOMINEE TRUST AND WILDWOOD CONSERVATION CORPORATION PROPERTIES

COMPOUND	EMISSION RATE (mg/s)		AIR CONCENTRATION (mg/m3)	
	AVERAGE	PLAUSIBLE MAXIMUM	AVERAGE	PLAUSIBLE MAXIMUM
WILDWOOD SOUTHERN SLUDGES				
Bis(2-ethylhexyl)phthalate	4.21E-05	5.01E-03	3.41E-08	4.06E-06
Cadmium	2.34E-05	6.01E-04	1.89E-08	4.87E-07
Chlordane	NA	6.68E-04	--	5.41E-07
Chromium	1.39E-03	1.37E-02	1.12E-06	1.11E-05
4,4'-DDT	2.15E-05	1.07E-02	1.74E-08	8.65E-06
trans-1,2-Dichloroethene	NA	4.01E-06	--	3.24E-09
Lead	2.13E-02	3.34E-01	1.73E-05	2.70E-04
cPAHs (a)	7.53E-05	3.35E-04	6.09E-08	2.71E-07
nPAHs (b)	2.02E-04	1.27E-03	1.64E-07	1.03E-06
Pentachlorophenol	NA	3.67E-03	--	2.97E-06
Tetrachloroethene	NA	2.87E-03	--	2.33E-06
Toluene	NA	5.01E-05	--	4.06E-08
1,1,1-Trichloroethane	NA	3.67E-04	--	2.97E-07
Trichloroethene	4.44E-07	5.01E-04	3.60E-10	4.06E-07

NA = Not applicable; average not calculated with only one positive detection.
(a) Carcinogenic polynuclear aromatic hydrocarbons.
(b) Noncarcinogenic polynuclear aromatic hydrocarbons.
(c) Polychlorinated biphenyls.
NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

where:

C_i = The concentration on-site for the ith contaminant, [g/m^3]

Q_{vi} = The emission rate of the ith contaminant, [g/m^2-s]

U = Average wind speed in the box, [m/s]

H = Height of the box, [m]

W = Crosswind width of the area source [m]

A = Size of the area source, [m^2].

The wind speed value of 5.4 m/s was determined using the meteorological data from the Logan Airport in Boston, MA. The dimensions for A were determined from the assumptions made regarding the area of the contaminated soils and sludges at both the New England Plastics Corporation and Wildwood Conservation Corporation properties. The value for W at the New England Plastics Corporation property was determined to be the width of the property. The value for W at the Wildwood Conservation Corporation property was determined by assuming that individuals would not attempt to cross the wetlands portion of the site. This left an approximately square area at the bottom of the site where the exposure could occur. Using site maps, this area was approximated as being 175 m by 175 m. Table C-15 lists the input parameters used to determine the on-site concentrations for both properties. Table C-16 summarizes the emission of flux rates and the associated ambient air concentrations for the chemicals of potential concern at the New England Plastics Corporation property. Table C-17 lists the emission or flux rates and the associated ambient air concentrations for all three emission sources investigated in this exposure scenario at the Wildwood Conservation Corporation property.

TABLE C-15

INPUT PARAMTERS FOR BOX MODEL
USED FOR DISPERSION OF VOLATILES

New England Plastics Corporation Property

$H = 3.0$ m

$W = 94.8$ m

$U = 5.4$ m/s

$A = 15.2$ m^2

Wildwood Conservation Corporation Property

$H = 4.7$ m

$W = 175$ m

$U = 5.4$ m/s

Surface Soils: $A = 30,400$ m^2

Northern Sludges: $A = 1,300$ m^2

Southern Sludges: $A = 4,000$ m^2

TABLE C-16

FLUX RATES AND ASSOCIATED AIR CONCENTRATIONS
FOR EMISSIONS DUE TO VOLATILIZATION OF ORGANIC CHEMICALS
AT THE NEW ENGLAND PLASTICS CORPORATION PROPERTY

CHEMICAL	Emission Rate [g/s] Mean	Emission Rate [g/s] Maximum	Air Concentration [mg/m^3] Mean	Air Concentration [mg/m^3] Maximum
Acetone	NA	4.80E-06	NA	3.12E-06
Bis(2-ethylhexyl)phthalate	7.08E-14	1.64E-11	4.61E-14	1.07E-11
Methylene chloride	2.66E-08	4.96E-06	1.73E-08	3.23E-06
Tetrachloroethene	3.51E-08	1.17E-04	2.28E-08	7.62E-05
1,1,1-Trichloroethane	5.93E-09	3.97E-06	3.86E-09	2.59E-06
Trichloroethene	6.76E-09	1.31E-05	4.40E-09	8.55E-06

NA = Not applicable; geometric mean concentration not calculated with only one positive detection.

NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places (i.e., the magnitude ot the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-04 = 0.0024).

TABLE C-17

FLUX RATES AND ASSOCIATED AIR CONCENTRATIONS
FOR EMISSIONS DUE TO VOLATILIZATION OF ORGANIC CHEMICALS
AT THE WILDWOOD CONSERVATION CORPORATION PROPERTY

CHEMICAL	Emission Rate [g/s] Mean	Emission Rate [g/s] Maximum	Air Concentration [mg/m^3] Mean	Air Concentration [mg/m^3] Maximum
Surface Soils				
Acetone	2.57E-03	3.79E-02	5.79E-04	8.54E-03
Bis(2-ethylhexyl)phthalate	1.20E-09	2.76E-08	2.70E-10	6.21E-09
Chlordane	1.01E-05	3.41E-03	2.27E-06	7.68E-04
4,4'-DDT	6.45E-08	1.59E-06	1.45E-08	3.57E-07
trans-1,2-Dichloroethene	7.44E-04	1.63E-02	1.68E-04	3.67E-03
Methylene chloride	9.23E-03	2.80E-01	2.08E-03	6.30E-02
cPAHs[a]	2.38E-10	1.32E-08	5.35E-11	2.96E-10
nPAHs[b]	4.72E-04	2.53E-03	1.06E-04	5.71E-04
PCBs[c]	6.75E-07	2.27E-04	1.52E-07	5.12E-05
Tetrachloroethene	5.74E-04	1.54E-01	1.29E-04	3.47E-02
Toluene	1.76E-04	1.41E-03	3.97E-05	3.17E-04
Trichloroethene	7.73E-02	1.13E+00	1.74E-09	2.55E-01
Northern Sludges				
Bis(2-ethylhexyl)phthalate	NA	4.67E-09	NA	1.08E-09
Chlordane	4.20E-05	5.14E-05	9.46E-06	1.16E-04
Chloroform	NA	2.41E-05	NA	5.43E-02
4,4'-DDT	NA	1.31E-05	NA	2.95E-07
cPAHs[a]	1.35E-10	5.47E-10	3.00E-11	1.20E-10
nPAHs[b]	7.33E-03	2.73E-02	1.65E-03	6.16E-03
Pentachlorophenol	NA	1.29E-08	NA	2.91E-09
Phenol	NA	1.97E-05	NA	4.44E-06
Xylenes	NA	9.04E-02	NA	2.03E-02
Southern Sludges				
Bis(2-ethylhexyl)phthalate	4.89E-10	5.82E-08	1.10E-10	1.21E-08
Chlordane	NA	3.90E-04	NA	8.79E-05
4,4'-DDT	2.62E-08	6.57E-05	5.89E-09	1.48E-05
trans-1,2-Dichloroethene	NA	2.89E-03	NA	6.50E-04
cPAHs[a]	1.19E-10	2.62E-10	3.00E-11	6.00E-11
nPAHs[b]	5.27E-04	3.31E-03	1.19E-04	7.45E-04
Pentachlorophenol	NA	6.84E-07	NA	1.54E-07
Toluene	NA	8.73E-01	NA	1.96E-01
Tetrachloroethene	NA	5.60E-03	NA	1.26E-03
1,1,1-Trichloroethane	NA	3.50E-01	NA	7.88E-02
Trichloroethene	1.65E-04	1.87E-01	3.72E-05	4.20E-02

C.5 EXPOSURE TO CONTAMINANTS RELEASED THROUGH GROUNDWATER USE IN PRODUCTION PROCESSES

Contaminated groundwater is used in the production processes at both the New England Plastics Corporation and the Central Area of the Wells G & H site. A surface water volatilization model was used to estimate releases in the buildings and subsequent exposure of workers at these companies. Once the volatilization rates were determined, the resulting air concentrations were calculated.

C.5.1 SURFACE WATER VOLATILIZATION MODEL

Emission rates for surface water volatilization were determined using a steady-state two-layer film model described by Liss and Slater (1974). Mass transfer from the liquid-phase to the gas-phase occurs across a small layer at the air-water interface. This layer is composed of two smaller layers or films above and below the water surface. Above the water surface is a gas-phase film and a second film, a liquid-phase film, extends downward from the water surface. A separate concentration gradient exists within each of these films. These concentration gradients drive the flux of chemicals from the water body and into the air. Above and below this layer it is assumed that the chemicals within the air and water are well mixed.

Both the gas and liquid-phase films are assumed to be stagnant. The mass transfer across these films is by molecular diffusion only. Chemical-specific mass transfer coefficients describe the rate of molecular diffusion for each phase. Liss and Slater (1974) suggest the following semi-empirical equations for calculating the chemical-specific mass transfer coefficients for the gas and liquid-phase.

$$k_l = 5.5 \times 10^{-3} (44/MW)^{1/2} \quad (15)$$

$$k_g = 0.83 \ (18/MW)^{1/2} \quad (16)$$

where:

k_l = liquid-phase mass transfer coefficient [cm/s];

k_g = gas-phase mass transfer coefficient [cm/s]; and
MW = molecular weight of the chemical.

The two-layer film model assumes that the flux rate of chemicals from the water to the air is the sum of the total resistance to mass transport from both the liquid-phase and gas-phase films. This resistance to mass transport within each phase can be defined by the reciprocal of the chemical-specific mass transfer coefficients. The interface between the gas and liquid-phase films is assumed to offer negligible resistance to mass transport.

The chemical-specific resistances to mass transport for the liquid and gas-phases are summed to determine the total resistance to mass transfer. The overall mass transfer coefficient represents the total resistance to the flux of a chemical from the water body into the overlying air. According to Liss and Slater (1974) the overall liquid mass transfer coefficient is given by:

$$\frac{1}{K_L} = \frac{1}{k_l} + \frac{RT}{k_g H} \tag{17}$$

where:

K_L = liquid overall mass transfer coefficient [cm/s];
H = Henry's Law Constant [atm-m^3/mol];
R = universal gas constant [8.19×10^{-5} atm-m^3/mol-K]; and
T = temperature at air/water interface [293 K].

Having calculated the total resistance to mass transfer for a specific chemical it is now possible to determine the transfer rate of that chemical from the water body into the air. The mass transfer or flux rate is the product of the volatilization rate constant and the chemical concentration in the liquid. The volatilization rate constant is a measure of the conductance or the ability of the system to conduct mass transfer which by definition, is equal to the reciprocal of resistance. Thus the volatilization rate constant can be defined by the reciprocal of the total resistance to mass transfer. Since the total resistance to mass transfer is given by the reciprocal of the overall mass transfer coefficient, so by simple algebra, the volatilization rate constant is equal to the overall mass transfer coefficient. The chemical-specific flux rate can be calculated by the following equation:

$$E_i = K_L C_s X \quad (18)$$

where:

E_i = flux rate of the ith chemical [g/m^2-s];

K_L = mass transfer coefficient [cm/s];

C_s = concentration of ith chemical in the surface water [g/cm^3]; and

X = conversion factor [10^4 cm^2/m^2].

Table C-18 lists the parameters used in calculating the mass transfer coefficients and the flux rates for the chemicals of potential concern at the New England Plastics Corporation and the Central area.

C.5.2 INDOOR AIR DISPERSION MODEL

A one compartment indoor air model was used to estimate indoor air concentrations in the industrial buildings. The calculated flux rate was combined with the surface area of the emission source and the air exchange rate of the building to determine the indoor air concentration. That is:

$$IAC = \frac{E_i \times SA}{AER}$$

where

IAC = indoor air concentration [g/m^3];

E_i = flux rate of the ith chemical [g/m^2-s];

SA = surface area of the emission sources [m^2]; and

AER = exchange rate [m^3/s].

The surface area of the sources and the air exchange rate are unique to the property under consideration. The assumptions used are discussed below.

There are seven troughs through which water is flowing constantly at a rate of 1 to 4 gallons per minute (gpm) at the New England Plastics Corporation. The largest trough has a volume of 10.66 ft^3 and the smallest has a volume of 2.85 ft^3. The largest trough is 16 ft. long by 13 in. wide with a surface area of 17.3 ft^2. There are also two recirculation ranks. Although there are 9

TABLE C-18

INPUT PARAMETERS AND FLUX RATES FOR SURFACE WATER VOLATILIZATION

Compound	Concentration (g/cm^3) Geometric Mean	Concentration (g/cm^3) Maximum	Molecular Weight (g/mol)	Henry's Law Constant ($atm\text{-}m^3/mol\text{-}k$)	k_l (cm/s)	k_g (cm/s)	K_L (cm/s)	Flux Rate ($g/m^2\text{-}s$) Geometric Mean	Flux Rate ($g/m^2\text{-}s$) Maximum
New England Plastics Corporation									
trans-1,2-Dichloroethene	NA	$9.00x10^{-9}$	96.9	$6.56x10^{-3}$	$3.71x10^{-3}$	$3.58x10^{-1}$	$3.57x10^{-3}$	NA	$3.21x10^{-7}$
Tetrachloroethene	$3.53x10^{-8}$	$2.70x10^{-7}$	166	$2.30x10^{-2}$	$2.83x10^{-3}$	$2.73x10^{-1}$	$2.80x10^{-3}$	$9.89x10^{-7}$	$7.56x10^{-6}$
1,1,1-Trichloroethene	$5.03x10^{-9}$	$1.70x10^{-8}$	133	$2.80x10^{-2}$	$3.16x10^{-3}$	$3.05x10^{-1}$	$3.14x10^{-3}$	$1.58x10^{-7}$	$5.33x10^{-7}$
Trichloroethene	$1.22x10^{-8}$	$5.20x10^{-8}$	131	$8.90x10^{-3}$	$3.18x10^{-3}$	$3.07x10^{-1}$	$3.10x10^{-3}$	$3.78x10^{-7}$	$1.61x10^{-6}$
Central Area									
trans-1,2-Dichloroethene	$8.05x10^{-9}$	$2.59x10^{-8}$	96.9	$6.56x10^{-3}$	$3.71x10^{-3}$	$3.58x10^{-1}$	$3.57x10^{-3}$	$2.87x10^{-7}$	$1.00x10^{-6}$
Tetrachloroethene	$5.48x10^{-9}$	$1.20x10^{-8}$	166	$2.30x10^{-2}$	$2.83x10^{-3}$	$2.73x10^{-1}$	$2.80x10^{-3}$	$1.53x10^{-7}$	$3.36x10^{-7}$
1,1,1-Trichloroethane	$7.59x10^{-9}$	$2.54x10^{-8}$	133	$2.80x10^{-2}$	$3.16x10^{-3}$	$3.05x10^{-1}$	$3.14x10^{-3}$	$2.38x10^{-7}$	$8.14x10^{-7}$
Trichloroethene	$2.34x10^{-8}$	$2.20x10^{-7}$	131	$8.90x10^{-3}$	$3.18x10^{-3}$	$3.07x10^{-1}$	$3.10x10^{-3}$	$7.25x10^{-7}$	$6.81x10^{-6}$

NA = Not applicable; geometric mean not calculated with only one positive detection.

NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places (i.e., the magnitude of the number). A negative exponent indicates the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

tanks/troughs of various sizes, the surface area of the largest tank was used to determine the ambient air concentration. This may overestimate releases from the tanks, and the results may present an upper bound concentration. There are four air volume exchanges at the New England Plastics building each hour. The volume of the building is 19,114 m^3. Thus, the air exchange rate used to calculate the indoor air concentration is 21.24 m^3/s. Table C-19 summarizes the results of the indoor air model.

Groundwater, drawn from Well S-46 in the central area and Well S-47 at the Riley Tannery, is used in the production process at the Riley Tannery. The Riley Tannery is not located within the Wells G & H site, although one their production wells is located at the site. Water is stored in vessels or drums at the tannery. There are 21 vessels with a 12 ft. diameter, 14 drums with a 20 ft. diameter, and 7 drums with a 8 ft. diameter. These data are used to calculate the surface area of the emission sources (662 m^2). This building has a floor space of 22,049 m^3. There are 8 air volume exchanges each which results in an air exchange rate of 49.10 m^3/s. The results of the indoor air model are summarized in Table C-19.

TABLE C-19

INDOOR AIR CONCENTRATIONS RESULTING FROM VOLATILIZATION OF VOLATILE ORGANIC COMPOUNDS RELEASED DURING PRODUCTION PROCESSES

Compound	Air Concentration (mg/m^3)	
	Geometric Mean	Maximum
New England Plastic Corporation		
trans-1,2-Dichloroethene	NA	2.19×10^{-4}
Tetrachloroethene	6.75×10^{-4}	5.16×10^{-3}
1,1,1-Trichloroethane	1.08×10^{-4}	3.64×10^{-4}
Trichloroethene	2.58×10^{-4}	1.10×10^{-3}
Central Area		
trans-1,2-Dichloroethene	3.88×10^{-3}	1.35×10^{-2}
Tetrachloroethene	2.07×10^{-3}	4.53×10^{-3}
1,1,1-Trichloroethane	3.38×10^{-3}	1.10×10^{-2}
Trichloroethene	9.80×10^{-3}	9.19×10^{-2}

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APPENDIX D

HAZARD IDENTIFICATION

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HAZARD IDENTIFICATION

A brief description of the toxicity of the chemicals of concern at the Wells G & H site is presented in this section. In addition, the standards and requirements that will be used to assess risk are described and identified.

In the Superfund Public Health Evaluation Manual (EPA 1986f), EPA directs that concentrations of contaminants at exposure points should be compared with applicable or relevant and appropriate requirements (ARARs) and with other criteria, advisories, and guidance that may be available. The EPA's interim guidance on ARARs (EPA 1987i) defines ARARs as follows:

> Applicable requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.
>
> "Applicability" implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement . . .
>
> Relevant and appropriate requirements means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.
>
> The relevance and appropriateness of a requirement can be judged by comparing a number of factors, including the characteristics of the remedial action, the hazardous substances in question, or the physical circumstances of the site, with those addressed in the requirement. It is also helpful to look at the objective and origin of the requirement. For example, while RCRA regulations are not applicable to closing undisturbed hazardous waste in place, the RCRA regulation for closure by capping may be deemed relevant and appropriate.
>
> A requirement that is judged to be relevant and appropriate must be complied with to the same degree as if it were applicable. However,

> there is more discretion in this determination: it is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed if judged not to be relevant and appropriate in a given case.
>
> Non-promulgated advisories or guidance documents issued by Federal or State governments do not have the status of potential ARARs. However, . . . they may be considered in determining the necessary level of cleanup for protection of health or environment.

Those ARARs or advisories or guidance that "set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants" (EPA 1987i) are used in this risk assessment.

No federal or Commonwealth of Massachusetts chemical-specific ARARs or guidance are available for the chemicals of potential concern in the soil or sediment at the Wells G & H site. Federal and Commonwealth of Massacusetts ARARs are available for the chemicals of potential concern in groundwater, however, and those that are considered pertinent to the endangerment assessment for the Wells G & H site are presented in Table D-1 and are discussed below.

According to EPA's interim guidance on ARARs, Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act (SDWA) are generally applicable or relevant and appropriate standards for water that is or may be used for drinking water source. The groundwater at the Wells G & H site is a potential drinking water source and therefore MCLs will be used as ARARs at this site. Maximum Contaminant Level Goals (MCLGs), also established under the SDWA, are additional chemical-specific standards which may be considered in the evaluation, but in the interim guidance, MCLs are used rather than MCLGs since MCLs are set as close as feasible to the respective MCLGs (EPA 1987m). The MCLs and MCLGs for the chemicals of potential concern in groundwater are listed in Table D-1.

TABLE D-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

(mg/liter)

Compound/Metal	ARAR	Other			Massachusetts Drinking Water Standards
	MCL	MCLG	AWQC Adjusted for Drinking Water Only	Lifetime Health Advisory	
Acetone	--	--	--	--	0.70
Aldrin	--	--	0 (1.2E-6) (c)	--	--
Antimony	--	--	0.146	--	--
Arsenic	0.05	0.05 (b)	0 (2.5E-6) (c)	0.05	0.05
Barium	1.0	1.5 (b)	--	1.5	1.0
Bis(2-ethylhexyl)phthalate	--	--	21	--	21 (i)
Cadmium	0.01	0.005 (b)	1E-2	0.005	0.01
Chlordane	--	0 (b)	--	--	0 (b,i)
Chloroform	0.1 (a)	--	0 (1.9E-4)	--	0.1 (a)
Chromium:	0.05	0.12 (b)	--	0.12	0.05
III	--	--	179	--	--
VI	--	--	0.05	--	--
Copper	1.3 (b)	1.3 (b)	1 (e)	--	--
4,4'-DDT	--	--	0 (1.2E-6) (c)	--	--
1,2-Dichlorobenzene	--	0.62 (b)	470	0.62	0.60
1,1-Dichloroethane	--	--	(f)	--	--
1,2-Dichloroethane	0.005	0	0 (9.5E-5) (c)	--	0.005
1,1-Dichloroethene	0.007	0.007	3.3E-5	0.007	0.007
trans-1,2-Dichloroethene	--	0.07 (b)	(f)	0.07	0.07 (b,i)
Iron	0.3 (d)	--	--	--	--
Lead (m)	0.05 [0.005 (b)]	20 (b) [0 (b)]	0.05	0.02	0.05
Manganese	0.05 (d)	--	--	--	0.05 (e)
Mercury	0.002	0.003	0.01	0.0011	0.002
Methylene Chloride	--	--	--	--	--
Nickel	--	--	1.5E-2	0.15	--
cPAHs [Benzo(a)pyrene (g)]	--	--	0 (3.1E-6) (c)	--	3.1E-7 (i)
nPAHs [Naphthalene (h)]	--		--	--	3.1E-7 (i)
PCBs	--	0 (b)	--	--	0 (b,i)
Pentachlorophenol	--	0.22 (b)	--	0.22	--
Phenol	--	--	--	--	3.5 (i)
Radionuclides (pCi/liter)					
- Radium 226 and 228	5	--	--	10	5
- Gross alpha activity (j)	15	--	--	10	15
- Gross beta activity (k)	4 mrem/year				4 mrem/year
- Strontium-90	8	--	--	8	8
- Tritium	20,000	--	--	20,000	20,000
Tetrachloroethene	--	0 (b)	0 (8.8E-4) (c)	0.01 (l)	0.005
Toluene	--	2.0 (b)	15	2.42	2.0
1,1,1-Trichloroethane	0.20	0.20	19	0.2	0.200
Trichloroethene	0.005	0	0 (2.8E-3) (c)	--	0.005
Uranium	--	--	--	--	--
Vinyl Chloride	0.002	0	0 (2.0E-3) (c)	--	0.002
Xylenes (total)	--	0.44 (b)	--	0.4	0.62
Zinc	5.0 (d)	--	5	--	5 (e)

(a) For total trihalomethanes; refers to sum of chloroform, dibromochloromethane, bromodichloromethane, and bromoform.
(b) Proposed.
(c) The AWQC is set at zero; in parentheses is the level associated with lifetime excess cancer risk of 10-6.
(d) Secondary MCLs based on organoleptic considerations.
(e) Based on organoleptic data.
(f) Insufficient data.
(g) Assumed to apply to all carcinogenic PAHs.
(h) Assumed to apply to all noncarcinogenic PAHs.
(i) Shall not exceed health advisories which have been adopted by the Massachusetts Division of Water Pollution Control and/or the EPA. For groundwater, this would equal the Clean Water Act Criteria for human health (drinking) water only) or Safe Drinking Water Act Maximum Concentration Limit Goals, whichever is more stringent.
(j) Gross alpha particle activity includes radium-226 but excludes radon and uranium.
(k) For total beta particle activity, Massachusetts standards are set at the average annual concentration which produces an annual dose equivalent to the total body or any internal organ greater than 4 mrem/year.
(l) Lifetime health advisory was based on the assumption that tetrachloroethene was a Group C carcinogen. Currently, EPA classifies tetrachloroethene as Group B2 - Possible Human Carcinogen.

Water Quality Criteria adjusted for drinking water intake only also can be considered as ARARs for groundwater exposures when other standards do not exist, but because some of these criteria are based on older toxicological studies, caution must be exercised in using them; when based on the most recent information these adjusted values are usually equal to the MCLGs. The AWQC for potential carcinogens is set at zero based on the assumption that there is no concentration below which there are no toxic endpoints. Since this level may not be attainable, the concentrations corresponding to a lifetime incremental cancer risk, given in parentheses in Table D-1, are used (EPA 1980b).

Generally, MCLs and MCLGs for toxic chemicals represent the allowable lifetime exposure to the contaminant for a 70-kg adult who is assumed to ingest 2 liters of water per day for a lifetime. MCLGs are non-enforceable goals which are set at levels which would result in no known or anticipated adverse health effects with an adequate margin of safety. MCLs are enforceable standards set as close to MCLGs as possible, but in addition to health factors, MCLs are required by law to reflect the technological and economic feasibility of removing the contaminant from the water supply. The limit set must be feasible given the best available technology and treatment techniques (EPA 1986f).

The Commonwealth of Massachusetts has set maximum contaminant levels (MCLs) for drinking water (310 CMR 22.00). These requirements apply to all public water systems in the state. These concentrations are considered to be ARARs for the Wells G & H site. Commonwealth of Massachusetts standards and criteria which are potential ARARs include the Groundwater Quality Standards (314 CMR 6.00), Surface Water Quality Standards (314 CMR 4.00), and Wetland Protection Regulations (310 CMR 10.00).

In addition to ARARs, three types of critical toxicity values for humans were selected to be used in conjunction with the results of the exposure assessment. These values are listed in the toxicity appendices for each

chemical and include (1) risk reference dose values (RfD), (2) chronic intake values (AIC), and (3) cancer potency factors.

Health criteria for chemicals exhibiting noncarcinogenic effects are generally developed using EPA Reference Doses (RfDs) developed by the RfD Work Group, or RfDs obtained from Health Effects Assessments (HEAs) and Drinking Water Health Advisories (HAs). In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure to the human population (including sensitive subpopulations) that is likely to occur without an appreciable risk of deleterious effects during a lifetime. The RfD is appropriately expressed in units of mg/kg/day (Barnes 1986). Development of health effects criteria, specific criteria, and specific chemicals exhibiting noncarcinogenic effects are discussed briefly below. The RfDs or AICs for the noncarcinogenic chemicals of concern are listed in Table D-2.

For chemicals exhibiting carcinogenic effects, most authorities recognize that a small number of molecular events can cause changes in a single cell or a small number of cells that can lead to tumor formation. This is recognized to be a non-threshold mechanism since there is essentially no level of exposure (i.e., a threshold) for a carcinogen which does not result in some finite possibility of causing the disease. In the case of chemicals exhibiting noncarcinogenic effects, most authorities consider that organisms have adaptive mechanisms that must be overcome before the toxic endpoint is manifested. For example, there could be a large number of cells performing the same or similar functions, and these cells must be significantly depleted before the effect is seen. This threshold view holds that a range of exposure from just above zero to some finite value can be tolerated by the organism without appreciable risk of causing the disease (Barnes 1986).

EPA's Carcinogen Assessment Group (CAG) has developed cancer potency factors for estimating the upperbound excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. In practice, cancer potency factors are derived from the results of human

TABLE D-2

CRITERIA FOR CHARACTERIZATION OF NONCARCINOGENIC EFFECTS
FOR CHEMICALS OF CONCERN AT THE WELLS G&H SITE

Compound	RfD (mg/kg/day) Oral	RfD (mg/kg/day) Inhalation
Acetone	1.0E-01 (a)	3.0 (e)
Aldrin	3.0E-05 (h)	---
Antimony	4.0E-04 (a)	---
Barium	5.0E-02 (a)	1.4E-04 (e)
Bis(2-ethylhexyl)phthalate	2.0E-02 (a)	---
Cadmium	5.0E-04 (b,c)	---
Chlordane	5.0E-05 (a)	---
Chloroform	2.0E-02 (a)	---
Chromium (hexavalent)	5.0E-03 (a)	---
Copper	3.7E-02 (e)	1.0E-02 (e)
4,4'-DDT	5.0E-04 (a)	---
1,2-Dichlorobenzene	9.0E-02 (c)	---
1,1-Dichloroethane	1.2E-01 (e)	1.38E-01 (e)
1,1-Dichloroethene	9.0E-03 (a)	---
trans-1,2-Dichloroethene	1.0E-02 (c)	---
Iron	1.0E+01 (i)	8.6E-03 (j)
Lead	6.0E-04 (c)	---
Manganese	2.2E-01 (e)	3.0E-04 (e)
Mercury	1.4E-03 (h)	---
Methylene Chloride	6.0E-02 (a)	---
Nickel	2.0E-02 (a)	---
PAHs (Naphthalene)	4.1E-01 (h)	---
Pentachlorophenol	3.0E-02 (a)	---
Phenol	4.0E-02 (a)	2.0E-02 (e)
Tetrachloroethene	2.0E-02 (a)	---
Toluene	3.0E-01 (a)	1.5 (e)
1,1,1-Trichloroethane	9.0E-02 (a)	3.1 (a)
Xylenes (total)	2.0E+00 (a)	4.0E-02 (f)
Zinc	2.1E-01 (e)	1.0E-02 (d)

(a) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987h.
(b) An interoffice workgroup of EPA is currently evaluating this criterion. A risk assessment summary of this evaluation will be included in EPA's Integrated Risk Information System when the review is completed.
(c) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1985i.
(d) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984u.
(e) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1986f.
(f) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984t.
(g) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987j.
(h) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1988e.
(i) NATIONAL ACADEMY OF SCIENCES (NAS). 1980.
(j) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984y.

Note: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

epidemiology studies or chronic animal bioassays. The data from animal studies are fitted to the linearized multistage model and a dose-response curve is obtained. The low-dose slope of the dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad hoc basis. These models provide rough, but plausible, estimates of the upper limits of lifetime risk. While the actual risk is unlikely to be higher than the estimated risk, it could be considerably lower. Table D-3 lists the potency factors used to assess cancer risks associated with oral exposure to potential carcinogens. Inhalation potency factors, if available, are listed for those potential carcinogens for which air exposure is a consideration.

According to EPA's system for characterization of the overall weight of evidence for carcinogenicity, the potential carcinogens considered in this assessment are classified as either Group A, Group B2 or Group C. Group A chemicals are agents for which there is sufficient evidence to support the causal association between exposure to the agents and cancer. Group B2 chemicals are agents for which there is inadequate evidence from human studies and sufficient evidence from animal studies. Group C chemicals are agents with limited evidence of carcinogenicity in animals in the absence of human data. For weight-of-evidence classification for each of the potential carcinogenic chemicals of concern is also listed in Table D-3.

The ambient water quality criteria are ARARs for the protection of aquatic life. These criteria are based on the concentrations which have been determined to cause chronic, acute, or sublethal effects, and are summarized below. Two values, a chronic value and an acute value are often used to define concentrations associated with adverse aquatic effects. A chronic value is defined as the threshold concentration above which adverse effects will be seen and is derived using data from a life-cycle, partial life-cycle, or early-life-stage test. Operationally, a chronic value is calculated using the geometric mean of the no-effect-level (NOEL) and the lowest level associated with an adverse effect (LOEL). An acute value is the concentration at which 50% of the test organisms die (LC_{50}). Acute values may also be

TABLE D-3

CRITERIA FOR CHARACTERIZATION OF CARCINOGENIC EFFECTS
FOR CHEMICALS OF CONCERN AT THE WELLS G&H SITE

Compound	Cancer Potency Factors (mg/kg/day)-1 Oral	Inhalation	Weight of Evidence
Arsenic	1.5 (n)	50 (p)	A (e,p)
Aldrin	17 (s)	17 (s)	B2
Bis(2-ethylhexyl)phthalate	8.4E-03 (l,m)		B2 (e,i)
Cadmium	NA	6.1 (a)	B1 (a)
Chlordane	1.3 (a)	1.3 (a)	B2 (a)
Chloroform	8.1E-02 (c,e,i)	8.1E-02 (c,i)	B2 (e,i)
Chromium (hexavalent)	NA	41 (a,d)	A (a)
4,4'-DDT	3.4E-01 (i,r)	--	B2 (i,r)
1,1-Dichloroethane	9.1E-02 (b,g,h)	--	Not Assigned
1,2-Dichloroethane	9.1E-02 (a)	9.1E-02 (a)	B2 (a)
1,1-Dichloroethene	6.0E-01 (a)	1.2 (a)	C (a)
Methylene Chloride	7.5E-03 (a)	1.4E-02 (a)	B2 (a)
PAHs (Benzo(a)pyrene)	11.5 (e,f)	6.11 (e,f)	Not Assigned
PCBs (Aroclor 1260)	7.7 (j,k)	--	B2 (e)
Tetrachloroethene	5.1E-02 (e,i)	3.3E-03 (b,i)	B2 (e,i)
Trichloroethene	1.1E-02 (a)	4.6E-03 (b,e,q)	B2 (a)
Vinyl Chloride	2.3 (e,o)	2.95E-01(b)	A (e)

NA = not applicable; not a carcinogen by this route.
(a) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987h.
(b) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987j.
(c) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1985e.
(d) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984i.
(e) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1986f.
(f) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984p.
(g) The oral cancer potency factor for 1,1-dichloroethane is based on structure-activity relationship to 1,2-dichloroethane (EPA 1988c).
(h) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1988a.
(i) An interoffice workgroup of EPA is currently evaluating this criterion. A risk assessment summary of this evaluation will be included in EPA's Integrated Risk Information System when the review is completed.
(j) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1988b.
(k) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987g.
(l) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1986c.
(m) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987f.
(n) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1987l.
(o) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984s.
(p) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984v.
(q) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984r.
(r) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1984g.
(s) ENVIRONMENTAL PROTECTION AGENCY (EPA). 1988e.

NOTE: Scientific notation (such as 2E-06) is a shorthand way of indicating decimal places, (i.e., the magnitude of the number). A negative exponent indicates that the decimal should be moved the specified number of places to the left (i.e., 2.4E-03 = 0.0024).

expressed as EC_{50} (the median effect concentration). The EC_{50} is the concentration that produces some sublethal response in 50% of the test organisms. The term is often used in reference to the immobilization of invertebrate organisms such as Daphnia.

Toxicity reference values (TRVs; described in Chapter 8) have been derived for birds, mammalian wildlife, and plants. They were only derived for each chemical of concern for which a potential pathway for the receptor has been identified. The basis for each TRV is detailed in this appendix.

If data were available, TRVs were based on NOELs from the chronic studies on birds and mammalian wildlife. Since few chronic toxicity studies with wild mammals have been reported, studies with laboratory rodents or humans used by EPA to determine chronic oral RfDs were often used as the basis for mammalian TRVs. A safety factor of 10 was applied if data were from a subchronic rather than chronic study. An additional safety factor of 10 was applied if data were LOELs rather than NOELs. In the absence of chronic data, acute LD_{50}s were divided by a safety factor of 5 based on the procedures of Urban and Cook (1986). For plants, TRVs were NOELS or LOELS. Because of the paucity of phytotoxicity data, no safety factors were applied.

D.1 ACETONE

D.1.1 HUMAN HEALTH EFFECTS

Acetone is readily absorbed by humans and experimental animals following oral or inhalation exposure (EPA 1984d). In a study by Bruckner and Peterson (1981), inhalation exposure of rats to acetone vapors (19,000 ppm, 3 hours/day, 5 days/week for 8 weeks) produced narcosis, decreased organ weights, and decreased body weights. Acute exposure of workers to acetone vapors at concentrations up to 2,150 ppm has been associated with mucous membrane irritation (EPA 1984d). Acetone is nonmutagenic in microbial assay systems; however, acetone was reported to induce chromosomal aberrations in

one study (EPA 1984d). EPA (1988f) reported a subchronic oral RfD of 1 mg/kg/day based on increased liver and kidney weight and kidney toxicity in rats administered acetone by gavage (EPA 1986g). EPA (1987h) derived a chronic oral RfD for acetone of 0.1 mg/kg/day based on a study in which organ weight changes were observed in rats exposed by gavage. EPA (1984d) derived an acceptable chronic intake (AIC) of 3 mg/kg/day for inhalation exposure; this value was based on the study by Bruckner and Peterson (1981). Carcinogenicity bioassays are limited to skin painting studies in which acetone served as a solvent control. In general, acetone did not induce tumors in these studies (EPA 1984d). Acetone is categorized by EPA (1984d) as a Group D agent (Not Classified). This category applies to agents for which there is inadequate evidence of carcinogenicity in animals.

D.1.2 TOXICITY TO WILDLIFE AND PLANTS

Acetone is a very volatile compound, therefore little effects or accumulation are expected. What little data are available show that acetone at concentrations of 10 ug/liter can influence growth rates of lake trout fry (Mac and Seelye 1981).

A chronic oral mammalian TRV of 10 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 100 mg/kg/day from a subchronic rat study was the basis. A safety factor of 10 for for extrapolation from a subchronic test to chronic value was applied. No bird toxicity or phytotoxicity data were found.

D.2 ALDRIN

D.2.1 HUMAN HEALTH EFFECTS

Aldrin can be absorbed following inhalation and dermal exposure in humans (NIOSH 1978a). Reported effects in humans following acute exposure to aldrin include malaise, incoordination, headache, dizziness, gastrointestinal

disturbances, and major motor convulsions (NRC 1982). In experimental animals, acute exposure to aldrin results in effects on the central nervous system, including irritability, tremors, and convulsions (Heath and Vandekar 1964). Increased liver weights and minor hepatic cell changes were observed in dogs fed 3 ppm aldrin in the diet. Fitzhugh et al. (1964) reported convulsions and mortality in dogs administered 0.5 mg/kg in the diet for 2 years and liver lesions in rats exposed to 0.5 ppm (0.025 mg/kg/day) aldrin in the diet for 2 years. An increase in fetal deaths and an increase in anomalies such as open eye, cleft palate, and webbed foot were reported in the offspring of golden hamsters administered a single oral dose of 50 mg/kg aldrin on days 7, 8, or 9 of gestation (Ottolenghi et al. 1974). In mice, aldrin at 25 mg/kg/day in the diet had a marked effect on fertility, gestation, viability, and lactation (Diechmann 1972). Hepatocellular carcinoma was reported in mice exposed to 3-8 ppm aldrin in the diet for 80 weeks (NCI 1978). Davis and Fitzhugh (1962) and Davis (1965) reported an increased incidence of hepatic hyperplasia and benign hepatomas in mice fed a diet containing 10 ppm aldrin for up to 2 years.

EPA (1988e) classified aldrin in Group B2--Probably Human Carcinogen based on adequate evidence of carcinogenicity in animal studies and developed an oral and inhalation cancer potency factor of 17 $(mg/kg/day)^{-1}$ based on the study by Davis (1965). EPA (1988e) also derived an oral reference dose of $3x10^{-5}$ mg/kg/day for aldrin based on the rat chronic feeding study by Fitzhugh et al. (1964) and using an uncertainty factor of 1,000.

D.2.2 TOXICITY TO WILDLIFE AND PLANTS

The ambient water quality criteria guidelines recommend that the concentration of aldrin in freshwater should not exceed 3.0 ug/liter (EPA 1986e). For saltwater the guideline is 1.3 ug/liter. Aldrin is very highly toxic to aquatic organisms (based on a scale by EPA 1985p). The lowest 96-hour LC_{50} for freshwater invertebrates is 1.3 ug/liter for stoneflies (Pteronarcys californica). Most other invertebrates that were tested were slightly less

sensitive, 48-hr EC_{50}s were 18.0 ug/liter for seed shrimp (Cypridopsis vidua), 23.0 ug/liter for the daphnid Simocephalus serrulatus, and 28.8 ug/liter for Daphnia pulex (Mayer and Ellersieck 1986). The scud Gammarus fasciatus is relatively tolerant of aldrin with a 96-hour LC_{50} of 4,300 ug/liter (Mayer and Ellersieck 1986).

The lowest 96-hr LC_{50} value for fish is 2.6 ug/liter for rainbow trout (Salmo gairdneri) (Mayer and Ellersieck 1986). Other fish tested also are sensitive to aldrin based on the following 96-hr LC_{50}s: 5.0 ug/liter for largemouth bass (Micropterus salmoides), 5.6 ug/liter for bluegill (Lepomis macrochirus), and 8.2 ug/liter for fathead minnow (Pimephales promelas) (Mayer and Ellersieck 1986). Channel catfish (Ictalurus punctatus) and black bullhead (Ictalurus melas) were somewhat less sensitive with 96-hr LC_{50}s of 53.0 ug/liter and 19.0 ug/liter, respectively (Mayer and Elllersieck 1986).

Very little information is available on the toxicity of aldrin to amphibians or reptiles. A 96-hr LC_{50} of 68 ug/liter has been reported for Fowler's toad tadpoles (Bufo woodhousei fowleri) (Mayer and Ellersieck 1986).

Aldrin is very toxic to birds (based on a scale by Hill et al. 1975 in Hill and Camardese 1986). A dietary acute LC_{50} of 62 ppm was reported for coturnix (Japanese quail, Coturnix japonica) (Hill and Camardese 1986). The lowest acute LD_{50} reported is 6.59 mg/kg for Northern bobwhite (Colinus virginianus). Ring-necked pheasant (Phasianus colchicus) and fulvous whistling ducks (Dendrocygna bicolor) were also fairly sensitive, with LD_{50}s of 16.8 mg/kg and 29.2 mg/kg, respectively (Hudson et al. 1984). Mallards (Anas platyrhynchos) were fairly tolerant of aldrin with an LD_{50} of 520 mg/kg (Hudson et al. 1984). Symptoms of poisoning included violent wing-beating convulsions, fluffed feathers, seizures, tremors, muscular incoordination, arching of the back and/or neck, and phonation (utterance of vocal sounds) (Hudson et al. 1984). Weight loss occurred at high doses in surviving animals. The lowest lethal daily dose over a 30-day period was 5 mg/kg for mallards, and indicates a relatively high degree of cumulative toxicity (Hudson et al. 1984).

Limited information is available on the toxicity of aldrin to mammalian wildlife. The acute LD_{50} for mule deer (Odocoileus hemionus hemionus) of 12 to 18 months age is 18.8 mg/kg to 37.5 mg/kg. Toxic symptoms included tremors, seizures, salivation, violent convulsions, and fasciculation (skin or superficial tremors) (Hudson et al. 1984). Refer to the previous section on human health effects for more information on the mammalian toxicity of aldrin.

Aldrin applied at 8.9 kg/ha to 17.9 kg/ha resulted in damage to agricultural crops such as cucumber, tomato, beans, beets, and cereals (Edwards 1973 in EPA 1985o). Estimated concentrations of aldrin in soil were 4.45 mg/kg to 8.95 mg/kg assuming the insecticide was incorporated into the upper 15 cm of soil. Tomato and cucumber had 10 to 24 percent reduced growth at estimated aldrin concentrations in soil of 11.2 mg/kg (Dennis and Edwards 1964 in EPA 1985o). Bean roots have shown 24 percent decreased growth at aldrin-soil concentrations of 12.5 mg/kg (Eno and Everett 1958 in EPA 1985o). A 6 percent increase in germination also occurred at this concentration, but at 100 mg/kg a 5 percent decreases in germination was observed (Eno and Everett 1958 in EPA 1985o).

D.3 ALUMINUM

D.3.1 HUMAN HEALTH EFFECTS

Aluminum has low acute toxicity following oral exposure. Oral LD_{50}s in several animal species range from 380 mg/kg to 780 mg/kg (EPA 1985i). Few data exist from subchronic or chronic animal studies; however, available data suggest that aluminum alters phosphorus balance (EPA 1985i). Neurofibrillar degeneration has been observed in experimental animals given subcutaneous injections of aluminum (NAS 1982). Intratracheal and intraperitoneal administration of aluminum compounds have been associated in experimental animals with pulmonary fibrosis and fibrotic peritonitis, respectively (NAS 1982). Evidence to date suggests that aluminum is not teratogenic or

fetotoxic; however, rats exposed by gavage to 2.5 mg/kg aluminum for 6 months had reduced sperm counts and reduced sperm motility (EPA 1985i). Studies to evaluate the potential of aluminum or its salts to induce mutagenic or carcinogenic effects have yielded negative results (EPA 1985i). In humans, pulmonary fibrosis has been observed following inhalation of aluminum bauxite fumes (Goyer 1986). Aluminum deposition in the brain has been suggested as a potential etiological factor in two neurological disorders: Alzheimer's disease and chronic renal failure accompanied by senile dementia (EPA 1985i). However, the importance of aluminum in these disorders has not been fully established. Because there are inadequate dose-response data from which to estimate an acceptable daily intake level for ionic aluminum in drinking water, EPA (1985i) has not proposed to establish a maximum contaminant level goal.

D.3.2 TOXICITY TO WILDLIFE AND PLANTS

The aquatic toxicity of aluminum is thought to be due to the soluble inorganic forms. Aluminum is amphoteric with minimum solubility at approximately pH 5.5. As pH increases and decreased from 5.5, aluminum solubility increases. The effect of pH on aluminum toxicity to rainbow trout is demonstrated in that toxicity increased from pH 6.8 to 8.99 (Freeman and Everhardt 1971) and from pH 7.0 to 9.0 (Hunter et al. 1980). Call (1984) found the opposite with rainbow trout as did Boyd (1979), Call (1984) and Kimball (manuscript) with fathead minnows. The variability in these results might be explained by the forms of aluminum in solution in each of the tests, but data are insufficient to substantiate this.

Chronic toxicity of aluminum has been tested with Daphnia magna (Kimball manuscript) which was found to have a chronic value of 1388 ug/liter after 28 days. Kimball (manuscript) found that the weight and length of fathead minnows were significantly different from controls after exposure to 7100 ug/liter in an embryo-larval test of 28 days (posthatch). No bioaccumulation data are available (EPA 1986e).

Tests for aquatic phytotoxicity using the alga Selenastrum capricornutum found it sensitive to aluminum at a concentration of 460 ug/liter (Call 1984). To date, no AWQC are in effect, but recommended values for soluble aluminum are 750 ug/liter for prevention of acute effects and 87 ug/liter for prevention of chronic effects (EPA 1988d).

A chronic mammalian TRV of 2.5×10^{-2} mg/kg was derived. This value is based on reproductive effects occurring in a rat subchronic study at 2.5 mg/kg/day (EPA 1985i). Safety factors of 10 for subchronic:chronic and 10 for LOEL:NOEL were applied. No bird toxicity data were found.

Susceptibility to aluminum poisoning varies widely among plant species. Wallace and Romney (1977) reported a threshold concentration of 20 mg/kg in rice shoots and 30 mg/kg in soybean leaves. The solution level necessary for these concentrations was 8 ug/ml. The concentration which caused severe toxicity was 81 ug/ml in solution. Most of the aluminum remained in the roots, but leaves contained more than stems in soybeans.

D.4 ANTIMONY

D.4.1 HUMAN HEALTH EFFECTS

Antimony is a metal which occurs both in the trivalent and pentavalent oxidation states (EPA 1980a). Absorption of this metal through the respiratory and gastrointestinal tracts is low (EPA 1980a). Oral or inhalation exposure of humans and animals to either trivalent or pentavalent forms can produce electrocardiogram (ECG) changes and myocardial lesions (EPA 1980a). Pneumoconiosis has been observed in humans exposed by inhalation and dermatitis has occurred in individuals exposed either orally or dermally. Oral exposure of humans to therapeutic doses has been associated with nausea, vomiting, and hepatic necrosis (EPA 1980a). Various forms of antimony have been found to induce DNA damage in bacterial assay systems and to increase the

incidence of chromatid breaks in human lymphocytes in culture (EPA 1980a). A single report (Balyeava 1967) noted an increase in spontaneous abortions, premature births, and gynecological problems in 318 female workers exposed to mixed dusts of antimony metal, antimony trioxide, and antimony pentasulfide. Epidemiological studies evaluating the carcinogenicity of antimony are inadequate, and presently available animal studies do not implicate this metal as a carcinogen. EPA (1987h) derived an oral RfD of $4x10^{-4}$ mg/kg/day for antimony based on a chronic oral study (Schroeder et al. 1970) in which rats given the metal in drinking water had altered blood glucose and blood cholesterol levels and decreased lifespan. EPA (1980a) has established an ambient water quality criterion of 146 ug/liter for ingestion of antimony through drinking water alone.

D.4.2 TOXICITY TO WILDLIFE

Acute toxicity data are available for one invertebrate and one vertebrate species (EPA 1980a). In tests conducted using antimony trichloride, LC_{50} values range from 18,800 ug/liter for Daphnia magna to 21,900 ug/liter for the fathead minnow (Pimephales promelas) (EPA 1980a). One study testing antimony potassium tartrate result in a LC_{50} of 9,000 ug/liter for Daphnia magna. Acute-chronic ratios of 3.5 and 14 have been calculated for Daphnia magna and the fathead minnow respectively.

In the freshwater alga Selenastrum capricornutum 50% chlorophyll a inhibition was noted at a concentration of 610 ug/liter.

D.5 AROCLOR 1260 (PCBs)

D.5.1 HUMAN HEALTH EFFECTS

Aroclor 1260 is one of a group of chemicals called polychlorinated biphenyls (PCBs). Aroclor is the trade name given PCB mixtures manufactured in the

United States; the last two digits in the Aroclor 1200 series refer to the percentage by weight of chlorine. Toxicity and potency have been shown to be dependent on degree of chlorination (EPA 1980p).

In humans exposed to PCBs (in the workplace or via accidental contamination of food), reported adverse effects include chloracne (a long-lasting, disfiguring skin disease), impairment of liver function, a variety of neurobehavioral and affective symptoms, menstrual disorders, minor birth abnormalities, and probably increased incidence of cancer. Animals experimentally exposed to PCBs have shown most of the same symptoms, as well as impaired reproduction; pathological changes in the liver, stomach, skin, and other organs; and suppression of immunological functions. PCBs are carcinogenic in rats and mice and, in appropriate circumstances, enhance the effects of other carcinogens. Reproductive and neurobiological effects of PCBs have been reported in rhesus monkeys at the lowest dose level tested, 11 mg/kg body weight/day over a period of several months (EPA 1980p).

EPA's Carcinogen Assessment Group (EPA 1988b) calculated an oral cancer potency factor for PCBs of 7.7 $(mg/kg/day)^{-1}$ based on a study of rats exposed orally to Aroclor 1260. An ambient water quality criterion of 0.079 ng/liter has been derived by EPA (1980p) for ingestion of fish and contaminated water. EPA (1984o) classified PCBs in Group B2--Probable Human Carcinogen--based on sufficient evidence in animal bioassays and inadequate evidence from human studies.

D.5.2 TOXICITY TO WILDLIFE AND PLANTS

Polychlorinated biphenyls are bioaccumulated and can be biomagnified. Therefore, their toxicity increases with length of exposure and position of the exposed species on the food chain. The toxicity of the various PCB mixtures is also dependent on their composition.

The 96-hour LC_{50} values for rainbow trout, bluegills, and channel catfish were around 20,000 mg/liter. The same species exposed for 10 to 20 days had LC_{50} values of about 100 mg/liter. Invertebrate species were also adversely affected, with some species having 7-day LC_{50} values as low as 1 mg/liter (EPA 1980p).

Three primary ways in which PCBs can affect terrestrial wildlife are outright mortality, adversely affecting reproduction, and changing behavior. PCB doses greater than 200 ppm in the diet or 10 mg/kg body weight (bw) caused some mortality in sensitive bird species exposed for several days. Doses around 1,500 ppm (diet) or about 100 mg/kg (bw) caused extensive mortality in these sensitive species. Some mammalian species are especially susceptible to PCBs. For example, mink died when fed as little as 5 ppm in the diet (equivalent to less than 1 mg/kg bw/day). Mink fed 1 ppm in the diet (0.2 mg/kg bw) had lower reproductive success, and there are indications that an increased incidence of premature births in some marine animals was linked to PCB exposure. Behavioral effects on wildlife include increased activity, decreased avoidance response, and decreased nesting, all of which could significantly influence survival in the wild. EPA (1980p) has established ambient water quality criteria for freshwater aquatic life of 2 mg/liter for acute toxicity and 0.014 mg/liter for chronic toxicity.

A bird TRV of 0.375 was derived based on a study in which there were no reproductive effects in screech owls fed 3 ppm Aroclor 1248 in the diet for two breeding seasons (Eisler 1986a). This converts to a dose of 0.375 mg/kg based on a dietary conversion factor of 0.125 mg/kg per ppm (USDA 1984). For mammals, a chronic TRV of 1.5×10^{-4} is derived based on a feeding study with mink reviewed by Eisler (1986a). Reproductive effects occurred at 1.5×10^{-3} and a safety factor of 10 is applied. Eisler (1986a) reported that mammals vary widely in their sensitivity to PCBs and that mink appear to be one of the most sensitive species.

PCBs are not very toxic to terrestrial plants, probably because of their strong sorption to soils. A 10 percent reduction in growth was reported in soybean blants exposed to 10 mg of PCBs per kg of soil (dry weight) (Webber and Mrozek 1979 in EPA 1985q). A PCB concentration of 100 mg/kg resulted in a 27 percent reduction in growth in soybean plants (Webber and Mrozek 1979 in EPA 1985q). Significant reduction in growth was also observed in corn at 100 mg/kg PCBs (Strek et al. 1981 in EPA 1985q). Strek et al. (1981 in EPA 1985q) reported that reduction in growth was not, however, significant for soybeans and beets at 100 mg/kg PCBs. Fries and Marrow (1981 in EPA 1985q) observed no significant effects on soybean growth at 2 to 3 mg/kg PCBs. Ostrich ferns growing on sediments with PCB residues of 26 mg/kg (mostly Aroclor 1254) showed a five-fold increase in somatic mutations as compared to ostrich ferns from control areas (Klekowski 1982 in Eisler 1986a). Other plants in the contaminated area were not genetically damaged. Based on the above discussion a toxicity reference value of 2.5 mg/kg was used in this analysis to assess potential adverse impacts to plants from exposure to PCBs.

D.6 ARSENIC

D.6.1 HUMAN HEALTH EFFECTS

Acute exposure of humans to the metal arsenic has been associated with gastrointestinal effects, hemolysis, and neuropathy. Chronic exposure of humans to this metal can produce toxic effects on both the peripheral and central nervous systems, keratosis, hyperpigmentation, precancerous dermal lesions, and cardiovascular damage (EPA 1984v). Arsenic is embryotoxic, fetotoxic, and teratogenic in several animal species (EPA 1984v).

Arsenic has long been recognized as a human carcinogen. Epidemiological studies have indicated that inhalation of arsenic is strongly associated with lung cancer and hepatic angiosarcoma; ingestion of arsenic has been linked to skin, bladder, liver, and lung cancer (Chen et al. 1986; Tseng et al. 1968). EPA (1984v) classifies arsenic as a Group A agent (Human Carcinogen). Cancer

potency factors of 1.5 $(mg/kg/day)^{-1}$ (EPA 1987j) and 50 $(mg/kg/day)^{-1}$ (EPA 1984v) have been derived for oral and inhalation exposures, respectively. The MCL and proposed MCLG for arsenic in drinking water are both 50 ug/liter (EPA 1985i). An ambient water quality criterion of 2.5 ng/liter has been established for ingestion of water containing arsenic (EPA 1980b).

D.6.2 TOXICITY TO WILDLIFE AND PLANTS

Arsenic is toxic to both aquatic and terrestrial animal species, and induces its toxic effects via enzyme inhibition. In aquatic species, arsenic has induced death following acute exposures and has caused death and deformity following chronic exposures. EPA (1984a) has established for aquatic species a continuous criterion of 190 ug/liter and a 1-hour average concentration criterion of 360 ug/liter for trivalent arsenic. Arsenic can bioaccumulate in aquatic vertebrates and invertebrates, but bioconcentration occurs to a greater extent in invertebrates. Bioconcentration factors of between 3 and 17 have been reported for snails (EPA 1984a). Spehar et al. (1980) found no accumulation of arsenic in trout, Zaroogian and Hoffman (1982) found a BCF of 350 for eastern oyster. A BCF of 4 was found for fish by the EPA (1978a).

Quantitative data on the toxicity of arsenic to terrestrial wildlife species are limited, but arsenic has been shown to induce death in wild rabbits and hares following acute oral exposures. Median lethal doses (LD_{50}) have been reported in the range of 10.5 to 40.4 mg/kg body weight (bw) (NRCC 1977). Lethal oral doses for most domestic mammals appear to be between 1 mg to 25 mg of sodium arsenite per kg of body weight, to 3 to 10 times that range as arsenic trioxide. Median lethal concentrations in the diets of wild birds have been reported in the range of 480 mg/kg bw for the bobwhite quail to 5000 mg/kg bw for mallards (Heath et al. 1972, Hill et al. 1975). Chronic poisonings in wild animals have not been clearly documented.

Arsenic also is toxic to plants, and can inhibit mitosis, photosynthesis, and respiration, and interfere with nucleic acid and protein synthesis. Toxic

effects have been observed in both aquatic and terrestrial species. A 14-day median effective concentration (EC_{50}) of 48 ug/liter has been reported for one species of algae (EPA 1984a), and soil arsenic concentrations of 500 mg/kg have been reported to completely inhibit growth in six vegetable crops (NRCC 1977). Concentrations of arsenic in soils as low as 15 mg/kg have been reported to be phytotoxic (Kabata-Pendias and Pendias 1984). Arsenic also can bioaccumulate in terrestrial species but the available data indicate that biomagnification in the food chain does not occur.

D.7 BARIUM

D.7.1 HUMAN HEALTH EFFECTS

Adverse effects in humans following oral exposure to soluble barium compounds include gastroenteritis, muscular paralysis, hypertension, ventricular fibrillation, and central nervous system damage (EPA 1984e). Inhalation of barium sulfate or barium carbonate in occupationally exposed workers has been associated with baritosis and pneumoconiosis (EPA 1984e). Experimental animals exposed chronically to barium in drinking water developed increased blood pressure (EPA 1984e). Inhalation of barium carbonate dust by experimental animals has been associated with reduced sperm count, increased fetal mortality, and atresia of the ovarian follicles (EPA 1984e).

EPA (1984e) has classified barium as a Group D agent--Not Classified. This category applies to agents for which there is inadequate evidence of carcinogenicity in animals. EPA (1987m) derived a 1-day and a 10-day health advisory of 0.51 mg/liter for a child based on an increase in blood pressure in rats administered barium in drinking water (Perry et al. 1983). EPA (1988f) reported a subchronic inhalation reference dose of 0.003 mg/kg/day for barium based on fetotoxicity produced in the offspring of rats administered barium carbonate by inhalation (Tarasenko et al. 1977).
A chronic oral reference dose (RfD) of 5×10^{-2} mg/kg/day (EPA 1987h) and an inhalation AIC of 1.4×10^{-4} mg/kg/day (EPA 1984e) have been derived for barium.

The latter value will serve as the inhalation RfD for this metal. A maximum contaminant level (MCL) and ambient water quality criterion of 1 mg/liter have been established for barium (EPA 1986e, 1985i). A proposed maximum contaminant level goal of 1.5 mg/liter also has been recommended (EPA 1985i).

D.7.2 TOXICITY TO WILDLIFE AND PLANTS

Very little information is available concerning the toxicity of barium. While many barium salts are soluble in water, they are generally thought to precipitate rapidly from solution by absorption and sedimentation (McKee and Wolf 1963). Ingestion of barium has shown such effects as vomiting and diarrhea, and central nervous system effects such as violent tonic and clonic spasms followed in some cases by paralysis (Browning 1961, Patty 1962). Due to its fast excretion, it is unlikely to be accumulated in bones, muscle, kidney or other tissues (Browning 1961, McKee and Wolf 1963). Limited data indicate, for aquatic species, an NOEL of 50 mg/liter soluble barium is fresh water. In most waters the amount of soluble barium available is limited by fast precipitation, therefore, the EPA does not feel that a restrictive criterion for aquatic life is warranted (EPA 1986e). Chaudhry et al. 1977 found that 2,000 mg Ba/kg of soil as $Ba(NO_3)_2$ decreased yields considerable and showed an uptake of barium by the plants (2% Ba in bush bean leaves and 1% in barley leaves).

D.8 BIS(2-ETHYLHEXYL)PHTHALATE

D.8.1 HUMAN HEALTH EFFECTS

Bis(2-ethylhexyl)phthalate (DEHP) is reported to be carcinogenic in rats and mice, causing increased incidences of hepatocellular carcinomas or neoplastic nodules following oral administration (NTP 1982). Chronic exposure to relatively high concentrations of DEHP in the diet can cause retardation of growth and increased liver and kidney weights in laboratory animals (NTP 1982, EPA 1980o). DEHP has previously been classified as a Group B2 agent (Probable

Human Carcinogen) (EPA 1986f). EPA (1986c, 1987f) has also previously calculated an oral cancer potency factor for DEHP of 8.4×10^{-3} $(mg/kg/day)^{-1}$. However, EPA (1987h) is currently reviewing this value and the weight of evidence for the carcinogenic effects of DEHP. EPA has recommended an oral reference dose (RfD) of 0.02 mg/kg/day for DEHP (EPA 1987h). The RfD and the previously reported cancer potency factor will be used to estimate noncarcinogenic and carcinogenic risk associated with human exposure to DEHP. Based on an acceptable daily intake (ADI) of 0.6 mg/kg/day, EPA recommended an ambient water quality criterion (AWQC) of 15 mg/liter for ingestion of drinking water and contaminated aquatic organisms. The AWQC for exposure to DEHP in drinking water alone is 21 mg/liter (EPA 1980o).

D.8.2 TOXICITY OF WILDLIFE AND PLANTS

Acute median effect values ranged from 1,000 to 11,100 ug/liter DEHP for the freshwater cladoceran Daphnia magna. The LC_{50} values for the midge, scud, and bluegill all exceeded the highest concentrations tested, which were 18,000, 32,000, and 770,000 ug/liter, respectively. As these values are greater than the water solubility of the chemical, it is unlikely that DEHP will be acutely toxic to organisms in natural waters. In a chronic toxicity test with Daphnia magna, significant reproductive impairment was found at the lowest concentration tested, 3 ug/liter. A chronic toxicity value of 8.4 ug/liter was reported for the rainbow trout. Bis(2-ethylhexyl)phthalate (DEHP) has a log K_{ow} of 5.11, indicating a high potential for bioaccumulation as is demonstrated by a BCF in scud (Gammarus pseudolinmaeus) of 3600 after 7 days of exposure to 0.1 ug/liter. While this is high, it is somewhat counterbalanced by a biologic half-life of about 4 weeks (Mayer and Sanders 1973). A BCF of 800 was found by Mayer et al. (1977) in fathead minnows exposed to 2.5 ug/liter DEHP for 28 days. Reported bioconcentration factors for DEHP in fish and invertebrates range from 14 to 2,680. Although insufficient data were presented to calculate the acute-chronic ratio for DEHP, it is apparently on the order of 100 to 1,000. Therefore, acute

exposure to the chemical exposure at the low ppm level may result in detrimental effects to aquatic life (EPA 1980o).

A chronic oral mammalian TRV of 1.9 mg/kg/day was derived based on information from the IRIS data base (EPA 1988e). A LOEL of 19 mg/kg/day from a one year feeding study with guinea pigs was the basis. A safety factor of 10 for LOEL:NOEL was applied.

No phytotoxicity data for bis(2-ethylhexyl)phthalate were found. For di-n-butyl phthalate, corn plants showed decreased growth at a soil concentration of 2000 mg/kg while no effects were observed at 200 mg/kg (EPA 1985r). Based on these data a plant TRV of 200 mg/kg was derived. No bird toxicity data were found.

D.9 CADMIUM

D.9.1 HUMAN HEALTH EFFECTS

Cadmium bioaccumulates in humans, particularly in the kidney and liver (EPA 1985j). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans at a renal cortex concentration of cadmium of 200 mg/kg (EPA 1985j). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lungs, kidney, and prostate (EPA 1985j). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats. Cadmium is a well-documented animal teratogen (EPA 1985j).

EPA (1987h) has classified cadmium as a B1 agent (Probable Human Carcinogen). This classification applies to agents for which there is limited evidence of carcinogenicity in humans from epidemiologic studies. An inhalation cancer

potency factor of 6.1 $(mg/kg/day)^{-1}$ has been derived from cadmium based on an epidemiologic study by Thun et al. (1985). EPA (1987n) derived a 1-day and a 10-day health advisory of 0.043 mg/liter for a child based on cadmium-induced emesis in adult humans following a single dose of cadmium (Lauwerys 1979). Using renal toxicity as an endpoint, a chronic oral reference dose (RfD) of $5x10^{-4}$ mg/kg/day has been derived (EPA 1985i). The MCL and ambient water quality criterion for cadmium are both 10 ug/liter (EPA 1980d, 1985i); the proposed MCLG is 5 ug/liter (EPA 1985i).

D.9.2 TOXICITY TO WILDLIFE AND PLANTS

The aquatic toxicity of cadmium was reviewed by EPA in its Water Quality Criteria Document (EPA 1984b). Cadmium toxicity increases with decreasing hardness and cadmium is generally more toxic in fresh vs. salt water. In freshwater fish, the genus Salmo was approximately 3400 times more acutely sensitive to cadmium than the genus, Carassius. EPA (1984b) criteria states that the freshwater organsisms will not be unacceptably affected if the four-day average concentration does not exceed $_e$(1.128[ln(hardness)]-3.828) (ug/liter), and if the one-hour acreage concentration is not in excess of $_e$(0.7852[ln(hardness])-3.490) (ug/liter) more than once in 3 years. Chronic toxicity values for fathead minnows and Daphnia magna tested over a range of hardness found a significant correlation between hardness and toxicity (EPA 1984b). In a 21-day test with Daphnia magna, Biesinger and Christensen (1972) found a 16% reduction in reproduction at 0.17 ug/liter (nominal concentration). Chapman (1978) found the 200-hour LC_{10} of 0.7 ug/liter for rainbow trout. BCFs for cadmium in freshwater range from 3 for brook trout muscle (Benoit et al. 1976) to 12,400 for whole body mosquitofish (Giesy et al. 1977). Cadmium is preferentially accumulated in the liver, thus reducing concentrations in the muscle. Accumulated cadmium is slowly depurated by freshwater fish (Benoit et al. 1976, Kumada et al. 1980). Kumada et al. (1980) found faster depuration of cadmium that was consumed in the diet versus that taken up from the water column.

The effects of cadmium on birds and terrestrial wildlife were reviewed by Eisler (1985). Behavioral changes were observed in young black ducks (Anas rubrides) produced from parents fed 4 ppm dietary cadmium for approximately 4 months before egg laying (Heinz and Haseltine 1983). A bird TRV of 0.05 mg/kg was derived based on this study. A dietary conversion factor of 0.125 mg/kg body weight per ppm in food and a safety factor of 10 (for a LOEL) were used.

Mammals have no effective mechanism for the elimination of ingested cadmium, with time, it tends to accumulate in the liver and kidney. Doyle et al. (1972) found that 30-60 ppm cadmium in the diet of sheep for 191 days reduced growth and feed intake. A mammalian TRV of $5x10^{-4}$ mg/kg/day was derived based on a human LOEL of 0.005 mg/kg/day (Friberg et al. 1974) and a safety factor of 10 (for LOEL:NOEL).

Allaway (1968) noted that 3 mg/kg cadmium in the tissues of plants depressed growth. Traynor and Knezek (1973) reported that corn grown on cadmium-enriched soils readily absorbed and translocated the element. They also found growth reduction in corn at its maximum when 281 mg/kg cadmium was added to the soil resulting in a plant concentration of 131 mg/kg (ash weight basis). Cadmium has been found to concentrate in plants as high as ten times the soil concentration (Chaney and Hornick 1977). Cadmium toxicity to soybeans was described as a 10% reduction in yield and discoloration of the plants at soil concentrations as low as 2.5 mg/kg. This soil concentration was also attributed to a 21% and 40% yield reduction in wheat and lettuce respectively (Haghiri 1973). Based on the Haghiri (1973) study, a toxicity reference value of 2.5 mg/kg was used in this analysis.

D.10 CHLORDANE

D.10.1 HUMAN HEALTH EFFECTS

Significant dose-related increases in hepatocellular carcinomas have been reported for laboratory mice exposed to chlordane in their diet (Epstein 1976,

NCI 1977, Becker and Sell 1979). The principal toxic effects in humans following acute and chronic exposures to chlordane include central nervous system excitation and blood dyscrasia (EPA 1987a). EPA (1987h) reported both an oral and inhalation cancer potency factor of 1.3 $(mg/kg/day)^{-1}$. The EPA (1987a) derived a 1-day and a 10-day health advisory of 0.06 mg/liter for a child based on minimum histopathological liver changes in rats administered chlordane by gavage (Ambrose et al. 1953). A recently revised chronic oral reference dose (RfD) of $5x10^{-5}$ mg/kg/day was reported by EPA (1987h). The potency factor and the RfD will be used to estimate carcinogenic and noncarcinogenic risks associated with exposure to chlordane. EPA's Office of Drinking Water derived a lifetime health advisory drinking water equivalent level (DWEL) of 2 ug/liter for a 70 kg adult ingesting 2 liters of water per day (EPA 1987a). EPA's Carcinogen Assessment Group (CAG) has classified chlordane in Group B2--Probable Human Carcinogen (EPA 1987h).

D.10.2 TOXICITY TO WILDLIFE AND PLANTS

The toxic effects of chlordane are seen at relatively low concentrations in some fish and invertebrate species. Chlordane also shows strong tendencies for bioaccumulation in some aquatic and terrestrial organisms. It can concentrate at levels thousands of times greater than the surrounding water medium in a variety of aquatic organisms, including bacteria, algae, daphnids, and fish. The EPA criterion for acute exposure to freshwater species is 2.4 ug/liter, and it is 0.17 ug/liter for chronic exposure (EPA 1986e).

Chlordane or oxychlordane residues have been found in a wide variety of wildlife species, but usually at relatively low levels. Chlordane does not appear to be extensively concentrated in the higher members of the terrestrial food chain. Although little information concerning bioaccumulation in these organisms is available, the potential bioconcentration of chlordane or oxychlordane by terrestrial insectivores is of concern. Little information on the toxic effects of chlordane to mammalian wildlife is available. Chlordane

or oxychlordane residues have been found in crops, meat, fish and poultry, dairy products, and eggs.

A chronic oral mammalian TRV of 4.5×10^{-3} was derived based on information from the IRIS database (EPA 1988e). A LOEL of 0.045 mg/kg/day from a chronic rat study was the basis. A safety factor of 10 for LOEL:NOEL was applied.

A bird TRV of 2.8 mg/kg/day was derived based on the review of Hudson et al. (1984). An acute oral LD_{50} of 14.1 mg/kg was reported in California quail. According to the procedures of Urban and Cook (1986) one-fifth of this value is used for safety assessment.

No information was found on the toxicity of chlordane to plants.

D.11 CHLOROFORM

D.11.1 HUMAN HEALTH EFFECTS

Chloroform has been reported to cause an increase in kidney epithelial tumors in rats and in hepatocellular carcinomas in mice (EPA 1985e). Suggestive evidence from human epidemiological studies indicates that exposure to chloroform and other trihalomethanes in water supplies may be associated with an increased incidence of bladder tumors. In humans, acute exposure to chloroform may result in death caused by ventricular fibrillation. Chronic exposure may lead to hepatic, renal, and cardiac effects and central nervous system depression (EPA 1984f, 1985e). EPA's Carcinogen Assessment Group (CAG) previously reported a cancer potency factor of 8.1×10^{-2} $(mg/kg/day)^{-1}$ for both ingestion and inhalation exposure (EPA 1985e). Chloroform has also been previously classified in Group B2--Probable Human Carcinogen (EPA 1985e). An interoffice work group of EPA (1987h) is currently reevaluating the cancer risk estimate and weight of evidence classification for chloroform. A risk reference dose (RfD) of 0.01 mg/kg/day was derived by EPA (1987h). The RfD and previously reported potency factor will be used to estimate

noncarcinogenic and carcinogenic risks associated with exposure to chloroform. A combined Maximum Contaminant Level (MCL) of 100 ug/liter has been established for trihalomethanes (chloroform is one of the four trihalomethanes included in this regulation) (EPA 1978b). EPA (1980f) developed an ambient water quality criterion of 0.19 ug/liter for both ingestion of water and aquatic organisms, and ingestion of water alone.

D.11.2 TOXICITY TO WILDLIFE AND PLANTS

Limited information is available concerning the toxicity of chloroform to organisms exposed at known concentrations (EPA 1980f). Median effect concentrations for two freshwater vertebrate and one invertebrate species range from 28,900 to 115,000 ug/liter. Twenty-seven day LC_{50} values of 2,030 and 1,240 ug/liter were reported for embryo-larval tests with rainbow trout in water at two levels of hardness.

An equilibrium bioconcentration factor of six with a tissue half-life of less than 1 day was determined for the bluegill. Although chloroform is not strongly bioaccumulated, it is thought to be widely distributed in the environment and can be detected in fish, water birds, marine mammals, and various crops.

A chronic oral mammalian TRV of 1.29 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A LOEL of 12.9 mg/kg/day from a chronic dog study was the basis. A safety factor of 10 for LOEL:NOEL was applied. No data were found on the effects of chloroform on birds or plants.

D.12 CHROMIUM

D.12.1 HUMAN HEALTH EFFECTS

The toxicity of chromium is dependent to a great degree on the chemical species. Certain chromium (VI) compounds are considered to be carcinogenic by

inhalation (but not by ingestion) and chromium (III) compounds are not considered to be very toxic. EPA (1987h) determined a cancer potency factor for lifetime inhalation exposure to chromium (VI) of 41 $(mg/kg/day)^{-1}$ based on occupational studies (Mancuso 1975). EPA has classified chromium (VI) in Group A--Human Carcinogen (by inhalation)--based on the weight of the evidence for carcinogenicity (EPA 1984i). EPA (1987o) derived a 1-day and 10-day health advisory of 1.4 mg/liter for a child based on a study by Gross and Heller (1946) that defined a no-effect-level in rats administered K_2CrO_4 (Cr^{+6}) in drinking water. EPA (1988f) reported a subchronic oral reference dose of 0.02 mg/kg/day based on a study by MacKenzie et al. (1958) that defined a no-effect-level in rats administered hexavalent chromium in drinking water. Liver and kidney damage has been documented in humans exposed to hexavalent chromium, but there is no supportive data from animal studies (EPA 1987o). The EPA (1988f) reported a subchronic oral reference dose of 10 mg/kg/day for trivalent chromium based on liver toxicity in rats administered 5% Cr_2O_3 in diet (Ivankovic and Preussman 1975). A chronic oral reference dose for chromium VI of $5x10^{-3}$ mg/kg/day was derived by EPA (1987h) based on a study by MacKenzie et al. (1958). EPA (1985i) promulgated an MCL of 50 ug/liter for chromium and has proposed an MCLG for chromium of 120 ug/liter.

D.12.2 TOXICITY TO WILDLIFE AND PLANTS

For freshwater aquatic organisms, chromium (VI) generally appears to be more toxic than chromium (III). Freshwater fish generally appear to be more tolerant of chromium than invertebrates. Slowed growth, increased locomotor activity, and enzyme inhibition have been reported following chronic exposure. EPA (1984i) has established a continuous concentration criterion for chromium (VI) of 11 ug/liter not to be exceeded more than once every 3 years. In acute assays, the most sensitive species is the scud Gammarus pseudolimnaeus with a 48-hour EC_{50} of 67 ug/liter. In chronic tests, the most sensitive species was the rainbow trout (Salmo gairdneri) with a maximum acceptable toxicant concentration of 75 ug/liter (Sauter et al. 1976). Chromium is not highly

bioconcentrated; Calamari (1982) has calculated a whole body bioconcentration factor of 3.4 for rainbow trout based on uptake and depuration.

A chronic oral mammalian TRV of 0.24 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 0.24 mg/kg/day from a chronic rat study was the basis.

A bird TRV of 0.125 mg/kg/day was derived based on information in Eisler (1986). A dietary level of 10 ppm altered growth in black ducks. Using a dietary conversion factor of 0.125 mg/kg body weight per ppm in food (USDA 1984), a value of 1.25 mg/kg/day was derived. A safety factor of 10 was applied for LOEL:NOEL.

The chromium content of plants is controlled mainly by the amount of soluble chromium in the soils. Chromium (VI) is the most soluble and available to plants, but it is also the most unstable form under normal soil conditions. Usually chromium distribution in plants results in the highest concentrations in the roots, then the leaves and stems and the lowest concentrations in the grain (Kabata-Pendias and Pendias 1984). Typical symptoms of chromium phytotoxicity are wilting of plant tops, root injury, chlorosis in young leaves, brownish-red leaves and chlorotic bands on cereals (Kabata-Pendias and Pendias 1984). Concentrations as low as 0.01 mg/kg in the soil were found to cause a reduction in the dry weight of bean leaves (NAS 1974). A toxicity reference value of 0.01 mg/kg was therefore used in this analysis to assess adverse impacts to plants.

D.13 COPPER

D.13.1 HUMAN HEALTH EFFECTS

Copper is an essential element. A daily copper intake of 2 mg is considered to be adequate for normal health and nutrition; the minimum daily requirement is 10 ug/kg (EPA 1985i). Adverse effects in humans resulting from acute over

exposure to copper by ingestion includes salivation, gastrointestinal irritation, nausea, vomiting, hemorrhagic gastritis, and diarrhea (ACGIH 1986). Dermal or ocular exposure of humans to copper salts can produce irritation (ACGIH 1986). Acute inhalation of dusts or mists of copper salts by humans may produce irritation of the mucous membranes and pharynx, ulceratation of the nasal septum, and metal fume fever. The latter condition is characterized by chills, fever, headache, and muscle pain. Limited data are available on the chronic toxicity of copper; however, chronic over-exposure to copper by humans has been associated with anemia (ACGIH 1986). Evidence to date indicates that copper is not teratogenic in experimental animals (EPA 1980g), and various copper compounds are negative for mutagenicity in microbial assay systems (EPA 1985i). Results of several animal bioassays suggest that copper compounds are not carcinogenic by oral administration; however, some copper compounds can induce injection-site tumors in mice (EPA 1985i).

EPA (1988f) reported that inadequate toxicity information was available to derive a subchronic oral reference dose for copper. Instead EPA reported the current drinking water standard of 1.3 mg/liter which is based on local GI tract irritation in humans administered a single dose of copper (EPA 1987p). EPA (1984z) has derived acceptable chronic intakes (AICs) of 3.7×10^{-2} mg/kg/day and 1.0×10^{-2} mg/kg/day, for oral and inhalation exposures, respectively. These values will be used as chronic reference doses (RfDs). An ambient water quality criterion for copper of 1 mg/liter has been established based on organoleptic data (EPA 1980g).

D.13.2 TOXICITY TO WILDLIFE AND PLANTS

Copper toxicity has been tested on a wide variety of aquatic species. Fish and invertebrate species seem to be about equally sensitive to the chronic toxicity of copper. In a chronic life-cycle test using Gammarus pseudoliminaeus (scud) an MATC of 6.1 ug/liter was reported at a water hardness of 45. In an early life-stage test using Salvelinus fontinalis

(brook trout), a MATC of 3.9 (ug/liter) was reported at a water hardness of 37.5 (EPA 1980g).

The toxicity of copper on ferns was examined by Francis and Petersen (1983) using percent germination as the toxic effects endpoint. They found a 50% failure of germination at 0.1 and 1.3 mg/L respectively for the two ferns Osmunda cinnamomea and Onoclea sensibilis. The no observed effect level (NOEL) was 0.05 mg/L for Osmunda cinnamomea (similar low concentrations were not performed with Onoclea sensibilis).

D.14 4,4'-DDT

D.14.1 HUMAN HEALTH EFFECTS

DDT is absorbed by humans following oral or dermal exposure. DDT and DDT metabolites are stored primarily in adipose tissues, where residues can persist up to 20 years (EPA 1984g). Chronic exposure of workers to DDT has been associated with altered enzyme activities, altered hematologic parameters, and increased incidences of miscarriages and postpartum disorders (EPA 1984g, NIOSH 1978b). In studies involving long-term dietary exposure of experimental animals, observed adverse effects to DDT have included increased mortality, gastrointestinal bleeding, hepatic lesions, and immunosuppression. Acute oral exposure of humans and animals to DDT can cause tremors, convulsions, parathesia, and other central nervous system effects. Adverse reproductive effects reported for DDT include reduced fertility, gonadal lesions, embryotoxicity, blastotoxicity, fetotoxicity, premature delivery and reduced fetal growth (EPA 1984g). Results of genotoxicity studies on DDT in various assay systems are mixed (EPA 1984g).

DDT has been shown to be carcinogenic to experimental animals by the oral route in at least 11 studies; the principal site of action was the liver, but increased incidences of tumors of the lung and lymphatic system were reported in several investigations (NIOSH 1978b). DDT is classified as a Group B2

agent (Probable Human Carcinogen). This classification applies to agents for which there is sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans (EPA 1984g). An oral cancer potency factor for DDT of 0.34 $(mg/kg/day)^{-1}$ has been derived by EPA (1984g). An oral reference dose (RfD) of $5x10^{-4}$ mg/kg/day also has been calculated by EPA (1987h).

D.14.2 TOXICITY TO WILDLIFE AND PLANTS

4,4'-DDT has been extensively studied in freshwater invertebrates and fishes and is quite toxic to most species. The range of toxicities was 0.18 to 1,800 ug/liter and the freshwater final acute value for 4,4'-DDT and its isomers was determined by EPA to 1.1 ug/liter. Only one chronic toxicity test on aquatic species was reported. This test indicated that the acute-chronic ratio for 4,4'-DDT might be high (65 in the reported study), but the data were insufficient to allow calculation of a final acute-chronic ratio. 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE are bioconcentrated by a factor of 10^3 to 10^5. 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE and the other persistent organochlorine pesticides are primarily responsible for the great decrease in the reproductive capabilities and consequently in the populations of fish-eating birds, such as the bald eagle, brown pelican, and osprey. 4,4'-DDT has also been shown to decrease the populations of numerous other species of waterbirds, raptors, and passerines significantly (EPA 1980h).

A chronic oral mammalian TRV of $5x10^{-3}$ mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 0.05 mg/kg/day from a subchronic rat study was the basis. A safety factor of 10 for subchronic:chronic was applied.

A bird TRV of 0.0375 mg/kg/day was derived. The basis for this value was a feeding study with American kestrels in which eggshell thinning occurred at 3 ppm DDE. The TRV was obtained by using a dietary conversion factor of 0.125 mg/kg per ppm diet (USDA 1984) and a safety factor of 10 for LOEL:NOEL.

DDT was found by Eno and Everett (1958) to cause a 35% reduction in root weight and an 11% reduction in top weight of Black Valentine beans at a soil concentration of 12.5 mg/kg. A toxicity reference value of 12.5 mg/kg was therefore used in this analysis.

D.15 1,2-DICHLOROBENZENE

D.15.1 HUMAN HEALTH EFFECTS

1,2-Dichlorobenzene is readily absorbed through the lungs, skin, and gastrointestinal tract (EPA 1987b). The principal toxic effects of this compound in humans and experimental animals from acute and longer-term exposure include central nervous system depression, blood dyscrasias, and lung, kidney, and liver damage (EPA 1985a). Chromosome breaks also have been observed in exposed humans (EPA 1987b). Available evidence suggests that 1,2-dichloroethane is not teratogenic, fetotoxic, mutagenic or carcinogenic. With respect to carcinogenicity, 1,2-dichlorobenzene is categorized as a Group D agent (Not Classified). This category applies to those agents for which there is inadequate evidence of carcinogenicity in animals. EPA (1988f) reported a subchronic oral reference dose of 0.9 mg/kg/day based on liver effects in rats administered 1,2-dichlorobenzene by gavage (NTP 1985). EPA (1988f) reported a subchronic inhalation reference dose of 0.4 mg/kg/day based on decreased body weight gain in rats administered 1,2-dichlorobenzene by inhalation (Hollingsworth et al. 1958). A chronic oral reference dose (RfD) of 8.9×10^{-2} mg/kg/day has been derived for 1,2-dichlorobenzene by EPA (1985a). The proposed MCLG and ambient water quality criterion for this compound are 0.62 mg/liter and 470 mg/liter, respectively (EPA 1980i).

D.15.2 TOXICITY TO WILDLIFE

1,2-Dichlorobenzene is a member of a class of halogenated aromatic compounds that are relatively volatile (Jordan 1954). Data available show that toxicity

to freshwater life would occur at concentrations as low as 250 ug/liter (EPA 1986e). Acute tests (48-h and 96-h) performed by EPA (1978a, 1980i) found that there is no great difference in sensitivity between bluegill and Daphnia magna and that the position of the chlorine atom on the benzene ring probably does not influence the toxicity of 1,2-dichlorobenzene very much.

Chronic toxicity has been demonstrated as low as 50 ug/liter, in a short-term (7.5 day) test. Lower chronic toxicities would be expressed. Equilibrium bioconcentration factors in bluegill exposed for 14 days was 89 for 1,2-dichlorobenzene respectively (EPA 1978a).

The freshwater alga Selenastrum capricornutum tested for effects of 1,2-dichlorobenzene on chlorophyll a and cell numbers found the EC_{50} values to range from 91600 ug/liter to 179,000 ug/liter (EPA 1980i).

D.16 1,1-DICHLOROETHANE

D.16.1 HUMAN HEALTH EFFECTS

1,1-Dichloroethane is absorbed following oral and inhalation exposure (EPA 1984h). Acute inhalation exposure of humans to 1,1-dichloroethane has been associated with cardiac arrhythmias, central nervous system depression, and irritation of the skin and respiratory tract (EPA 1980j). Renal damage has been observed in cats exposed to 1,1-dichloroethane by subchronic inhalation exposure (EPA 1980j). Subchronic inhalation exposure of pregnant rats to high doses (6,000 ppm) of 1,1-dichloroethane also produces retarded fetal development (EPA 1980j).

1,1-Dichloroethane has not been extensively tested for genotoxicity, although this compound was mutagenic in one bacterial assay system (EPA 1984h). Carcinogenicity bioassays of this compound to date have been limited by poor survival of both treatment and control groups (NTP 1978); however, EPA (1987j, 1988c) has reported an oral cancer potency factor of 9.1×10^{-2} $(mg/kg/day)^{-1}$ for

1,1-dichloroethane based on structure-activity relationship to 1,2-dichloroethane, a Group B2 agent (Probable Human Carcinogen). In its Health Assessment document, EPA (1984h) derived oral and inhalation RfDs for 1,1-dichloroethane of 0.12 mg/kg/day and 0.138 mg/kg/day, respectively.

D.16.2 TOXICITY TO WILDLIFE AND PLANTS

The available information on the toxicity of 1,1-dichloroethane to aquatic life is very limited. Species average LC_{50} values were reported to be 160,000 ug/liter, 202,000 ug/liter, and 550,000 ug/liter for pinperch, guppy and bluegill, respectively (Konemann 1981, Verschueren 1983). No data are available on chronic toxicity or toxicity to plants.

D.17 1,2-DICHLOROETHANE

D.17.1 HUMAN HEALTH EFFECTS

Results of studies with experimental animals indicate that 1,2-dichloroethane is absorbed following oral, inhalation and dermal exposure (EPA 1985f). Acute and chronic inhalation exposure of humans to 1,2-dichloroethane has been associated with irritation of the mucous membranes and respiratory tract, central nervous system depression, gastrointestinal disturbances, and symptoms of nausea, fatigue and drowsiness (EPA 1985f). In occasional cases where humans have died because of respiratory and circulatory failure following acute inhalation exposure to 1,2-dichloroethane, hemorrhagic lesions of the liver, kidney, spleen, lungs and gastrointestinal tract have been observed (EPA 1985f). Lesions of the liver and other organs also have been observed in experimental animals following chronic inhalation of 1,2-dichloroethane (EPA 1985f). Chronic oral exposure of rats and mice to 1,2-dichloroethane produces increased mortality and body weight depression (EPA 1985f).

1,2-Dichloroethane and it metabolites are mutagenic in a variety of assay systems (EPA 1985f). EPA (1987h) has classified 1,2-dichloroethane as a Group

B2 agent (Probable Human Carcinogen). Cancer potency factors of 9.1×10^{-2} $(mg/kg/day)^{-1}$ for both oral and inhalation exposure have been derived for this compound (EPA 1987h). The ambient water quality criterion for 1,2-dichloroethane is 0.94 ug/liter; this concentration is associated with a 10^{-6} excess lifetime cancer risk (EPA 1980e). The MCL and MCLGs for 1,2-dichloroethane are 5 and 0 ug/liter, respectively (EPA 1987k).

D.17.2 TOXICITY TO WILDLIFE

Acute and chronic toxicity data for all tested aquatic species demonstrate a direct positive relationship between toxicity and the degree of chlorination. An increase of 2 orders of magnitude exists between 1,2-dichloroethane and hexachloroethane for acute toxicity values and chronic toxicity values for fathead minnows increase about 40 times. This relationship is also found for BCFs for bluegill which increase from 2 to 139 for 1,2-dichloroethane and hexachloroethane respectively.

Based on nominal concentrations, the 48-hour LC/EC value for Daphnia magna exposed to 1,2-dichloroethane was 218,000 ug/liter (EPA 1978a). Fathead minnows tested under constant-flow procedures to 1,2-dichloroethane had an LC_{50} of 118,000 ug/liter. Bluegill exposed for 96-hours in static bioassays demonstrated LC_{50}s of 55,000 ug/liter (Dawson et al. 1977) and 431,000 ug/liter (EPA 1978a) for 1,2-dichloroethane (nominal concentrations). Chronic toxicity of 1,2-dichloroethane was determined by a fathead minnow embryo-larval bioassay to be 20,000 ug/liter (EPA 1978a).

Chlorinated ethanes were not found to readily bioconcentrate in fish. Measured steady state BCFs for bluegill for 1,2-dichloroethane to be 2. Chlorinated ethanes were found to have a depuration rate of less than 2 days as measured by whole body levels (EPA 1978a).

No data were found concerning toxicity of chlorinated ethanes to terrestrial wildlife.

D.18 1,1-DICHLOROETHENE

D.18.1 HUMAN HEALTH EFFECTS

1,1-Dichloroethene caused kidney tumors (in males only) and leukemia in one study of mice exposed by inhalation, but results of other studies were equivocal or negative (EPA 1987c). 1,1-Dichloroethene is mutagenic and caused adverse reproductive effects when administered to rats and rabbits by inhalation (EPA 1987c). Chronic exposure causes liver damage, and acute exposure to high doses produces nervous system damage (EPA 1987c). EPA (1987h) has derived cancer potency factors for both oral and inhalation exposure. The oral cancer potency factor is 0.6 $(mg/kg/day)^{-1}$ and the inhalation cancer potency factor is 1.2 $(mg/kg/day)^{-1}$. 1,1-Dichloroethene has been classified in Class C--Possible Human Carcinogenic (EPA 1987h). EPA (1987c) derived a 1-day health advisory of 2.0 mg/liter for a child based on liver damage in rats orally administered 1,1-dichloroethene (Chieco et al. 1981). EPA (1987c) derived a 10-day health advisory of 1 mg/liter for a child based on liver damage in rats administered 1,1-dichloroethene in drinking water (Rampy et al. 1977). A chronic oral reference dose (RfD) of 0.009 mg/kg/day has been determined by EPA (1987h). These values will be used to estimate risks associated with human exposure to 1,1-dichloroethene. EPA has recently promulgated both a final maximum contaminant level goal (MCLG) and a maximum contaminant level (MCL) of 7 ug/liter for 1,1-dichloroethene in drinking water (EPA 1987k).

D.18.2 TOXICITY TO WILDLIFE

1,1-Dichloroethene is not very toxic to aquatic species, with acute LC_{50} values generally ranging from 80 ug/liter to 200 ug/liter (EPA 1980e). A chronic study in which no adverse effects were observed indicated that the acute-chronic ratio was less than 40; a 13-day study that produced an LC_{50} of

29 ug/liter indicated that the acute-chronic ratio is greater than 4. No reports of the toxicity of 1,1-DCE to terrestrial wildlife were available.

D.19 trans-1,2-DICHLOROETHENE

D.19.1 HUMAN HEALTH EFFECTS

There are no reports of carcinogenic or teratogenic activity by trans-1,2-dichloroethene in animals or humans. trans-1,2-Dichloroethene has anesthetic properties and has been found to cause nausea, vomiting, weakness,and cramps in humans (EPA 1984c). Compound-specific information concerning toxicity of trans-1,2-dichloroethene is not adequate, and health-based criteria are derived from 1,1-dichloroethene. EPA (1987d) derived a 1-day health advisory of 20 mg/L for a child based on slight liver effects in rats administered trans-1,2-dichloroethene by inhalation (Freundt et al. 1977). EPA (1987d) derived a 10-day health advisory of 1.43 mg/L for a child based on liver and lung effects in rats administered trans-1,2-dichloroethene by inhalation (Freundt et al. 1977). EPA's Office of Drinking Water has derived a chronic oral risk reference dose (RfD) of 0.01 mg/kg/day (EPA 1987d). This is the toxicity value that will be used to estimate risks associated with human exposure to this compound. A maximum contaminant level goal (MCLG) of 70 mg/liter has been proposed. EPA has classified trans-1,2-dichloroethene in Class D--Not Classified (EPA 1985i).

D.19.2 TOXICITY TO WILDLIFE AND PLANTS

Practically no information concerning the toxicity of trans-1,2-dichloroethene to wildlife and domestic animals exists. The reported 96-hour LC_{50} value under static conditions is 135,000 ug/liter for the bluegill. Under the same test conditions, the LC_{50} value for 1,1-dichloroethene is 73,900 ug/liter. The available data are not adequate for establishing criteria for protection of aquatic life (EPA 1980e).

A chronic oral mammalian TRV of 1.7 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 17 mg/kg/day from a subchronic rat study was the basis. A safety factor of 10 for subchronic:chronic was applied. No toxicity data on birds or plants were found.

D.20 IRON

D.20.1 HUMAN HEALTH EFFECTS

Gastrointestinal absorption of iron in humans ranges from 1 to 25% (EPA 1984y). Absorption of iron following inhalation exposure has not been thoroughly studied. Iron is an essential element and is therefore nontoxic at doses necessary for maintaining normal health and nutrition (EPA 1984y). However, overexposure to iron can cause adverse health effects. Gastrointestinal irritation is the primary effect observed in humans following acute oral overexposure to iron. Chronic oral overexposure of humans to iron has been associated with gastrointestinal bleeding, metabolic acidosis, hepatic toxicity, hemosiderosis, and hemochromatosis (EPA 1984y). Human fatalities have occurred following ingesting of iron at doses of 100 mg/kg/day (Venugopal and Luckey 1978). Chronic inhalation overexposure of humans to iron-containing dusts and fumes produces respiratory irritation and various pulmonary lesions (EPA 1984y). There is limited evidence from studies with experimental animals that certain soluble iron salts are teratogenic. Certain iron compounds are also reported to be genotoxic. Iron oxide enhances the carcinogenic action of various organic carcinogens (benoz[a]pyrene for example) and may act as a tumor promoter. Local sarcomas have been induced by subcutaneous injection of iron-dextran (EPA 1984y).

EPA (1984y) categories iron as a Group C agent (Possible Human Carcinogen). This category applies to agents for which there is limited evidence of carcinogenicity in animals. However, no quantitative estimateof cancer potency has been derived for iron. EPA (1984y) has derived a chronic acceptable inhalation intake (AIC) of 0.6 mg/day (0.0086 mg/kg/day) for iron

based on the American Conference of Governmental Industrial Hygienists' (ACGIH 1986) recommended time-weighted average threshold limit value (TWO-TLV) for the most toxic iron compound evaluated (iron pentacarbonyl). This AIC value will be used as an inhalation RfD.

Reliable quantitative data for assessment of risks associated with ingestion exposure to iron are not available. However, NRC (1980) has noted that the levels of iron associated with the long-term toxicity in mongastric animals are 340 to 1,700 times greater than the dietary requirement. Therefore, in the absence of more suitable data, the maximum recommended daily intake of iron can be used as a conservative allowable intake for chronic exposure. The National Research Council of the National Academy of Sciences (NRC 1980) has suggested the following recommended dietary allowances (RDAs) for iron: infants to 6 months, 10 mg; 6 months to 3 years, 15 mg; 4-10 years, 10 mg; males 11-18 years, females (not pregnant) 11-50 years, and lactating females, 18 mg; males 19 years and older and females 51 years and older, 10 mg; and pregnant females 18+ mg. In addition, iron supplements of 30-60 mg/day may be advisable for pregnant women (EPA 1984). Thus, since pregnant women can obtain up to about 18 mg of iron through the diet and it is recommended that they supplement their dietary intakes with up to an additional 60 mg/day, a reference dose of 78 mg/day or approximately 1 mg/kg/day can be derived. This value is far less than the amount that would be likely to produce chronic toxic effects and represents a conservative guidelines values for risk assessment.

D.20.2 TOXICITY TO WILDLIFE AND PLANTS

Ferrous (Fe^{+2}) and ferric (Fe^{+3}) iron are the species of concern in aquatic systems, although ferric iron is practically insoluble (EPA 1986e). Iron concentrations of 1,000 ug/liter to 2,000 ug/liter were lethal to Northern pike (Esox lucius) and trout (species not known) (Doudoroff and Katz 1953). Precipitates of iron coat the gills and inhibit oxygen uptake, and also create

a smothering effect detrimental to fish eggs and bottom-dwelling organisms. The EPA water quality criteria guideline for iron is 1.0 mg/liter (EPA 1986e).

No information was found on the toxicity of iron to wild birds, however limited information is available for domestic birds. Chicks were able to tolerate 1,600 mg/kg of iron when also given adequate amounts of copper in the diet. Decreased weight gain and increased mortality occurred at 200 mg/kg iron and 5 mg/kg copper (McGhee et al. 1965 in NAS 1980). Rickets were produced in young chicks at 4,500 mg/kg iron (Deobald and Elvehjem 1935 in NAS 1980). Turkeys showed no adverse effects at 440 ppm iron (Woerpel and Balloun 1964 in NAS 1980). NAS (1980) suggests that the maximum tolerable level of dietary iron is 1,000 mg/kg for poultry.

Acute effects of hepatic congestion due to iron were seen in rabbits at a concentration of 750 mg ferrous sulfate/kg body weight (Luongo and Bjornson 1954). While this concentration caused death in 24-48 hours, 2,000 mg ferrous sulfate/kg body weight caused death in all rabbits within a few hours of administration. Iron concentrations of 3,000 mg/kg in feed resulted in no effect on swine after 56 days, however, at 4,000 mg/kg reduced growth was observed (EPA 1985n). Cattle fed 477 mg/kg iron for 84 days showed a slight decrease in weight gains; at 1,677 mg/kg a significant decline in growth rate was observed (EPA 1985n).

Limited information is available on the toxicity of iron to plants. Concentrations of 100 mg/liter to 500 mg/liter soluble iron in soil were shown to be toxic to rice; concentrations above 500 mg/liter were highly toxic (Foy et al. 1978 in EPA 1985n). Iron is an essential trace element required by both plants and animals. In highly alkaline lakes where it is precipitated, it may be a limiting factor to the growth of algae and other plants.

D.21 LEAD

D.21.1. HUMAN HEALTH EFFECTS

Absorption of lead from the gastrointestinal tract of adult humans is estimated at 8%-45%. In children, absorption from non-paint sources ranges from 30% to 50% (Hammond 1982, EPA 1986). There are other interpretations of the data (Duggan 1983) which suggest this may be as high as 70%. For adult humans, the deposition rate of particulate airborne lead is 30%-50%, and essentially all of the lead deposited is absorbed. Lead is stored in the body in bone, kidney, and liver (EPA 1984). The major adverse effects in humans caused by lead include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of this metal in blood. Blood concentration levels of over 80 ug/dl in children and over 100 ug/dl in sensitive adults can cause severe, irreversible brain damage, encephalopathy, and possible death. The Centers for Disease Control (CDC 1985) have used the value of 25 ug/L as an acceptable level of blood lead. Recent information, however (EPA 1988a), indicates that physiological and/or biochemical effects can occur at even lower levels. These include enzyme inhibition (16 ug/dL), elevated erythrocyte protoporphyrin (15 ug/dL), interference with Vitamin D metabolism, cognitive dysfunction in infants (10 to 15 ug/dL), electrophysiological dysfunction (6 ug/dL), and reduced childhood growth (4 ug/dL). Decreased fertility, fetotoxic effects, and skeletal malformations have been observed in experimental animals exposed to lead (EPA 1984).

Oral ingestion of certain lead salts (lead acetate, lead phosphate, lead subacetate) has been associated in experimental animals with increased renal tumors. Doses of lead that induced kidney tumors were high and were beyond the lethal dose in humans (EPA 1985). EPA classified certain lead salts in Group B2--Probable Human Carcinogen (EPA 1985), although no cancer potency factor has been established (EPA 1988b). This category applies to those agents for which there is sufficient evidence of carcinogenicity in animals

and inadequate evidence of carcinogenicity in humans. EPA (1988a) has recently proposed a maximum contaminant level goal (MCLG) of zero for lead and considers it inappropriate to develop a reference dose (RfD) for inorganic lead and lead compounds since many of the health effects associated with lead intake may occur essentially without a threshold. For purposes of this document, a provisional RfD of 6.0×10^{-4} mg/kg/day has been calculated from the previously proposed MCLG of 0.02 mg/liter, assuming consumption of 2 liters of water per day by a 70 kg individual for a lifetime. This value is used for purposes of this risk assessment only and should not be construed to represent a verified RfD which has undergone EPA peer-review.

D.21.2 TOXICITY TO WILDLIFE AND PLANTS

The primary mechanism of acute toxicity of lead to freshwater organisms is unknown. Lead toxicity decreases with increasing water hardness. EPA (1984j) has established a continuous concentration criterion for lead not to exceed the value given by $_e$(1.266[ln(hardness)]-4.661) and a one-hour average concentration criterion not to exceed the value given by $_e$(1.266[ln(hardness)]-1.416) more than once every 3 years. In acute bioassays, invertebrate species are more sensitive than vertebrate species. The 48-hour EC_{50} of 124 ug/liter is reported for the scud at a water hardness of 46 mg/L $CaCO_3$ (Spehar et al. 1978). The lowest maximum acceptable toxicant concentration from chronic studies is 19 mg/liter for rainbow trout at a water hardness of 128 mg/L $CaCO_3$ (Davies et al. 1976). Klein (1962) found that a water concentration of 0.3 ppm was toxic to fish, but had little effect on invertebrates. A whole-body bioconcentration factor of 45 was reported using a natural small lake population of bluegills (Atchison et al. 1977).

Eisler (1988) reviewed the toxic effects of lead in birds. A number of studies report toxic effects and accumulation in game birds that ingested lead shot. These exposures are often lethal. Lead-poisoned birds show the following symptoms: loss of appetite, lethargy, weakness, emaciation, tremors, drooped wings, and impaired locomotion and balance. Decreased delta

amino levulinic acid dehydrogenase (ALAD) levels is frequently an early symptom of poisoning.

In an experimental exposure with mallards, the only observed effects from 12 week dietary exposure to 25 mg Pb/kg (as lead nitrate) were decreases in blood ALAD activity and increases in blood lead levels. This concentration can be converted to a dose of 3.12 mg/kg by multiplying by a dietary conversion factor of 0.125 mg/kg per ppm diet (USDA 1984). A bird TRV of 0.312 mg/kg was obtained by adding a safety factor of 10 for LOEL:NOEL.

A chronic oral mammalian TRV of 0.005 mg/kg/day was derived based on information reviewed by Eisler (1988). The basis for this value was a chronic rat study in which there was irreversible inhibition of ALAD activity at 0.05 mg/kg/day. A safety factor of 10 for LOEL:NOEL was applied.

Lead inhibits plant growth, reduces photosynthesis and reduces mitosis and water absorption (Eisler 1988). Inhibition of photosynthesis is attributed to the blocking of protein sulfhydryl groups and to changes in phosphate levels in the cell (Eisler 1988). Lead levels of approximately 500 mg/kg in soil reduced pollen germination by greater than 90 percent in two weed species (Eisler 1988). Normal germination rates were observed at soil lead levels of 46 mg/kg but other adverse effects were observed at lead levels of 12 mg/kg to 312 mg/kg soil (Eisler 1988). The 12 mg/kg value is used in this assessment to assess potential impacts to plants.

D.22 MANGANESE

D.22.1 HUMAN HEALTH EFFECTS

Manganese is absorbed at low levels following oral or inhalation exposure (EPA 1984k,w). Chronic oral and inhalation exposure of humans to manganese has been associated with a condition known as manganism, a progressive neurological disease characterized by speech disturbances, tremors, and

difficulties in walking. Altered hematologic parameters (hemoglobin concentrations, erythrocyte counts) have also been observed in persons exposed chronically. Manganese has not been reported to be teratogenic; however, this metal has been reported to cause depressed reproductive performance and reduced fertility in humans and experimental animals. There is no evidence that manganese is carcinogenic. Manganese is classified as a Group D agent; this category applies to agents for which there is inadequate evidence of carcinogenicity in animals (EPA 1984k,w). EPA (1988f) reported a subchronic oral reference dose of 0.5 mg/kg/day based on reproductive effects in rats (Laskey et al. 1982). EPA (1988f) reported a subchronic inhalation reference dose of 0.0003 mg/kg/day based on CNS effects in humans exposed to manganese in the air while working (Saric et al. 1982). EPA (1988f) reported chronic reference doses (RfDs) of 2.2×10^{-1} mg/kg/day and 3.0×10^{-4} mg/kg/day for oral and inhalation exposure, respectively (EPA 1988f). The ambient water quality criterion for manganese is 50 ug/liter (EPA 1986e).

D.22.2 TOXICITY TO WILDLIFE AND PLANTS

Manganese is not highly toxic to freshwater organisms. Acute toxic effects have been reported for manganese chloride at manganese concentrations ranging from 50,000 ug/liter for the invertebrate *Daphnia magna* to 7,850,000 ug/liter for the fish *Orizias* sp. Similar values have been reported for manganese in the form of manganese difloride, manganese nitrate, and manganese sulfate. No freshwater criteria have been established for manganese. McKee and Wolf (1963) suggest that 1,000 ug/liter is not deleterious to fish and aquatic life.

D.23 MERCURY

D.23.1 HUMAN HEALTH EFFECTS

In humans, elemental and inorganic mercury are absorbed following inhalation exposure but are poorly absorbed following oral exposure (EPA 19841).

Occupational exposure of workers to elemental mercury vapors (0.1 to 0.2 mg/m^3) has been associated with mental disturbances, tremors, and gingivitis (EPA 19841). The central nervous system is a major target for organic mercury compounds. Adverse effects in humans from exposure to organic mercury compounds have included destruction of cortical cerebral neurons, damage to Purkinje cells, and lesions of the cerebellum. Clinical symptoms following exposure to organic mercury compounds have included paresthesia, loss of sensation in extremities, ataxia, and hearing and visual impairment (WHO, 1976). A primary target organ for inorganic compounds is the kidney. Human exposure to inorganic mercury compounds has been associated with anuria, polyuria, proteinuria, and renal lesions (Hammond and Beliles 1980). Embryotoxic and teratogenic effects, including malformations of the skeletal and genitourinary systems, have been observed in animals exposed to organic mercury (EPA 19841). Both organic and inorganic compounds are reported to be genotoxic in eukaryotic systems (Leonard et al. 1984).

EPA (19841) has categorized mercury as a Group D agent (Not Classified). This classification applies to those agents for which there is inadequate evidence of carcinogenicity in animals. EPA (1987q) derived a 1-day and 10-day health advisory of 1.6 ug/liter for a child based on kidney damage in rats administered mercuric chloride by subcutaneous injections (Druet et al. 1978). EPA (1988f) reported subchronic oral reference doses for alkyl and inorganic mercury and for inorganic mercury only. The subchronic oral reference dose of 0.0003 mg/kg/day for alkyl and inorganic mercury is based on CNS effects in humans with a blood mercury level of 200 ng/ml (EPA 1980t). The subchronic oral reference dose of 0.002 mg/kg/day for inorganic mercury is based on kidney effects in rats administered mercury acetate in diet (Fitzhugh et al. 1950). EPA (1987j) has reported a chronic oral reference dose for inorganic mercury of 1.4×10^{-3} mg/kg/day. The ambient water quality criterion for ingestion of water and aquatic organisms contaminated with inorganic mercury is 144 ng/liter (EPA 1985k). A MCLG for inorganic mercury of 0.003 ug/liter has been proposed (EPA 1985i). Essentially all mercury detected in drinking water to date is in the form of inorganic mercury (EPA 1985i).

D.23.2 TOXICITY TO WILDLIFE

Mercury has no known biological function, and any presence of the metal in organisms is considered undesirable (NAS 1978). Inorganic mercury is relatively non-toxic to organisms. Inorganic mercury, however, may be transformed through biological processes under anaerobic conditions to form methyl mercury which can be bioaccumulated and biomagnified. Methyl mercury has been found to be mutagenic, teratogenic in various species and is also associated with embryocidal, cytological, and histopathological effects. Mercury generally tends to accumulate rapidly and depurate slowly (Eisler 1987a). The EPA AWQC has set a maximum concentration for freshwater which is not to exceed 0.012 ug/liter for a chronic 4-day average and 2.4 ug/liter for an acute hourly average. These are based on methyl mercury and are therefore very conservative estimates for inorganic mercury which is neither as toxic or as easily bioaccumulated as methyl mercury.

Mercury at relatively low concentrations adversely affects the reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange in animals. Adverse effects have been documented in mammals consuming as little as 1,100 ug/kg Hg in their diet, for birds the lowest observed adverse effects level (LOEL) has been found to be 100 ug/kg consumed in the diet. Mercury toxicity to birds varies widely with the form of the element, dose, route of administration, species, sex, age, and physiological condition (Fimreite 1979). Acute oral toxic concentrations were found to range from 2.2 mg/kg and 31.0 mg/kg body weight and 4.0 to 40.0 mg/kg diet for most avian species tested.

D.24 METHYLENE CHLORIDE

D.24.1 HUMAN HEALTH EFFECTS

Methylene chloride is absorbed following oral and inhalation exposure (EPA 1985g). Acute inhalation exposure of humans to methylene chloride produces irritation of the eyes and respiratory tract, central nervous system depression, and elevated carboxyhemoglobin levels (EPA 1980k). Chronic inhalation exposure of animals produces renal and hepatic toxicity (EPA 1980k).

Methylene chloride is mutagenic in the Ames assay without metabolic activation (EPA 1980k). There is clear evidence that methylene chloride is carcinogenic to experimental animals by inhalation; however, there is only suggestive evidence for carcinogenicity from oral studies (EPA 1985g). EPA (1987h) has classified methylene chloride as a Group B2 agent (Probable Human Carcinogen). Cancer potency factors of 1.4×10^{-2} $(mg/kg/day)^{-1}$ and 7.5×10^{-3} $(mg/kg/day)^{-1}$ have been derived for inhalation and oral exposure, respectively (EPA 1987h). An oral RfD of 0.06 mg/kg/day for noncarcinogenic effects has also been derived for methylene chloride (EPA 1987h). The ambient water quality criterion is 12.4 mg/liter (EPA 1980k).

D.24.2 TOXICITY TO WILDLIFE AND PLANTS

Very little information concerning the toxicity of methylene chloride to wildlife exists (EPA 1980k). Acute values for the freshwater species *Daphnia magna*, the fathead minnow, and the bluegill are 224,000 ug/liter, 193,000 ug/liter, and 224,000 ug/liter, respectively. No data concerning chronic toxicity are available. The 96-hour EC_{50} value for freshwater algae is greater than the highest concentration tested, 662,000 ug/liter.

A chronic oral mammalian TRV of 5.85 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 5.85 mg/kg/day from a chronic rat study was the basis. No bird or plant toxicity data were found.

D.25 NICKEL

D.25.1 HUMAN HEALTH EFFECTS

Nickel compounds can be absorbed following inhalation, ingestion, or dermal exposure. The amount absorbed depends on the dose administered and the chemical and physical form or the particular nickel compound (EPA 1986d). Adverse effects associated with acute exposure in animals have included depressed weight gain, altered hematological parameters, and increased iron deposition in blood, heart, liver, and testes (EPA 1987e). Chronic or subchronic exposure of experimental animals to nickel has been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthma, nasal septal perforations, rhinitis, sinusitis, hyperglycemia, decreased prolactin levels, decreased iodine uptake, and vasoconstriction of the coronary vessels. Dermal exposure of humans to nickel produces allergic contact dermatitis (EPA 1986d). Teratogenic and fetotoxic effects have been observed in the offspring of exposed animals (EPA 1986d). Certain nickel compounds are genotoxic in bacterial and mammalian assay systems (EPA 1986d).

Inhalation exposure of experimental animals to nickel carbonyl or nickel subsulfide induces pulmonary tumors (EPA 1986d). Several nickel slats cause localized tumors when administered by subcutaneous injection or implantation. Epidemiological evidence indicates that inhalation of nickel refinery dust and nickel subsulfide is associated with cancers of the nasal cavity, lung, larynx, kidney, and prostate (EPA 1986d). There is no evidence that nickel is carcinogenic in animals or humans when the metal is ingested, and EPA (1987e) does not consider nickel to be carcinogenic by the oral route.

Nickel refinery dust and nickel subsulfide by inhalation are both categorized as Group A agents (Human Carcinogens). These materials have inhalation cancer potency factors of 0.84 $(mg/kg/day)^{-1}$ and 1.7 $(mg/kg/day)^{-1}$, respectively. Nickel carbonyl by inhalation is categorized as a Group B2 agent (Probable Human Carcinogen); however, a potency factor has not been derived for nickel carbonyl (EPA 1986d). Nickel compounds by the oral exposure route have been categorized as Group D agents (Not Classified) (EPA 1984m). EPA (1987e) derived a 1-day and a 10-day health advisory of 1 mg/liter for a child based on body weight gain, hematology parameters, and cytochrome oxidase activity affected in rats administered nickel in the diet (Whanger 1973). EPA (1988f) reported a subchronic oral reference dose of 0.02 mg/kg/day based on reduced body and organ weight in rats administered nickel sulfate in diet (Ambrose et al. 1976). EPA (1987h) has derived a chronic oral reference dose (RfD) for nickel of $2x10^{-2}$ mg/kg/day. An ambient water quality criterion of 15.4 ug/liter has been established for ingestion of nickel through drinking water (EPA 1980m).

D.25.2 TOXICITY TO WILDLIFE AND PLANTS

The adverse effects of nickel on aquatic organisms include alteration of all membranes, formation of precipitates on gills, hematological effects and reproductive impairment. In a chronic life-cycle test, Daphnia magna, a maximum acceptable toxicant concentration (MATC) of 14.8 ug/liter was reported at a water hardness of 51. In an early life-stage test using the fathead minnow, a MATC of 109 ug/liter was reported at a water hardness of 44 (EPA 1984m). Calamari et al (1982) found a BCF of 1.1 for fish.

The EPA criterion for nickel is also variable according to the water hardness. A four-day average concentration (ug/liter) of nickel should not exceed $_e$(0.8460[ln(hardness)] + 1.1645) more than once every 3 years and that an one-hour average concentration (in ug/liter) does not exceed $_e$(0.8460[ln (hardness)] + 3.3612) more than once every 3 years (EPA 1984m).

Animals have shown a low to moderate toxicity to nickel. Mammals appear to have a mechanism which limits absorption of the element in the intestine (Gough et al. 1979).

The toxicity of nickel on the growth of wheat and the subsequent ingestion of the wheat by Japanese quail was tested by Stoewsand et al. (1984). They found that wheat grown on sludge containing 198.4 mg/kg (dry weight) nickel contained 0.98 mg/kg nickel. The sludge-grown wheat also had a higher protein, fiber and ash content than did the control wheat. Two generations of Japanese quail were raised on a diet containing the contaminated wheat (diet concentration = 0.71 mg/kg nickel), while they found significantly higher levels of nickel in the livers of the first generation birds of the sludge-grown wheat than the controls, no difference was found in the second generation which consumed the diet for 26 weeks as compared to 13 weeks in the first generation. While higher levels were found in the first generation livers, no significant differences were observed in growth, food intake or egg production in either of the two dietary treatments. Dietary effects of nickel on survival and growth of mallard ducklings was examined (Cain and Pafford 1981). They found a NOEL at a dietary intake of 200 mg/kg nickel in the feed.

Kabata-Pendias and Pendias (1984) reviewed the literature on metal phytotoxicity and identified the total concentrations of selected metals in surface soils that were phytotoxically excessive. The concentration for nickel was 100 mg/kg (dry weight).

D.26 PENTACHLOROPHENOL

D.26.1 HUMAN HEALTH EFFECTS

Pentachlorophenol (PCP) is readily absorbed following oral, inhalation and dermal exposure and accumulates in liver, kidney, brain, spleen, and adipose tissue (EPA 1985b). PCP is an uncoupler of cellular oxidation and phosphorylation. Acute poisonings in humans have been associated with

symptoms of fever, gastrointestinal complaints, and weight loss; liver and kidney damage have been observed in human cases of fatal poisoning (EPA 1985b). In experimental animals, exposure to PCP has been associated with hepatic, renal and central nervous system lesions. A number of studies have provided evidence that PCP is fetotoxic but that it has a low potential for teratogenic effects. PCP has not been shown to be carcinogenic, and has produced negative results in initiation/promotion studies (EPA 1985b). EPA (1986f) has classified PCP as a Group D agent (Not Classified); this category applies to those compounds for which there is inadequate evidence of carcinogenicity in animals. EPA (1987r) derived a 1-day health advisory of 1.0 mg/liter for a child based on liver effects in rats administered a single oral dose of sodium pentachlorophenate (Nishimura et al. 1982). EPA (1987r) derived a 10-day health advisory of 0.30 mg/liter for a child based on renal and hepatic effects in rats administered pentachlorophenol in diet (Johnson et al. 1973). EPA (1988f) reported a subchronic oral reference dose of 0.03 mg/kg/day based on fetotoxicity in rats administered pentachlorophenol by gavage (Schwetz et al. 1978). A chronic oral reference dose (RfD) and a proposed MCLG of 0.03 mg/kg/day (EPA 1987h) and 0.22 mg/liter (EPA 1985i), respectively, have been derived for PCP.

D.26.2 TOXICITY TO WILDLIFE AND PLANTS

In determining a criterion for pentachlorophenol (PCP), data regarding toxicity to 23 invertebrate and 13 vertebrate species were collected (EPA 1986a). Of the invertebrates, the most sensitive species is Daphnia magna with a species mean acute value of 55 ug/liter. The most tolerant species tested is the crayfish Orconectes immunis with a species eman acute value of >43,920 ug/liter.

Species acute values for freshwater fish range from 4.4 ug/liter for the common carp Cyprinus carpio to 291.6 ug/liter for the flagfish Jordanella floridae.

Chronic data based on life cycle, partial life cycle, or early life stange tests were collected for 4 invertebrate and 2 vertebrate species. The chronic values range from <1.835 ug/liter for the cladoceran Ceriodaphnia reticulata to 79.66 ug/liter for the cladoceran Simocephalus vetulus. Average acute-chronic ratios of 0.89, 2.5, 3.9 and 4.6 have been calculate for Simocephalus vetulus, Daphnia magna, Pimephales promelas, and Salmo gairdneri, respectively.

EPA (1986a) found that the acute and chronic toxicity of PCP in freshwater increases with decreases in pH and dissolved oxygen. On the basis of this information EPA has proposed that the four day average concentration for freshwater aquatic life should not exceed the value derived by the equation $_e$[1.005(pH)-5.290] (EPA 1986a).

A chronic oral mammalian TRV of 3 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 3 mg/kg/day from a chronic rat study was the basis.

A bird TRV of 76 was derived based on data reviewed by Hudson et al. (1984). The basis for this value is an acute oral LD_{50} of 380 mg/kg for the mallard. A safety factor of 5 was applied according to the procedures of Urban and Cook (1986).

No data on the toxicity of pentachlorophenol to terrestrial plants was found.

For the freshwater alga Chlorella pyrenoidosa and duckweed Lemna minor chlorosis has been observed in 2-4 days at concentrations as low as 7.5 ug/liter and 800 ug/liter, respectively.

D.27 PHENOL

D.27.1 HUMAN HEALTH EFFECTS

Phenol is readily absorbed following oral, inhalation, and dermal exposure (EPA 1980n). Adverse effects in humans and experimental animals following acute exposure to phenol have included central nervous system depression, coma and cardiac arrest. Direct dermal or ocular contact with phenol may cause necrosis (EPA 1980n). Subchronic and chronic oral exposure of experimental animals to phenol has been associated with renal damage and decreased body weights (EPA 1984n). Phenol is mutagenic in several assay systems, but there is no evidence that the compound is carcinogenic when given to rats and mice in drinking water (EPA 1984n). Phenol has tested positive for carcinogenicity in studies in which mice were given repeated dermal applications. EPA (1984n) has classified phenol as a Group D compound (Not Classified). This category applies to agents for which there is inadequate evidence of carcinogenicity in animals. EPA (1988f) reported a subchronic oral reference dose of 0.4 mg/kg/day based on kidney and liver damage in rats administered phenol by gavage (Dow Chemical Co. 1945). EPA has derived a chronic oral reference dose (RfD) for phenol of $4x10^{-2}$ mg/kg/day (EPA 1987h) and an acceptable chronic intake (AIC) for inhalation exposure of $2x10^{-2}$ mg/kg/day (EPA 1984n). An ambient water quality criterion of 0.3 mg/liter has been established for phenol based on organoleptic properties (EPA 1980n).

D.27.2 TOXICITY TO WILDLIFE AND PLANTS

Information concerning the presence and persistence, and fate of phenol in the environment is incomplete or not available. The phenol molecule easily substitutes in the environment to form compounds such as halophenol, which may be more toxic than the parent compound. Phenol is degraded by a number of bacteria and fungi that are capable of depressing the dissolved oxygen content of the water and allowing slime growths, thus reducing the quality of the receiving waters.

Tests for the acute toxicity of phenol found rainbow trout to be the most sensitive species with an LC_{50} of 5,020 ug/liter (McLeay 1976). Along with interspecific variability, intraspecific variability was found with fathead minnows and bluegill, LC_{50}s ranged from 24,000 ug/liter to 67,500 ug/liter and 11,500 ug/liter to 28,116 ug/liter respectively (Ruesink and Smith 1975, USEPA 1978b, Cairns and Scheier 1959, Cairns et al. 1978). This indicates the possibility of toxicity being influenced by abiotic parameters such as pH, temperature, or hardness. Chronic toxicity was examined using a fathead minnow early life stage test (Holcombe et al. 1980) to produce a maximum acceptable toxicant concentration (MATC) of 1,830 ug/liter to 3,570 ug/liter to give a chronic value of 2,560 ug/liter (EPA 1980n). The BCFs calculated from studies on goldfish exposed to phenol for 5 days (Kobayashi et al. 1976, and Kobayashi and Akitake 1975) ranged from 1.2 to 2.3. BCFs this low indicate that no residue problems should occur.

A chronic oral mammalian TRV of 0.357 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A LOEL of 35.7 mg/kg/day from a rat subchronic study was the basis. Safety factors of 10 for LOEL:NOEL and 10 for subchronic:chronic were applied. No bird or plant toxicity data were found.

D.28 POLYCYCLIC AROMATIC HYDROCARBONS

D.28.1 HUMAN HEALTH EFFECTS

Polycyclic aromatic hydrocarbons (PAHs) are a diverse group of compounds consisting of two or more aromatic rings. Adverse effects observed in experimental animals following exposure to PAHs have included immunosuppression, and renal, hepatic and dermal lesions. Ocular lesions have been reported in experimental animals following oral exposure to PAHs. PAHs also inhibit DNA replication, and can cause cytotoxicity in cells of the

testes and hematopoietic and lymphoid systems. Acute dermal contact of humans to PAHs produces dermatitis and phototoxicity (Santodonato et al. 1981).

A number of PAHs are potent carcinogens, inducing tumors both at the site of application and systemically, in several different animal species, when administered by various routes (IARC 1983). The PAH, benzo(a)pyrene [B(a)P], for example, produces gastric tumors, pulmonary adenomas, and leukemias when administered to mice in the diet (IARC 1983). Although many PAHs are classified as noncarcinogenic because they are not complete carcinogens, some noncarcinogenic PAHs may act as tumor promoters or cocarcinogens (IARC 1983). EPA (1984p) derived cancer potency factors of 11.5 $(mg/kg/day)^{-1}$ and 6.11 $(mg/kg/day)^{-1}$ for oral and inhalation exposure to PAHs based on studies with B(a)P. B(a)P is one of the most potent carcinogens among the PAHs (EPA 1984p).

D.28.2 TOXICITY TO WILDLIFE AND PLANTS

The polycyclic aromatic hydrocarbons (PAHs) are a class of organic compounds consisting of substituted and unsubstituted polycyclic aromatic rings formed by numerous processes including the incomplete combustion of organic materials. Their chemical, physical and biological properties vary with their size and shape. Very little information on specific PAHs is available. PAHs found in the water and sediments at the Wells G & H site are: ancenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(b,k)fluoranthene, benzo(q,h,i)perylene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. No AWQC have been set for polycyclic aromatic hydrocarbons, Eisler (1987b) recommended levels 0.1 ug/liter to 5.0 ug/liter for the protection of aquatic life. The variability is due to the differing abilities of species to metabolize the compounds and the inducibility of the detoxifying enzymes. The BCF for rainbow trout continuously exposed to 0.4 ug/liter benzo(a)pyrene for 10 days was found by Gerhart and Carlson (1978) to be 920, however, in general bioaccumulation data is equivocal due to the influence of metabolism.

Data on the toxicity of PAHs to birds and other terrestrial species are limited. Mallards, fed for 7 months on diets containing various PAHs at a total concentration of 4000 mg/kg, exhibited increased liver weights and blood flow to the liver when compared to controls (Eisler 1987b). This was the only feeding study with birds identified in the literature. No TRV was estimated because of the paucity of data.

For carcinogenic PAHs, a chronic oral mammalina TRV of $2x10^{-4}$ mg/kg/day was derived based on information reviewed by Eisler (1987b). The lowest reported oral carcinogenic dose of benzo(a)pyrene was 0.002 mg/kg/day. A safety factor of 10 for LOEL:NOEL was applied.

No data were found on the toxicity of PAHs to plants.

D.29 RADIONUCLIDES

D.29.1 HUMAN HEALTH EFFECTS

Following inhalation or ingestion, radionuclides are absorbed into body tissues and irradiate nearby cells. The ultimate effects of the irradiation depends on the particular physical and chemical characteristics of the radionuclide (which determines its distribution and retention in the body) and its emitted radiation. For example, alpha particles have great ionizing power but because of their large size have poor penetrating power. Beta particles on the other hand, have less ionizing power but greater penetrating power. In humans, exposure to radiation generally results in the induction of cancer, genetic disease, teratogenic effects, and degenerative changes. The target organs of the cancer and degenerative effects are the respiratory tract, bone liver, and the reticuloendothelium system (NRC 1988).

Radioactivity in drinking water is generally divided into two categories, namely, naturally occurring or man-made. Naturally occurring components are

generally alpha emitters and EPA has established an MCL for gross alpha particles of 15 pCi/liter (EPA 1976). This value includes the activity of radium-226 but excludes radium-228, radon, and uranium. More specific values are given below for radium and uranium. Man-made components are generally beta emitters and EPA has established an MCL for beta emitters and photon radioactivity such that the concentration of these radionuclides in drinking water shall not produce an annual dose equivalent to the body or any internal organ that is greater than 4 mrem/year (EPA 1976).

Radium. Studies in which radium-226 was injected into rats and dogs have shown that low-dose exposure results in an increase in the incidence of bone sarcomas (Mays and Finkel, 1979). In humans, ingestion of radium-226 is clearly linked to the induction of bone sarcomas and to a lesser extent, carcinomas of the paranasal sinuses and the mastoid air cells (EPA 19851). The latter carcinomas of the head are probably due to radon-222 gas generated within the body from the decay of radium-226 and are not likely to occur after the ingestion of pure radium-224 and 228 because these forms do not produce long-lived radon gas. On the basis of these studies, EPA has established an MCL for combined radium 226 and 228 of 5 pCi/liter (EPA 1976). This value corresponds to a lifetime risk of 4.4×10^{-5}.

Uranium. Following ingestion, uranium is distributed primarily to the kidneys and to bone. Animal studies have shown that uranium exposure results in necrosis of the proximal convoluted tubules of the kidney (Yuile 1973, Haley 1982). A NOAEL for uranium of 0.1 mg/kg/day to 1.0 mg/kg/day has been derived based on studies in which rats fed 0.1 mg/kg/day uranyl for 11 months and rabbits fed 0.42 mg/kg uranyl nitrate for 12 months did not develop any significant adverse effects. From this value, an adjusted allowable daily intake of 6 ug/liter to 60 ug/liter or 4 pCi/liter to 40 pCi/liter can be calculated (EPA 1985m). This does not allow for the intake of uranium from other sources. Studies have also shown that uranium-232 and -233 exert carcinogenic effects, however, there is no direct evidence of the

radiotoxicity of natural uranium. Since uranium is distributed to bone, its toxic effects are likely to be similar to those described for radium.

D.30 TETRACHLOROETHENE

D.30.1 HUMAN HEALTH EFFECTS

Oral and inhalation exposure to tetrachloroethene has been associated with an increased incidence of hepatocellular carcinoma in both mice and rats (EPA 1985h). Principal toxic effects in humans and animals from both acute and chronic exposures include central nervous system depression and liver and kidney damage (EPA 1985h). Inhalation and oral cancer potency factors of 3.3×10^{-3} $(mg/kg/day)^{-1}$ (EPA 1987j) and 5.1×10^{-2} $(mg/kg/day)^{-1}$ (EPA 1985h), respectively, have previously been derived. Tetrachloroethene also has been previously classified in Group B2--Probable Human Carcinogen (EPA 1986f). An interoffice work group of EPA (1987h) is currently reviewing the cancer risk estimates and the weight of evidence classification of tetrachloroethene. EPA (1987s) derived an 1-day and 10-day health advisory of 2 mg/liter for a child based on liver toxicity in mice administered tetrachloroethene by gavage (Buben and O'Flaherty 1985). EPA has calculated a chronic oral reference dose (RfD) of 0.02 mg/kg/day for noncarcinogenic effects (EPA 1987h). The RfD and previously reported cancer potency values will be used to estimate risks associated with exposure to this compound.

D.30.2 TOXICITY TO WILDLIFE AND PLANTS

Tetrachloroethene is the most toxic of the chloroethylenes to aquatic organisms but is only moderately toxic relative to other types of compounds. The limited acute toxicity data indicate that the LC_{50} value for freshwater species is around 10,000 ug/liter; the trout was the most sensitive (LC_{50} = 4,800 ug/liter). A chronic value of 840 ug/liter was reported for freshwater species, and an acute-chronic ratio of 19 was calculated. No

information on the toxicity of tetrachloroethene to terrestrial wildlife was available in the literature (EPA 1980q).

No AWQC has been established for tetrachloroethene. There are little data available on the chronic toxicity of this compound to aquatic life. Rainbown trout appear to be the most sensitive species with an acute LC_{50} of 5800 ug/liter. Chronic tests performed with slightly less sensitive species, fathead minnows, gave a MATC of 840 ug/liter for an ambryo-larval test (EPA 1980q). The BCF for bluegill (EPA 1978q) was determined to be 49. Equilibrium was reached in 21 days and the depuration rate was rapid with a half life of less than 1 day. No information on the toxicity of tetrachloroethene to terrestrial wildlife was available in the literature (EPA 1980q).

A chronic oral mammalian TRV of 1.4 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 14 mg/kg/day from a subchronic rat study was the basis. A safety factor of 10 for subchronic:chronic was applied.

No plant toxicity data were found.

D.31 TOLUENE

D.31.1 HUMAN HEALTH EFFECTS

There is no conclusive evidence that toluene is carcinogenic or mutagenic in animals or humans. In laboratory animals, acute oral and inhalation exposures to toluene resulted in central nervous system (CNS) depression and histological changes in the lungs, liver, and kidneys. In humans, the major acute effects of toluene are CNS depression and narcosis. Chronic effects of toluene to both humans and experimental animals are similar to acute effects, consisting primarily of damage to the CNS, liver, kidneys,and lungs (EPA 1985i). EPA (1987t) derived a 1-day health advisory of 21.5 mg/liter for a

child based on fatigue, muscular weakness, and incoordination in humans exposed to toluene by inhalation (Gamberale and Hultengren 1972). EPA (1987t) derived a 10-day health advisory of 3.46 mg/liter for a child based on a no-effect-level in rats administered toluene by inhalation (CIIT 1980). EPA (1988f) reported oral and inhalation subchronic reference doses for toluene. The oral subchronic reference dose of 0.4 mg/kg/day is based on CNS effects in rats exposed to toluene by gavage (Wolf et al. 1956). The inhalation subchronic reference dose of 1 mg/kg/day is based on CNS effects in rats administered toluene by inhalation (CIIT 1980). EPA (1987h) has derived a chronic oral risk reference dose (RfD) of 0.3 mg/kg/day. A chronic inhalation RfD of 1.5 mg/kg/day also has been derived by EPA (1984q) based on a chronic inhalation study in rats (CIIT 1980). Toluene has been classified by EPA (1984q) in Group D--Not Classified. EPA's Office of Drinking Water has proposed a maximum contaminant goal (MCLG) of 2 mg/liter for toluene in drinking water (EPA 1985i).

D.31.2 TOXICITY TO WILDLIFE AND PLANTS

Of five freshwater species tested with toluene, the cladoceran Daphnia magna was most resistant to any acute effects (EPA 1984q). The EC_{50} and LC_{50} values for all five species range from 12,700 ug/liter to 313,000 ug/liter. No chronic tests are available for freshwater species. The two freshwater algal species tested are relatively insensitive to toluene with EC_{50} values of 245,000 ug/liter or greater being reported.

Insufficient information was found for the derivation of TRVs for mammalian wildlife, birds, or plants.

D.32 1,1,1-TRICHLOROETHANE

D.32.1 HUMAN HEALTH EFFECTS

Exposure to 1,1,1-trichloroethane resulted in central nervous system depression and cardiovascular dysfunction in humans and animals. The influence of 1,1,1-trichloroethane on liver and kidney function has been investigated, but studies report conflicting results dependent on species, doses, and treatment schedule. NTP (1984) reported an increase in the incidence of hepatocellular carcinomas in female mice when administered 1,1,1-trichloroethane by gavage; however, this study is currently being audited. EPA (1987u) derived a 1-day health advisory of 140 mg/liter for a child based on depressed liver microsomal metabolic indices in rats administered a single oral dose of 1,1,1-trichloroethane (Vainio et al. 1976). EPA (1987u) derived a 10-day health advisory of 35 mg/liter for a child based on reduced body weight gain and CNS effects in rats administered 1,1,1-trichloroethane by gavage (Bruckner et al. 1985). EPA (1988f) reported oral and inhalation subchronic reference doses for 1,1,1-trichloroethane. The oral subchronic reference dose of 0.9 mg/kg/day and the inhalation subchronic reference dose of 3 mg/kg/day are both based on hepatotoxicity in guinea pigs administered 1,1,1-trichloroethane by inhalation (Torkelson et al. 1958). EPA (1987h) derived chronic reference doses (RfD) of 9×10^{-2} mg/kg/day and 3.1 mg/kg/day for oral and inhalation exposure to 1,1,1-TCA, respectively. These toxicity values will be used to estimate risks associated with human exposure to this compound at the Wells G&H site. A final maximum contaminant level goal (MCLG) and maximum contaminant level (MCL) of 200 ug/liter has been promulgated by EPA (1987k). An ambient water quality criterion of 18.4 mg/liter has been established for ingestion of fish and contaminated water (EPA 1980e).

D.32.2 TOXICITY TO WILDLIFE AND PLANTS

The acute toxicity of 1,1,1-trichloroethane to aquatic species is rather low, with the LC_{50} concentration for the most sensitive species tested being 31,200 ug/liter. No chronic toxicity studies were available in the literature on 1,1,1-trichloroethane, but acute-chronic ratios for the other chlorinated ethanes ranged from 2.8 to 8.7. 1,1,1-trichloroethane was only slightly bioaccumulated with a steady-state bioconcentration factor of nine and an elimination half-life of two days (EPA 1980e).

D.33 TRICHLOROETHENE

D.33.1 HUMAN HEALTH EFFECTS

Trichloroethene (TCE) is a central nervous system depressant from acute and chronic exposure, by both ingestion and inhalation. Industrial use of TCE may also result in dermatitis from exposure to vapors of concentrated solvent. In carcinogenicity studies on mice, an increased incidence of hepatocellular carcinoma was reported following oral administration of TCE (NCI 1976, NTP 1983). EPA's Carcinogen Assessment Group (CAG) has derived cancer potencies of 1.1×10^{-2} $(mg/kg/day)^{-1}$ for oral exposure and 1.3×10^{-2} $(mg/kg/day)^{-1}$ for inhalation exposure (EPA 1987h). These toxicity values will be used to estimate risk associated with human exposure to this compound. TCE has been classified by EPA (1984r,1987h) in Group B2--Probable Human Carcinogen. An oral RfD for TCE is under review by an EPA (1987h) work group. EPA's Office of Drinking Water has promulgated a maximum contaminant level goal (MCLG) of 0 ug/liter (EPA 1987k) and a maximum contaminant level (MCL) of 5 ug/liter for TCE in drinking water.

D.33.2 TOXICITY TO WILDLIFE AND PLANTS

There was only limited data on the toxicity of trichloroethene to aquatic organisms. The acute toxicity to freshwater species was similar in the three

species tested, with LC_{50} values of about 50 mg/liter. No chronic toxicity tests were reported. No information on the toxicity of trichloroethene to terrestrial wildlife was available in the literature reviewed (EPA 1980r).

The AWQC for trichloroethene is 1500 ug/liter. Analyses for the ability of the compound to concentrate in bluegill determined a bioconcentration factor (BCF) of only 17 and the half-life in the tissues was less than half a day (indicating fast metabolism and/or excretion of the compound) (EPA 1980r).

Insufficient information was found for the derivation of TRVs for mammalian wildlife, birds, or plants.

D.34 VINYL CHLORIDE

D.34.1 HUMAN HEALTH EFFECTS

Human exposure to vinyl chloride has been associated with increased incidence of liver cancer (hepatic angiosarcoma) and brain, lung, and hemolymphopoietic cancers in humans. Chronic inhalation and ingestion of vinyl chloride has induced cancer in the liver and other tissues in rats and mice (IARC 1979). Mutagenic effects of vinyl chloride have been documented. Short-term exposure of workers to vinyl chloride produces symptoms such as dizziness, headaches, and narcosis, and long-term exposure is associated with hepatotoxicity, central nervous system, and cardiovascular disturbances and gastrointestinal toxicity (EPA 1985c). EPA reported cancer potency factors of $2.3\ (mg/kg/day)^{-1}$ (EPA 1984s) for oral exposure and $2.95 \times 10^{-1}\ (mg/kg/day)^{-1}$ (EPA 1987j) for inhalation exposure. These are the values that will be used to estimate risk associated with human exposure to this compound. Vinyl chloride has been classified in Group A--Human Carcinogen--based on the weight of evidence for carcinogenicity (EPA 1984s). EPA's Office of Drinking Water has promulgated a final maximum contaminant level goal (MCLG) of 0 ug/liter and a maximum contaminant level (MCL) of 2 ug/liter (EPA 1987k).

D.34.2 TOXICITY TO WILDLIFE AND PLANTS

No data are available regarding the toxicity of vinyl chloride to wildlife or plants. Vinyl chloride probably belongs to the large category of chemicals that are lethal by a nonspecific mode of action called narcosis (Veith et al. 1985). In homologous series of narcosis-producing compounds, acute toxicity generally increases with increasing chlorination (EPA 1980s, Veith et al. 1985).

D.35 XYLENES

D.35.1 HUMAN HEALTH EFFECTS

Preliminary findings by the National Toxicology Program indicate that xylene does not appear to be carcinogenic in rats following oral exposure (EPA 1985d). Acute exposure to rather high levels of xylene affects the central nervous system and irritates mucous membranes. Long-term exposure to xylene reportedly affects the liver (EPA 1984t, 1985d). EPA (1987v) derived a 1-day health advisory of 12 mg/liter for a child based on CNS effects in humans administered xylenes by inhalation (Gamberale et al. 1978). EPA (1987v) derived a 10-day health advisory of 7.8 mg/liter for a child based on a no-effect-level in rats administered xylenes by inhalation (Carpenter et al. 1975). EPA (1988f) reported subchronic oral and inhalation reference doses for xylenes. The subchronic oral reference dose of 4 mg/kg/day is based on a no-effect-level in rats administered xylenes by gavage (NTP 1986). The subchronic inhalation reference dose of 0.7 mg/kg/day is based on fetotoxicity in rats administered xylenes by inhalation (Litton Bionetics 1978). EPA (1987h) has derived a chronic oral reference dose (RfD) of 2 mg/kg/day for xylenes. This is the toxicity value that will be used to estimate risk associated with human exposure to xylene. Oral and inhalation chronic acceptable intakes (AICs) of 0.01 mg/kg/day and 0.398 mg/kg/day have been calculated by EPA (1984t). This latter AIC value for inhalation will be used as the inhalation RfD. Xylene has been categorized for carcinogenicity by EPA

(1984t) in Group D--Not Classified. The Office of Drinking Water proposed a maximum contaminant level goal (MCLG) of 0.44 mg/liter (EPA 1985i).

D.35.2 TOXICITY TO WILDLIFE AND PLANTS

Xylene adversely affected adult trout at concentrations as low as 3.6 mg/liter in a continuous-flow system, and trout fry avoided xylene at concentrations greater than 0.1 mg/liter. The LC_{50} value in adult trout was determined to be 13.5 mg/liter. LC_{50} values for other freshwater fish were approximately 30 mg/liter in a static system, which probably underestimated toxicity. No information on the toxicity of xylene to terrestrial wildlife or plants was available in the literature reviewed.

A chronic oral mammalian TRV of 179 mg/kg/day was derived based on information from the IRIS database (EPA 1988e). A NOEL of 179 mg/kg/day from a chronic rat and mouse study was the basis.

D.36 ZINC

D.36.1 HUMAN HEALTH EFFECTS

Chronic and subchronic inhalation exposure of humans to zinc has been associated with gastrointestinal disturbances, dermatitis, and metal fume fever, a condition characterized by fever, chills, coughing, dyspnea, and muscle pain (EPA 1984u). Chronic oral exposure of humans to zinc may cause anemia and altered hematological parameters. Reduced body weights have been observed in studies in which rats were administered zinc in the diet. There is no evidence that zinc is teratogenic or carcinogenic (EPA 1984u). With respect to carcinogenicity, zinc is categorized as a Group D agent (Not Classified) (EPA 1984u). EPA (1988f) reported a subchronic oral reference dose of 0.2 mg/kg/day based on anemia in humans administered a therapeutic dose of zinc (Prasad et al. 1975). EPA (1984u) has derived acceptable chronic daily intake values of 2.1×10^{-1} mg/kg/day and 1×10^{-2} mg/kg/day for oral and

inhalation exposures, respectively. These values will be used as chronic reference doses (RfDs).

D.36.2 TOXICITY TO WILDLIFE

Zinc is an essential trace nutrient important to cell growth and differentiation. Exposure to sublethal concentrations of zinc causes extensive edema and necrosis of liver tissue. Death results from gill necrosis and hypoxia. Zinc toxicity is dependent on water hardness. EPA (1984u) has proposed that the 1-hour average concentration for total recoverable zinc should not exceed the value given by $_e$(0.8195 [ln(hardness)+0.787]) ug/liter, and the 4-day average should never exceed the value given by $_e$(0.8195[ln(hardness)]+0.6881). The value is the ARAR for zinc. The most sensitive vertebrate species in acute assays is the rainbow trout, with a 96-hour LC_{50} of 90 ug/liter (Garton 1972); however, a 7-day EC_{50} of 30 ug/liter based on growth inhibition was reported for the green alga Selenastrum capricornutum (Bartlett et al. 1974). In chronic studies a maximum acceptable toxicant concentration of 47 ug/liter was reported for both Daphnia magna and flagfish Jordanella floridae (Biesinger and Christenson 1972, Spehar 1978b). A whole body bioconcentration factor of 432 was reported for the flagfish following 100 days of exposure (Spehar et al. 1978b).

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APPENDIX E

ANALYTICAL DATA SUMMARY TABLES

W.R. GRACE AND COMPANY

W.R. GRACE PROPERTY: SURFACE SOILS

	SB1-(0'-2') EBASCO DATA 1987	SB2-(0'-2') EBASCO DATA 1987	SB4-(0'-2') EBASCO DATA 1987	SB9-(0'-2') GEOMETRIC MEAN
ORGANICS (ug/kg)				
VOLATILES				
ACETONE	R	R	5 ND	5 ND
1,1,1-TRICHLOROETHANE	2.5 ND	8	2.5 ND	2.5 ND
CHLOROFORM	2.5 ND	2.5 ND	2.5 ND	3.5
TETRACHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TRICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND
METHYLENE CHLORIDE	2.5 ND	2.5 ND	2.5 ND	2.5
SEMI-VOLATILES				
DI-N-BUTYL PHTHALATE	NT	NT	NT	3
BENZO(B)FLUORANTHENE	NT	NT	NT	2
PESTICIDES/PCBs				
4,4'-DDT	NT	NT	NT	24
4,4'-DDE	NT	NT	NT	5.4
INORGANICS (mg/kg)				
ALUMINUM	NT	NT	NT	13049.14
ARSENIC	NT	NT	NT	15.3
BARIUM	NT	NT	NT	21.98
CALCIUM	NT	NT	NT	856.56
CHROMIUM	NT	NT	NT	23.69
COBALT	NT	NT	NT	5.33
COPPER	NT	NT	NT	16.31
IRON	NT	NT	NT	12433.02
LEAD	NT	NT	NT	37.11
MAGNESIUM	NT	NT	NT	2939.8
MANGANESE	NT	NT	NT	126.9
MERCURY	NT	NT	NT	0.06
NICKEL	NT	NT	NT	10.44
POTASSIUM	NT	NT	NT	764.15
SODIUM	NT	NT	NT	81.5
VANADIUM	NT	NT	NT	24.08
ZINC	NT	NT	NT	40.42
CYANIDE	NT	NT	NT	0.5 ND

W.R. GRACE PROPERTY: SUBSURFACE SOIL

	SB1-(2'-4') EBASCO DATA 1987	SB2-(2'-4') EBASCO DATA 1987	SB3-(2'-4') EBASCO DATA 1987	SB3-(4'-6') EBASCO DATA 1987	SB4-(6'-8') EBASCO DATA 1987	SB5-(2'-4') EBASCO DATA 1987	SB5-(4'-6') EBASCO DATA 1987	SB6-(2'-4') EBASCO DATA 1987	SB6-(4'-6') EBASCO DATA 1987	SB7-(2'-4') EBASCO DATA 1987	SB7-(6'-8') EBASCO DATA 1987
ORGANICS (ug/L)											
VOLATILES											
ACETONE	R	R	21.0	21.0	5.0 ND	R	R	12.0	5.0 ND	5.0 ND	RB
1,1,1-TRICHLORETHANE	11.0	8.0	2.5 ND	2.5 ND	2.5 ND	4.0 J	2.5 ND	2.5 ND	2.5 ND	2.5 ND	5.0 J
SEMI-VOLATILES											
DI-N-BUTYL PHTHALATE	NT	NT	NT	NT	NT	NT	NT	NT	165.0 ND	1.0	165.0 ND
INORGANICS (mg/Kg)											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	8010.0	N/A
ARSENIC	NT	NT	NT	NT	NT	NT	NT	NT	N/A	11.0	N/A
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	24.0 [	N/A
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	1830.0	N/A
CHROMIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	16.0 *	N/A
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	N/A	9.4 [	N/A
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	N/A	21.0 *	N/A
IRON	NT	NT	NT	NT	NT	NT	NT	NT	N/A	13800.0 *	N/A
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	N/A	5.2 *	N/A
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	4730.0	N/A
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	N/A	236.0	N/A
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	N/A	0.1 [N	N/A
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	N/A	17.0	N/A
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	1300.0 E	N/A
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	148.0 [	N/A
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	N/A	20.0	N/A
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	N/A	31.0	N/A

	S89-(2'-4') GEOMETRIC MEAN	
ORGANICS (ug/L)		
VOLATILES		
ACETONE	5.0	ND
1,1,1-TRICHLORETHANE	2.5	ND
SEMI-VOLATILES		
DI-N-BUTYL PHTHALATE	165.0	ND
INORGANICS (mg/Kg)		
ALUMINUM		N/A
ARSENIC		N/A
BARIUM		N/A
CALCIUM		N/A
CHROMIUM		N/A
COBALT		N/A
COPPER		N/A
IRON		N/A
LEAD		N/A
MAGNESIUM		N/A
MANGANESE		N/A
MERCURY		N/A
NICKEL		N/A
POTASSIUM		N/A
SODIUM		N/A
VANADIUM		N/A
ZINC		N/A

W.R. GRACE: GROUNDWATER
(ug/liter)

	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85
SAMPLE LOCATION	GW-3S	GW-3D	GW-3DB	GW-4S	GW-4D	GW-7S	GW-7D	GW-9	GW-11S	GW-11D	GW-12S	GW-12D
SAMPLE NUMBER	12453	12454	12455	12441	12443	12439	12440	12438	12447	12450	12448	12449
TRAFFIC REPORT NUMBER	AB531	AB532	AB535	AB519	AB520	AB525	AB526	AB527	AB521	AB522	AB523	AB524
DILUTION FACTORS---->	100	100	500	1	10	1	1	1	1	1	5	5
VOLATILES												
VINYL CHLORIDE	NDR	NDR	NDR	5 ND	0 NDR	15	5 ND	5 ND	5 ND	5 ND	NDR	NDR
METHYLENE CHLORIDE	250 ND	250 ND	1250 ND	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
1,1-DICHLOROETHENE	NDR	NDR	NDR	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	72	220	95	300
TRANS-1,2-DICHLOROETHENE	1400 J	1800 J	7500 J	21	790	340	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
1,2-DICHLOROETHANE	250 ND	250 ND	1250 ND	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
VINYL ACETATE	500 ND	500 ND	2500 ND	5 ND	50 ND	5 ND	5 ND	5 ND	5 ND	5 ND	25 ND	25 ND
TRICHLOROETHENE	# R	# R	# R	19	200	310	2.5 ND	2.5 ND	85	70	420	640
TETRACHLOROETHENE	NDR	NDR	110 J	2.5 ND	NDR	8	2.5 ND	2.5 ND	2 J	12	NDR	11 J
TOLUENE	250 ND	250 ND	1250 ND	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
ETHYLBENZENE	250 ND	250 ND	1250 ND	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
TOTAL-XYLENE	250 ND	250 ND	1250 ND	2.5 ND	25 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND
SEMIVOLATILES												
NAPHTHALENE	5 ND	5 ND	5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	5 ND	17	230	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS												
ALUMINUM	41	11.5 ND	11.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	18	15	6 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	53000	86000	63000	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	# R	# R	12.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	94	86	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	1 ND	1 ND	1 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	19000	18000	7700	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	540	1.5 ND	9.3	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	0.05 ND	0.05 ND	0.05 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	# R	20 ND	20 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	10000	3100	3300	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	43000	28000	17000	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	23	# R	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYANIDE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

W.R. GRACE: GROUNDWATER
(ug/liter)

	MAY 1985	MAY 1985	MAY 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985
SAMPLE LOCATION	GW-3S	GW-3D	GW-3DB	GW-3S	GW-3D	GW-3DB	GW-4S	GW-4D	GW-11S	GW-11D	GW-12S	GW-12D
SAMPLE NUMBER	12724	12725	12726	13265	13267	13269	13259	13260	13261	13262	13263	13264
TRAFFIC REPORT NUMBER	AB396	AB701	AB702	AC241	AC243	AC245	AC235	AC236	AC237	AC238	AC239	AC240
DILUTION FACTORS---->	1	1	1	5	5	7.07	1	5	5	5	5	5
VOLATILES												
VINYL CHLORIDE	48	220 J	40 J	159 J	319 J	132 J	5 ND	NDR	NDR	NDR	NDR	NDR
METHYLENE CHLORIDE	2.5 ND	2.5 ND	2.5 ND	# R	# R	# R	2.5 ND	# R	# R	# R	# R	# R
1,1-DICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND	17.675 ND	2.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
TRANS-1,2-DICHLOROETHENE	920	1100 J	670 J	2739	4299	1797	# R	1900 J	# R	300	130 J	570
1,2-DICHLOROETHANE	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND	17.675 ND	2.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
VINYL ACETATE	5 ND	5 ND	5 ND	25 ND	25 ND	35.35 ND	5 ND	25 ND	25 ND	25 ND	1500	25 ND
TRICHLOROETHENE	1200	2000 J	1800 J	856	2650	2249	10 J	390 J	100	80	640	1100
TETRACHLOROETHENE	29 J	49 J	34 J	21	61	47	2.5 ND	NDR	NDR	NDR	5	15
TOLUENE	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND	17.675 ND	2.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND	17.675 ND	2.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
TOTAL-XYLENE	2.5 ND	2.5 ND	2.5 ND	12.5 ND	12.5 ND	17.675 ND	2.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
SEMIVOLATILES												
NAPHTHALENE	5 ND	5 ND	5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	180 J	5 ND	88 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS												
ALUMINUM	NDR	# R	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	5 ND	5 ND	5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	50 ND	50 ND	50 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	46000	71000	61000	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	5 ND	5 ND	5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	10 ND	10 ND	10 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	50 ND	50 ND	50 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	2.5 ND	2.5 ND	2.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	41000	17000	7600	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	460	98	6 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	0.1 ND	0.23 J	0.1 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	130	140	110	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	7800	2600	2100	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	41000	27000	16000	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	20 ND	20 ND	20 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	39 J	49 J	7.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYANIDE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

W.R. GRACE: GROUNDWATER ---------
(ug/liter)

SAMPLE LOCATION	G21S-01	G21D-01	G3D	G20S-01	G29S-01	G19S-01	G11S-01	G14D	G11D	G6S-01	G4D-01
SAMPLE NUMBER	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987
DILUTION FACTORS---->											
VOLATILES											
VINYL CHLORIDE	5 ND	5 ND	250	5 ND	5 ND	5 ND	5 ND	# R	5 ND	5 ND	5 ND
METHYLENE CHLORIDE	3 ND	3 ND	3 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1-DICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	6	2.5 ND	2.5 ND	2.5 ND
TRANS-1,2-DICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,2-DICHLOROETHANE	3 ND	3 ND	# R	800	2.5 ND	180	120	# R	240	10	670
VINYL ACETATE	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
TRICHLOROETHENE	3 ND	3 ND	# R	2,800	5	# R	69	# R	76	7	120
TETRACHLOROETHENE	3 ND	3 ND	70	2.5 ND	2.5 ND	83	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOLUENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	3 ND	3 ND	3 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES											
NAPHTHALENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYANIDE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

W.R. GRACE: GROUNDWATER
(ug/liter)

SAMPLE LOCATION	G12S	G12D	G14S	G14S-D	G3DB	G16D	G15S	G26S	G9S	G7S	G25S
SAMPLE NUMBER	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987
DILUTION FACTORS---->											
VOLATILES											
VINYL CHLORIDE	5 ND	5 ND	1,500	1,600	23 J	120	2,900	5 ND	5 ND	5 ND	5 ND
METHYLENE CHLORIDE	2.5 ND	# R	2.5 ND	2.5 ND	# R	# R	# R	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1-DICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TRANS-1,2-DICHLOROETHENE	3 ND	45	250	260	530	250	1,200	19	2.5 ND	63	3 ND
1,2-DICHLOROETHANE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
VINYL ACETATE	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
TRICHLOROETHENE	460	370	3 ND	2.5 ND	1,200	1,700	2.5 ND	5	2.5 ND	72	3 ND
TETRACHLOROETHENE	3 ND	3 ND	3 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	3 ND
TOLUENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2,100	2.5 ND	2.5 ND	2.5 ND	2.5 ND
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	150	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	360	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES											
NAPHTHALENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
BIS(2-ETHYLHEXYL) PHTHALATE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
INORGANICS											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
ARSENIC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
CHROMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.1 ND
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A
CYANIDE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	N/A

W.R. GRACE: GROUNDWATER
(ug/liter)

SAMPLE LOCATION	G3S		G-G15D	
SAMPLE NUMBER	EBASCO		EBASCO	
TRAFFIC REPORT NUMBER	DATA 1987		DATA 1987	
DILUTION FACTORS---->				
VOLATILES				
VINYL CHLORIDE	160		3,600	
METHYLENE CHLORIDE	63		2.5	ND
1,1-DICHLOROETHENE	2.5	ND	2.5	ND
TRANS-1,2-DICHLOROETHENE	1,400		7,300	
1,2-DICHLOROETHANE	2.5	ND	2.5	ND
VINYL ACETATE	5	ND	5	ND
TRICHLOROETHENE	1,300		280	
TETRACHLOROETHENE	35		3	ND
TOLUENE	2.5	ND	3600	J
ETHYLBENZENE	2.5	ND	350	
TOTAL-XYLENE	2.5	ND	630	
SEMIVOLATILES				
NAPHTHALENE	5	ND	3	
BIS(2-ETHYLHEXYL) PHTHALATE	5	ND	4	
INORGANICS				
ALUMINUM	6,810		560	
ARSENIC	5	ND	10	
BARIUM	47	[	33	[
CALCIUM	41,600		55,200	
CHROMIUM	24		5	ND
COPPER	40		26	
IRON	7,730		306	
LEAD	18		12	
MAGNESIUM	10,600		5,150	
MANGANESE	830		14,300	
MERCURY	0.1	ND	0.1	ND
NICKEL	20	ND	15	[
POTASSIUM	9,740		4,740	[
SODIUM	36,700		17,000	
VANADIUM	25	ND	16	[
ZINC	96		46	
CYANIDE	14		5	ND

W.R. GRACE: GROUNDWATER
METALS ONLY
(ug/liter)

	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85
SAMPLE LOCATION	GW-3S	GW-3D	GW-3DB	GW-4S	GW-4D	GW-7S	GW-7D	GW-9	GW-11S	GW-11D	GW-12S	GW-12D
SAMPLE NUMBER	12453	12454	12455	12441	12443	12439	12440	12438	12447	12450	12448	12449
TRAFFIC REPORT NUMBER	AB531	AB532	AB535	AB519	AB520	AB525	AB526	AB527	AB521	AB522	AB523	AB524
VOLATILES												
INORGANICS												
ALUMINUM	41	11.5 ND	11.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	18	15	6 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	53000	86000	63000	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	# R	# R	12.5 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	94	86	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	1 ND	1 ND	1 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	19000	18000	7700	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	540	1.5 ND	9.3	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	0.05 ND	0.05 ND	0.05 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	# R	20 ND	20 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	10000	3100	3300	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	43000	28000	17000	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	2 ND	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	23	# R	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYANIDE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

W.R. GRACE: GROUNDWATER
METALS ONLY
(ug/liter)

	MAY 1985		MAY 1985		MAY 1985		JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985
SAMPLE LOCATION	GW-3S		GW-3D		GW-3DB		GW-3S	GW-3D	GW-3DB	GW-4S	GW-4D	GW-11S	GW-11D	GW-12S	GW-12D
SAMPLE NUMBER	12724		12725		12726		13265	13267	13269	13259	13260	13261	13262	13263	13264
TRAFFIC REPORT NUMBER	AB396		AB701		AB702		AC241	AC243	AC245	AC235	AC236	AC237	AC238	AC239	AC240
VOLATILES															
INORGANICS															
ALUMINUM		NDR	#	R	#	R	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	5	ND	5	ND	5	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	50	ND	50	ND	50	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	46000		71000		61000		NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	5	ND	5	ND	5	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	10	ND	10	ND	10	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	50	ND	50	ND	50	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	2.5	ND	2.5	ND	2.5	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	41000		17000		7600		NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	460		98		6	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	0.1	ND	0.23	J	0.1	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	130		140		110		NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	7800		2600		2100		NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	41000		27000		16000		NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	20	ND	20	ND	20	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	39	J	49	J	7.5	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
CYANIDE		NT		NT		NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

NEW ENGLAND PLASTICS CORPORATION

NEW ENGLAND PROPERTY: SURFACE SOILS

	NE-SS-01 EBASCO DATA 1987	NE-SS-02 EBASCO DATA 1987	NE-SS-03 EBASCO DATA 1987	NE-SS-04 EBASCO DATA 1987	NE-SS-05 EBASCO DATA 1987	NE-SB2-01 EBASCO DATA 1987	NE-SB3-01 EBASCO DATA 1987
ORGANICS (ug/kg)							
VOLATILES							
ACETONE	R	120000 J	5 ND	5 ND	R	7.50 UJ	8.50 UJ
BENZENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	1 U	2.5 ND
CHLOROFORM	2.5 ND	2.5 ND	3 J	2.5 ND	2.50 ND	2.50 ND	2.50 ND
METHYLENE CHLORIDE	R	9400	53 B	12	R	12.00 UJ	4.50 UJ
TETRACHLOROETHENE	68000 E	1200000	9	370 E	470.00	2.50 ND	2.50 ND
1,1,1-TRICHLOROETHANE	210 J	13000 J	2.5 ND	6	4.00	2.50 ND	2.50 ND
TRICHLOROETHENE	1100	110000	2.5 ND	28	35.00	2.50 ND	2.50 ND
SEMI-VOLATILES							
BENZOIC ACID	800 ND	800 ND	800 ND	290 J	800.00 ND	800.00 ND	800.00 ND
BIS(2-ETHYLHEXYL)PHTHALATE	2900000	4400000 J	300000 J	59000 J	165.00 ND	165.00 ND	165.00 ND
CHRYSENE	165 ND	165 ND	165 ND	120 J	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYL PHTHALATE	165 ND	165 ND	165 ND	73 J	165.00 ND	165.00 ND	165.00 ND
DI-N-OCTYL PHTHALATE	165 ND	640000 J	150000	165 ND	165.00 ND	165.00 ND	165.00 ND
PESTICIDES/PCBs							
AROCLOR-1260	80 ND	80 ND	80 ND	80 ND	580	80 ND	80 ND
INORGANICS (mg/kg)							
ALUMINUM	7940	7180	8540	8560	7050	10100	6510
ANTIMONY	3 ND	3 ND	7.1	3 ND	3 ND	3 ND	3 ND
ARSENIC	5.5 J	0.5 ND	6.8 J	4.8 J	4.7 J	2.9	3
BARIUM	37	118	46	176	76	34	27
BERYLLIUM	0.1	0.1	0.1	0.2	0.2	2.5 ND	2.5 ND
CADMIUM	1.5	17	3.6	10	6.3	2.5 ND	2.5 ND
CALCIUM	1180	2560	1410	2620	2080	4680	2580
CHROMIUM	13	15	10	21	13	15	10
COBALT	4.6	6.6	31	10	5.7	9.2	7.7
COPPER	65	91	86	161	64	18	19
IRON	8800	9090	7660	12800	10400	18400	13000
LEAD	44	192	48	289	236	4.6	8.7
MAGNESIUM	1930	2690	1760	3380	2910	4860	3210
MANGANESE	110	80	67	159	96	207	148
MERCURY	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND
NICKEL	11	12	9.6	23	11	19	8.7
POTASSIUM	589	951	560	901	824	R	R
SODIUM	250 ND	250 ND	250 ND	250 ND	250 ND	187	98
THALLIUM	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND
VANADIUM	18	26	18	40	34	37	25
ZINC	47	59	65	56	46	36	34

NEW ENGLAND PROPERTY: SUBSURFACE SOIL

	NE1-01 EBASCO DATA 1987	NE1-02 EBASCO DATA 1987	NE2-01 EBASCO DATA 1987	NE2-02 EBASCO DATA 1987	NE2-03 EBASCO DATA 1987	NE3-01 EBASCO DATA 1987	NE3-02 EBASCO DATA 1987	NE-SB1-01 EBASCO DATA 1987	NE-SB3-02 EBASCO DATA 1987
ORGANICS (ug/kg)									
VOLATILES									
ACETONE	10.50 UJ	5.00 ND	R	R	R	R	R	8.50 UJ	24.00
METHYLENE CHLORIDE	8.50 UJ	2.50 UJ	R	4.00	R	R	R	7.00 UJ	19.00 B
SEMI-VOLATILES									
BIS(2-ETHYLHEXYL)PHTHALATE	140.00	165.00 ND	38.00 J	165.00 ND	120.00	53.00	630.00	1700.00	165.00 ND
DI-N-OCTYL PHTHALATE	165.00 ND	165.00 ND	34.00 J	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
INORGANICS (mg/Kg)									
ALUMINUM	9850.00	8470.00	8710.00	9320.00	9850.00	7010.00	7830.00	6730.00	6280.00
ANTIMONY	3.00 ND	3.00 N(D)	7.80	3.00 ND	3.00 ND	3.00 ND	12.00	3.00 ND	3.00 ND
ARSENIC	0.50 ND	0.50 ND	4.70 J	4.80	3.90 J	5.90	6.70 J	2.20	3.40
BARIUM	37.00	41.00	31.00	37.00	30.00	11.00	17.00	23.00	21.00
BERYLLIUM	0.25 ND	0.25 ND	0.06	0.08	0.30	0.10	0.10	0.25 ND	0.25 ND
CADMIUM	0.98 [ND	0.25 ND	0.25 ND	5.80	8.00	2.90	0.25 ND	0.25 ND	0.25 ND
CALCIUM	4670.00	5260.00	2470.00	2180.00	2330.00	1060.00	1370.00	4130.00	3030.00
CHROMIUM	22.00	15.00	15.00	13.00	16.00	8.80	11.00	12.00	14.00
COBALT	10.00	10.00	8.60	7.70	11.00	4.40	5.30	8.10	7.40
COPPER	23.00	26.00	28.00	27.00	36.00	14.00	14.00	13.00	14.00
IRON	21800.00	10800.00	12000.00	11600.00	14600.00	7970.00	10700.00	14600.00	12500.00
LEAD	4.60	5.20	15.00	17.00	17.00	14.00	17.00	3.20	4.70
MAGNESIUM	6680.00	5140.00	4070.00	4510.00	4400.00	2150.00	2600.00	3490.00	3460.00
MANGANESE	223.00	184.00	135.00	148.00	155.00	91.00	160.00	163.00	139.00
MERCURY	0.01 ND	0.01 ND	0.01 ND	0.13	0.01 ND	0.16	0.13	0.01 ND	0.01 ND
NICKEL	19.00	14.00	11.00	11.00	15.00	7.20	7.60	10.00	10.00
POTASSIUM	R	R	1410.00	1530.00	1880.00	530.00	599.00	R	R
SODIUM	165	239	250 ND	250 ND	250 ND	250 ND	250 ND	171	158
VANADIUM	40.00	39.00	25.00	23.00	29.00	14.00	18.00	29.00	25.00
ZINC	32.00	32.00	20.00	21.00	28.00	25.00	26.00	26.00	25.00

	NE-SB4-01 EBASCO DATA 1987	NE-SB4-02 EBASCO DATA 1987	NE-SB5-01 EBASCO DATA 1987
ORGANICS (ug/kg)			
VOLATILES			
ACETONE	8.00 UJ	26.00 B	13.00 B
METHYLENE CHLORIDE	6.00 UJ	14.00 B	4.00 BJ
SEMI-VOLATILES			
BIS(2-ETHYLHEXYL)PHTHALATE	180.00	270.00 J	7500.00
DI-N-OCTYL PHTHALATE	51.00	165.00 ND	94.00 J
INORGANICS (mg/Kg)			
ALUMINUM	5070.00	10100.00	4640.00
ANTIMONY	3.00 ND	3.00 ND	3.00 ND
ARSENIC	0.50 ND	0.50 ND	0.50 ND
BARIUM	15.00	43.00	19.00
BERYLLIUM	0.25 ND	0.25 ND	0.07
CADMIUM	0.25 ND	0.25 ND	1.30
CALCIUM	2510.00	4780.00	1490.00
CHROMIUM	9.00	22.00	8.00
COBALT	5.20	13.00	6.50
COPPER	7.30	20.00	18.00
IRON	8670.00	23100.00	7430.00
LEAD	2.30	4.90	9.80
MAGNESIUM	1910.00	5620.00	2470.00
MANGANESE	112.00	312.00	92.00
MERCURY	0.01 ND	0.01 ND	0.01 ND
NICKEL	7.00	21.00	7.50
POTASSIUM	R	R	855.00
SODIUM	122	282	250 ND
VANADIUM	17.00	40.00	13.00
ZINC	18.00	37.00	16.00

NEW ENGLAND PROPERTY:
GROUNDWATER

	WELL NE-1-01 EBASCO DATA 1987	WELL NE-2-01 EBASCO DATA 1987	WELL NE1-01 EBASCO DATA 1987	WELL NE1-02 EBASCO DATA 1987	WELL NE2-01 EBASCO DATA 1987	WELL NE3-01 EBASCO DATA 1987	WELL No.1-01 EBASCO DATA 1987	WELL No.2-01 EBASCO DATA 1987	WELL No.3-01 EBASCO DATA 1987
ORGANICS (ug/L)									
VOLATILES									
1,1-DICHLOROETHANE	2.50 ND	2.50 ND	1.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TRANS-1,2-DICHLOROETHENE	2.50 ND	11.00	2.00	1.00	2.00	6.00	2.50 ND	9.00	2.50 ND
CHLOROFORM	1.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	1.00
1,1,1-TRICHLOROETHANE	2.00 J	16.00	26.00	26.00	2.50 ND	5.00	3.00 J	17.00	2.50 ND
TRICHLOROETHENE	5.00	59.00	37.00 J	41.00 J	R	27.00 J	14.00	52.00	2.50 ND
BENZENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00
TETRACHLOROETHENE	18.00	330.00	96.00	92.00	9.00	84.00	65.00	270.00 E	2.50 ND
TOTAL XYLENES	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	6.00 J
INORGANICS (ug/L)									
ALUMINUM	90.00 [	100.00 ND	15600.00	15500.00	16600.00	9230.00	N/A	N/A	100.00 ND
ARSENIC	5.00 ND	5.00 ND	8.70 B	9.50 B	18.70	6.80 B	N/A	N/A	5.00 ND
BARIUM	100.00 ND	100.00 ND	111.00 B	97.00 B	200.00	84.00 B	N/A	N/A	113.00 B
CALCIUM	46300.00	58100.00	42700.00	34800.00	30700.00	33500.00	N/A	N/A	63300.00
CHROMIUM	5.00 ND	5.00 ND	24.00	24.00	12.00	20.00	N/A	N/A	5.00 ND
COBALT	25.00 ND	25.00 ND	25.00 ND	39.00 B	25.00 ND	25.00 ND	N/A	N/A	25.00 ND
COPPER	26.00	12.50 ND	55.00 *	43.00 *	59.00 *	20.00 B*	N/A	N/A	12.50 ND
IRON	306.00	50.00 ND	25300.00	26300.00	19600.00	15200.00	N/A	N/A	230.00
LEAD	6.10 *	17.00 *	19.00 s	15.50 s	16.80 s	2.50 ND	N/A	N/A	2.50 ND
MAGNESIUM	9270.00	8690.00	12600.00	12000.00	8070.00	9630.00	N/A	N/A	11600.00
MANGANESE	11.00 [	7.50 ND	1560.00	1080.00	520.00	757.00	N/A	N/A	174.00
NICKEL	20.00 ND	20.00 ND	20.00 ND	20.00 ND	35.00 B	20.00 ND	N/A	N/A	20.00 ND
POTASSIUM	3180.00 [	3230.00	6270.00	5980.00	4960.00 B	5080.00	N/A	N/A	1280.00 B
SODIUM	64700.00	36400.00	15600.00	15900.00	54400.00	63600.00	N/A	N/A	52900.00
VANADIUM	12.00 [	25.00 ND	40.00 B	44.00 B	26.00 B	22.00 B	N/A	N/A	25.00 ND
ZINC	335.00	4270.00	61.00	181.00	71.00	39.00	N/A	N/A	1180.00

NEW ENGLAND PROPERTY: GROUNDWATER SAMPLES, METALS ONLY
(ug/liter)

METAL	JUNE,1988 NE1-01	JUNE,1988 NE2-01	FREQ. OF DETECTION	GEOM MEAN	MAX VALUE
BARIUM	6.0	34.9 J	2/2	14.5	34.9
CALCIUM	32100	28700	2/2	30400	32100
IRON	ND	36.8	1/2	---	36.8
MAGNESIUM	5600	5420	2/2	5510	5600
MANGANESE	19.3	ND	1/2	---	19.3
POTASSIUM	2180	2390	2/2	2280	2390
SODIUM	14200	58500	2/2	28800	58500
ZINC	23.9 JB	21.1 JB	2/2	22.5	23.9

OLYMPIA NOMINEE TRUST

OLYMPIA PROPERTY:
SURFACE SOILS

	OLYMPIA SURFACE SOIL SAMPLES					OLYMPIA SOIL BORING SAMPLES (0-2 ft.)					
	OL-SS01 EBASCO DATA 1987	OL-SS02 EBASCO DATA 1987	OL-SS03 EBASCO DATA 1987	OL-SS04 EBASCO DATA 1987	OL-SS05 EBASCO DATA 1987	SB1 (0'-2') GEOM.MEAN DATA 1987	SB2 (0'-2') EBASCO DATA 1987	SB3 (0'-2') EBASCO DATA 1987	SB4 (0'-2') GEOM.MEAN DATA 1987	SB5 (0'-2') EBASCO DATA 1987	SB6 (0'-2') EBASCO DATA 1987
ORGANICS (ug/kg)											
VOLATILES											
CHLOROFORM	# R	# R	# R	# R	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	4.00
1,1,1-TRICHLOROETHANE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	5.00 J	2.50 ND
TRICHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
SEMI-VOLATILES											
BENZOIC ACID	800.00 ND	800.00 ND	210.00	800.00 ND	800.00 ND	800.00 ND	800.00 ND	800.00 ND	800.00 ND	800.00 ND	800.00 ND
BIS(2-ETHYLHEXYL)PHTHALATE	# R	# R	# R	# R	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BUTYLBENZYL PHTHALATE	165.00 ND	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
3,3-DICHLOROBENZIDENE	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND	330.00 ND
DIETHYL PHTHALATE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYLPHTHALATE	165.00 ND	165.00 ND	# R	# R	165.00 ND	165.00 ND	165.00 ND	2.00	3.00	165.00 ND	6.00
ANTHRACENE	165.00 ND	# R	165.00 ND	320.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)ANTHRACENE	165.00 ND	61.00	45.00 JB	590.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)PYRENE	165.00 ND	165.00 ND	41.00 JB	520.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(b)FLUORANTHENE	165.00 ND	165.00 ND	48.00 JB	1100.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(k)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	250.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CHRYSENE	165.00 ND	# R	# R	630.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
DIBENZO(A,H)ANTHRACENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
INDENO(1,2,3-CD)PYRENE	165.00 ND	165.00 ND	165.00 ND	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CARCINOGENIC PAHs, TOTAL	ND	61.00	134.00	3410.00	ND	ND	ND	ND	ND	ND	ND
ACENAPHTHLYENE	165.00 ND	165.00 ND	165.00 ND	440.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(g,h,i)PERYLENE	165.00 ND	165.00 ND	40.00 JB	230.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
FLUORANTHENE	# R	# R	# R	1100.00	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
FLUORENE	165.00 ND	18.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENANTHRENE	165.00 ND	# R	165.00 ND	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PYRENE	# R	165.00 ND	# R	850.00	# R	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
NONCARCINOGENIC PAHs, TOTAL	ND	18.00	40.00	2620.00	ND	ND	ND	ND	ND	ND	ND
PESTICIDES/PCBs											
4,4'-DDD	8.00 ND	8.00 ND	8.00 ND	38.00	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDT	8.00 ND	8.00 ND	8.00 ND	240.00	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDE	8.00 ND	8.00 ND	8.00 ND	88.00	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	31.00
INORGANICS (mg/kg)											
ALUMINUM	13000.00 J	15300.00 J	7950.00 J	6720.00 J	8940.00 J	4883.13 J	7850.0	6050.0	8950.78	5900.0	8280.0
ARSENIC	22.00 J	11.00 J	7.00 J	8.00 J	9.60 J	11.11	139.0	4.9	10.17 S	3.4	8.9

OLYMPIA PROPERTY:
SURFACE SOILS

	OLYMPIA SURFACE SOIL SAMPLES					OLYMPIA SOIL BORING SAMPLES (0-2 ft.)					
	OL-SS01 EBASCO DATA 1987	OL-SS02 EBASCO DATA 1987	OL-SS03 EBASCO DATA 1987	OL-SS04 EBASCO DATA 1987	OL-SS05 EBASCO DATA 1987	SB1 (0'-2') GEOM.MEAN DATA 1987	SB2 (0'-2') EBASCO DATA 1987	SB3 (0'-2') EBASCO DATA 1987	SB4 (0'-2') GEOM.MEAN DATA 1987	SB5 (0'-2') EBASCO DATA 1987	SB6 (0'-2') EBASCO DATA 1987
BARIUM	55.00 J	46.00 J	24.00 J	879.00 J	2000.00 J	8.58	15.0	4.9	19.75	7.4	19.0
BERYLLIUM	1.10	1.10	0.50	0.60	0.40	0.50 ND	0.5 ND	0.5 ND	0.50 ND	0.50 ND	0.5 ND
CADMIUM	3.20 JB	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.5 ND	0.5 ND	0.50 ND	0.5 ND	0.5 ND
CALCIUM	3890.00	4620.00	3030.00	30000.00	2010.00	280.57	713.0 J	93.0	601.15	193.0	589.0
CHROMIUM	45.00 J	29.00 J	14.00 J	924.00	161.00 J	8.49	35.0	1.0 ND	12.41	5.5	16.0
COBALT	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.0 ND	2.70	5.00 ND	2.70
COPPER	68.00	22.00	13.00	31.00	14.00	7.89	37.0	2.5 ND	6.45	2.9	7.8
IRON	36400.00 J	17400.00 J	9700.00 J	12000.00 J	10800.00 J	4336.27	11100.00	4070.00	8472.36	4520.00	7780.00
LEAD	39.00 J	41.00 J	19.00 J	36.00 J	21.00 J	16.97	42.00 JB	2.50	14.39	18.00	21.00 S
MAGNESIUM	5780.00	4100.00	23.00	3340.00	2910.00	832.72	1900.00	572.00	1608.20	985.00	1930.00
MANGANESE	285.00	212.00	130.00	192.00	169.00	39.24	83.00	20.00	133.63	36.00	96.00
MERCURY	0.16 J	0.02 ND	0.02 ND	0.12 J	0.16 J	0.20 J	0.50 J	0.02 ND	0.10 J	0.02 ND	0.20 N
NICKEL	27.00 J	4.00 ND	14.00 J	14.00 J	9.90 J	3.85	4.20	4.00 ND	6.01	4.00 ND	6.40
POTASSIUM	2000.00	2210.00	1170.00	925.00	1220.00	247.04 E	739.00 E	82.00 E	495.51	218.00 E	785.00 E
SILVER	1.00 ND	1.00 ND	1.00 ND	1.00 ND	1.00 ND	1.00 ND	1.00 ND	1.00 ND	5.20	1.00 ND	1.00 ND
SODIUM	271.00 JB	253.00 JR	125.00 JB	228.00 JB	120.00 JB	57.45	81.00	67.00	62.16	72.00	75.00
VANADIUM	39.00 J	35.00 J	18.00 J	29.00 J	16.00 J	7.56	20.00	3.40	15.49	6.50	13.00
ZINC	74.00 J	62.00 J	38.00 JB	486.00 J	146.00 J	15.87	52.00	7.40	21.02	13.00	19.00

OLYMPIA PROPERTY:
SURFACE SOILS

	SB7 (0'-2') EBASCO DATA 1987	SB8 (0'-2') EBASCO DATA 1987	SB9 (0'-2') EBASCO DATA 1987	SB10 (0'-2') EBASCO DATA 1987
ORGANICS (ug/kg)				
VOLATILES				
CHLOROFORM	2.50 ND	2.50 ND	2.50 ND	2.50 ND
1,1,1-TRICHLOROETHANE	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TRICHLOROETHENE	8.00	2.50 ND	2.50 ND	2.50 ND
SEMI-VOLATILES				
BENZOIC ACID	800.00 ND	800.00 ND	800.00 ND	800.00 ND
BIS(2-ETHYLHEXYL)PHTHALATE	165.00 ND	5.00	165.00 ND	2.00
BUTYLBENZYL PHTHALATE	165.00 ND	1.00 J	165.00 ND	165.00 ND
3,3-DICHLOROBENZIDENE	330.00 ND	2.00 J	330.00 ND	330.00 ND
DIETHYL PHTHALATE	165.00 ND	165.00 ND	0.40	165.00 ND
DI-N-BUTYLPHTHALATE	5.00	5.00	7.00	1.00
ANTHRACENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)ANTHRACENE	2.00	2.00	165.00 ND	1.00
BENZO(a)PYRENE	165.00 ND	2.00	165.00 ND	2.00
BENZO(b)FLUORANTHENE	2.00	165.00 ND	1.00	3.00
BENZO(k)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CHRYSENE	2.00	1.00	1.00	2.00
DIBENZO(A,H)ANTHRACENE	165.00 ND	3.00 J	165.00 ND	165.00 ND
INDENO(1,2,3-CD)PYRENE	165.00 ND	3.00 J	165.00 ND	165.00 ND
CARCINOGENIC PAHs, TOTAL	6.00	11.00	2.00	8.00
ACENAPHTHLYENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(g,h,i)PERYLENE	165.00 ND	3.00 J	165.00 ND	165.00 ND
FLUORANTHENE	2.00	0.40	165.00 ND	2.00
FLUORENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENANTHRENE	2.00	165.00 ND	0.50	1.00
PYRENE	3.00 J	0.80 J	0.90 J	2.00 J
NONCARCINOGENIC PAHs, TOTAL	7.00	4.20	1.40	5.00
PESTICIDES/PCBs				
4,4'-DDD	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDT	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDE	8.00 ND	8.00 ND	8.00 ND	8.00 ND
INORGANICS (mg/kg)				
ALUMINUM	8110.0	3630.0	6250.0	8400.0
ARSENIC	8.5	4.8	5.8	11.0 S

OLYMPIA PROPERTY:
SURFACE SOILS

	SB7 (0'-2') EBASCO DATA 1987		SB8 (0'-2') EBASCO DATA 1987		SB9 (0'-2') EBASCO DATA 1987		SB10 (0'-2') EBASCO DATA 1987	
BARIUM	90.0		11.0		95.0		161.0	
BERYLLIUM	0.5	ND	0.5	ND	0.5	ND	0.5	ND
CADMIUM	0.5	ND	0.5	ND	0.5	ND	0.5	ND
CALCIUM	1300.0		716.0		1620.0		1950.0	
CHROMIUM	7.7		3.9		43.0		36.0	
COBALT	5.00	ND	5.00	ND	5.00	ND	5.5	
COPPER	14.0		6.9		17.0		17.0	
IRON	10800.00		5430.00		9070.00		11300.00	
LEAD	424.00		3.40		35.00	S+	40.00	
MAGNESIUM	1450.00		1390.00		2810.00		2740.00	
MANGANESE	211.00		85.00		165.00		270.00	
MERCURY	0.02	ND	0.02	ND	0.02	ND	0.80	N
NICKEL	4.00	ND	4.00	ND	3.30		9.40	
POTASSIUM	445.00	E	584.00	E	586.00	E	1070.00	E
SILVER	1.00	ND	1.00	ND	1.00	ND	1.00	ND
SODIUM	58.00		77.00		59.00		117.00	
VANADIUM	17.00		4.10		11.00		26.00	
ZINC	2.00	ND	13.00		85.00		84.00	

OLYMPIA NOMINEE TRUST PROPERTY
SURFACE SOIL SAMPLES
(Values in ng/g)

DIOXIN FORM	OL-SS-14	OL-SS-015	OL-SS-16
TCDD	ND	ND	ND
PeCDD	ND	ND	ND
HxCDD	ND	ND	ND
HpCDD	ND	1.17	ND
OCDD	ND	16.54	ND
TCDF	ND	ND	ND
PeCDF	ND	ND	ND
HxCDF	ND	ND	ND
HpCDF	ND	ND	ND
OCDF	ND	ND	6.7

OLYMPIA PROPERTY: SUBSURFACE SOIL
SOIL BORINGS (below 2 ft.)

	SB1-(2'-4' EBASCO DATA 1987	SB2-(2'-4') EBASCO DATA 1987	SB2-(4'-6') EBASCO DATA 1987	SB3-(2'-4') EBASCO DATA 1987	SB4-(2'-4') EBASCO DATA 1987	SB4-(4'-6') EBASCO DATA 1987	SB5-(2'-4') EBASCO DATA 1987	SB6-(2'-4',4'-6) EBASCO DATA 1987	SB6-(6'-8') EBASCO DATA 1987	SB7-(2'-4',4'-6') EBASCO DATA 1987
ORGANICS (ug/Kg)										
VOLATILES										
ACETONE	R	5.00 ND	5.00 ND	R	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	R
TOLUENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00	2.50 ND	2.50 ND
TETRACHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00	2.50 ND	2.50 ND
CHLOROFORM	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	3.00	4.00	2.50 ND
METHYLENE CHLORIDE	RJ	2.50 ND	R	R	R	R	2.50 ND	7.00	R	2.50 ND
TRICHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TRANS-1,2-DICHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	R	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
BENZENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
SEMI-VOLATILES										
BIS-(2-ETHYLHEXYL)PHTHALATE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	2.00	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYL PHTHALATE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	2.00	2.00	0.50	5.00	1.00	3.00
1,2,4-TRICHLOROBENZENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(A)PYRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	6.00	165.00 ND	165.00 ND
CHRYSENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	1.00	165.00 ND	165.00 ND	15.00	165.00 ND	165.00 ND
BENZO(B)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	10.00 J	165.00 ND	165.00 ND
BENZO(A)ANTHRACENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	1.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(K)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	370.00	165.00 ND	165.00 ND
CARCINOGENIC PAH'S	ND	ND	ND	ND	2.0	ND	ND	401.0	ND	ND
NAPHTHALENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	9.00	165.00 ND	165.00 ND
PHENANTHRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	1.00	165.00 ND	165.00 ND	1.00	165.00 ND	165.00 ND
2-METHYLNAPHTHALENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	6.00	165.00 ND	165.00 ND
NON-CARCINOGENIC PAH'S	ND	ND	ND	ND	1.0	ND	ND	16.0	ND	ND
PESTICIDES/PCB'S										
4,4'-DDT	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
INORGANICS (mg/Kg)										
ALUMINUM	2870.00	6410.00	6680.00	4240.00	27900.00	1810.00	5560.00	7010.00	4190.00	5440.00
ARSENIC	2.90	6.00 S	12.00 S	3.20	24.00 S	2.80	6.70 S	21.00	7.70 S	5.50
BARIUM	4.10	8.00	8.20	6.10	109.00	12.00	11.00	33.00	13.00	18.00
BERYLLIUM	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND
CADMIUM	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND
CALCIUM	224.00	260.00	385.00	212.00	4430.00	3500.00	781.00	992.00	843.00	816.00
CHROMIUM	3.40	12.00	3.60	2.90	55.00	8.50	6.20	103.00	11.00	7.50
COBALT	2.50 ND	2.50 ND	2.50 ND	2.50 ND	19.00	2.50 ND	2.50 ND	4.10	5.10	2.50 ND
COPPER	1.25 ND	18.00	2.20	1.70	70.00	1.25 ND	12.00	31.00	13.00	8.00
IRON	2700.00	6270.00	5190.00	3100.00	37400.00	3100.00	8610.00	14600.00	5840.00	7690.00
LEAD	0.25 ND	2.90	4.60	1.50	21.00	2.50	3.10	44.00	4.30	3.90
MAGNESIUM	700.00	975.00	842.00	923.00	12000.00	258.00	1970.00	2720.00	1910.00	2060.00
MANGANESE	22.00	46.00	55.00	27.00	524.00	50.00	101.00	141.00	133.00	127.00
MERCURY	0.01 ND	0.01 ND	0.10 N	0.20 N	0.01 ND	0.01 ND	0.01 ND	0.20 N	0.70 N	0.01 ND

OLYMPIA PROPERTY: SUBSURFACE SOIL
SOIL BORINGS (below 2 ft.)

	SB1-(2'-4' EBASCO DATA 1987	SB2-(2'-4') EBASCO DATA 1987	SB2-(4'-6') EBASCO DATA 1987	SB3-(2'-4') EBASCO DATA 1987	SB4-(2'-4') EBASCO DATA 1987	SB4-(4'-6') EBASCO DATA 1987	SB5-(2'-4') EBASCO DATA 1987	SB6-(2'-4',4'-6) EBASCO DATA 1987	SB6-(6'-8') EBASCO DATA 1987	SB7-(2'-4',4'-6') EBASCO DATA 1987
NICKEL	2.00 ND	2.00 ND	2.00 ND	2.00 ND	37.00	2.00 ND	2.90	8.30	7.90	2.00 ND
POTASSIUM	216.00 E	204.00 E	178.00 E	193.00 E	3530.00 E	42.00 E	653.00 E	794.00	684.00 E	788.00 E
SELENIUM	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SILVER	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND
SODIUM	77.00	49.00	53.00	65.00	301.00	136.00	103.00	97.00	80.00	75.00
VANADIUM	2.50 ND	6.70	5.00	3.70	69.00	1.60	9.10	16.00	8.80	8.00
ZINC	8.00	25.00	13.00	6.60	83.00	8.30	14.00	27.00	16.00	25.00

WELL BORINGS

	SB9-(2'-4') EBASCO DATA 1987	OL1-01 EBASCO DATA 1987	OL2-01 EBASCO DATA 1987	OL2-02 EBASCO DATA 1987	OL2-03 EBASCO DATA 1987	OL3-01 EBASCO DATA 1987	OL3-02 EBASCO DATA 1987	OL3-03 EBASCO DATA 1987	OL4-01 EBASCO DATA 1987	OL5-01 EBASCO DATA 1987
ORGANICS (ug/Kg)										
VOLATILES										
ACETONE	R	5.00 ND	R	R	R	R	R	R	5.00 ND	R
TOLUENE	2.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TETRACHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	4.00 J	9.00	2.50 ND	8.00	2.50 ND
CHLOROFORM	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00 J	2.50 ND
METHYLENE CHLORIDE	2.50 ND	R	R	R	R	R	R	R	R	R
TRICHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	6.00	12.00	19.00	2.00	2.50 ND
TRANS-1,2-DICHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	4.00	2.50 ND	2.50 ND	2.50 ND
BENZENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00	2.50 ND
SEMI-VOLATILES										
BIS-(2-ETHYLHEXYL)PHTHALATE	3.00	65.00	165.00 ND	165.00 ND	165.00 ND	89.00 J	165.00 ND	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYL PHTHALATE	3.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
1,2,4-TRICHLOROBENZENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	73.00	165.00 ND	165.00 ND	165.00 ND
BENZO(A)PYRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CHRYSENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(B)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(A)ANTHRACENE	0.08	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(K)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CARCINOGENIC PAH'S	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	980.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENANTHRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
2-METHYLNAPHTHALENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
NON-CARCINOGENIC PAH'S	ND	ND	ND	ND	ND	980.00	ND	ND	ND	ND
PESTICIDES/PCB'S										
4,4'-DDT	8.00 ND	22.00	8.00 ND	8.00 ND	8.00 ND	46.00	8.00 ND	8.00 ND	8.00 ND	8.00 ND
INORGANICS (mg/Kg)										
ALUMINUM	2060.00	5450.00	5350.00	4400.00	4010.00	10200.00	6780.00	8350.00	11500.00	6410.00
ARSENIC	0.50 ND	6.40 J	6.50 J	6.30 J	4.50 J	9.20 J	7.80 J	6.80 J	6.70 J	7.60 J
BARIUM	61.00	38.00	9.30	11.00	10.00 ND	18.00	11.00	29.00	10.00 ND	21.00
BERYLLIUM	0.25 ND	0.08	0.01	0.05	0.05	0.10	0.10	0.25 ND	0.05	0.08
CADMIUM	0.25 ND	2.20	0.70	0.25 ND	0.25 ND	1.40	0.70	1.10	0.25 ND	1.00
CALCIUM	461.00	1330.00	1530.00	494.00	692.00	647.00	484.00	3320.00	250.00 ND	2950.00
CHROMIUM	8.60	383.00	9.10	6.90	9.00	15.00	15.00	22.00	7.30	18.00
COBALT	2.50 ND	2.50 ND	2.30	2.40	2.60	4.10	3.30	6.50	2.50 ND	5.20
COPPER	3.10	143.00	23.00	10.00	10.00	21.00	13.00	20.00	5.00	17.00
IRON	2170.00	6220.00	7230.00	6060.00	5770.00	8990.00	7550.00	12500.00	4470.00	9480.00
LEAD	5.70	122.00	44.00	9.80	8.50	40.00	13.00	14.00	18.00	26.00
MAGNESIUM	719.00	1130.00	1780.00	1420.00	1610.00	1530.00	2110.00	3660.00	674.00	2510.00
MANGANESE	24.00	41.00	75.00	68.00	61.00	110.00	64.00	156.00	22.00	112.00
MERCURY	0.01 ND	4.20	0.26	0.15	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND

WELL BORINGS

	SB9-(2'-4') EBASCO DATA 1987	OL1-01 EBASCO DATA 1987	OL2-01 EBASCO DATA 1987	OL2-02 EBASCO DATA 1987	OL2-03 EBASCO DATA 1987	OL3-01 EBASCO DATA 1987	OL3-02 EBASCO DATA 1987	OL3-03 EBASCO DATA 1987	OL4-01 EBASCO DATA 1987	OL5-01 EBASCO DATA 1987
NICKEL	2.00 ND	8.90	6.80	5.50	6.40	8.60	7.50	15.00	3.70	13.00
POTASSIUM	203.00 E	484.00	597.00	698.00	592.00	523.00	657.00	1690.00	274.00	1110.00
SELENIUM	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	1.2 J	2.5 ND
SILVER	0.50 ND	2.40	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND
SODIUM	84.00	250.00 ND	250.00 ND	250.00 ND	250.00 ND	250.00 ND	250.00 ND	250.00 ND	250.00 ND	250.00 ND
VANADIUM	2.40	13.00	15.00	8.50	8.50	16.00	11.00	20.00	8.70	15.00
ZINC	18.00	69.00	16.00	18.00	14.00	32.00	28.00	26.00	9.00	24.00

OLYMPIA: GROUNDWATER
(ug/liter)

	APRIL 1985			MAY 1985			JUNE 1985					
SAMPLE LOCATION	S72S	S72M	S72D	S72S	S72M	S72D	S72S	S72M	S72D	WELL OL1-01	WELL OL2-01	WELL OL2-02
SAMPLE NUMBER	12394	12396	12395	12773	12772	12777	13298	13299	13185	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	AB359	AB384	AB360	AB814	AB815	AB810	AC431	AC427	AC424	DATA 1987	DATA 1987	DATA 1987
VOLATILES												
1,1-DICHLOROETHANE	6.0	2.5 ND	2.5 ND	6.0	2.5 ND	2.5 ND	2.5 ND	# R	# R	2.5 ND	2.5 ND	2.5 ND
TRANS-1,2-DICHLOROETHENE	2.5 ND	# R	2.5 ND	1.0 J	2.5 ND	2.5 ND	# R	# R	2.5 ND	2.5 ND	# R	# R
2-BUTANONE	5.0 ND	5.0 ND	5.0 ND	# R	# R	# R	5.0 ND	5.0 ND	5.0 ND	5.0 ND	5.0 ND	35.00 J
1,1,1-TRICHLOROETHANE	2.5 ND	# R	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1,2,2-TETRACHLOROETHANE	2.5 ND	10.0	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TRICHLOROETHENE	4.0 J	74.0 J	9.0	5.0	16.0	11.5	# R	# R	# R	2.5 ND	3100.00	3400.00
BENZENE	2.5 ND	# R	2.5 ND	2.5 ND	3.0 J	2.5 ND	2.5 ND	5.0 J	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TETRACHLOROETHENE	6.0	2.5 ND	2.5 ND	# R	# R	# R	# R	# R	# R	2.5 ND	41.00	33.00
TOLUENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	5.0	# R	# R	# R
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	5.00	2.5 ND	2.5 ND
TOTAL-XYLENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	29.00	170.00	140.00
SEMIVOLATILES												
BIS(2-ETHYLHEXYL) PHTHALATE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	5.0 ND	# R	# R
===												
NAPHTHALENE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	5.0 ND	5.0 ND	1.00
2-METHYLNAPHTHALENE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	3.00	5.0 ND	5.0 ND
ACENAPTHYLENE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	5.0 ND	5.0 ND	5.0 ND
ACENAPHTHENE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	5.0 ND	5.0 ND	5.0 ND
PHENANTHRENE	NT	5.0 ND	NT	NT	NT	NT	NT	NT	NT	5.0 ND	5.0 ND	5.0 ND
======												
NON-CARCINOGENIC PAH'S	NT	ND	NT	NT	NT	NT	NT	NT	NT	3.0	ND	1.0
INORGANICS												
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	148000	685000 J	652000 J
ARSENIC	NT	NT	NT	NT	NT	NT	NT	NT	NT	5.0 ND	574.00 J	550.00 J
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	969.00	1800.00	1430.00
BERYLLIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	12.00	39.00 J	23.00 J
CADMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.5 ND	2.5 ND	2.5 ND
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	65100.00	25400	226000
CHROMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	281	1220	757
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	NT	138 J	402 J	270 J
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	576	790 J	522 J
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	232000	1030000	554000
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	79.6 J	188 J	224 J
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	53800	254000	153000
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	1850	16700	13400
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	254 J	959 N	577 J
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	23700 J	96400	51900
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	23900	65500	57600

OLYMPIA: GROUNDWATER
(ug/liter)

	APRIL 1985			MAY 1985			JUNE 1985					
SAMPLE LOCATION	S72S	S72M	S72D	S72S	S72M	S72D	S72S	S72M	S72D	WELL OL1-01	WELL OL2-01	WELL OL2-02
SAMPLE NUMBER	12394	12396	12395	12773	12772	12777	13298	13299	13185	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	AB359	AB384	AB360	AB814	AB815	AB810	AC431	AC427	AC424	DATA 1987	DATA 1987	DATA 1987
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	368	1590 N	810 J
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	406	1820 NE	110 J
PESTICIDES/PCB'S												
CHLORDANE	NT	0.3 ND	NT	NT	NT	NT	NT	NT	NT	0.3 ND	0.3 ND	0.3 ND

OLYMPIA: GROUNDWATER GROUNDWATER SAMPLE RESULTS
(ug/liter)

SAMPLE LOCATION	WELL OL3-01	WELL OL4-01	WELL OL5-01	WELL S76M-01	WELL S72S-01
SAMPLE NUMBER	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987
VOLATILES					
1,1-DICHLOROETHANE	2.5 ND	NT	2.00 J	2.5 ND	1.00 J
TRANS-1,2-DICHLOROETHENE	23.00	NT	2.5 ND	2.5 ND	2.5 ND
2-BUTANONE	5.0 ND	NT	5.0 ND	5.0 ND	5.0 ND
1,1,1-TRICHLOROETHANE	2.5 ND	NT	2.5 ND	2.00	2.5 ND
1,1,2,2-TETRACHLOROETHANE	2.5 ND	NT	2.5 ND	2.5 ND	2.5 ND
TRICHLOROETHENE	180.00	NT	2.5 ND	2.5 ND	2.00 J
BENZENE	2.5 ND	NT	2.5 ND	2.5 ND	2.5 ND
TETRACHLOROETHENE	45.00	NT	2.5 ND	2.5 ND	2.00 J
TOLUENE	# R	NT	# R	# R	2.5 ND
ETHYLBENZENE	2.5 ND	NT	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	2.5 ND	NT	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES					
BIS(2-ETHYLHEXYL) PHTHALATE	5.0 ND	5.0 ND	5.0 ND	14.00	8.00
NAPHTHALENE	5.0 ND	120.00	5.0 ND	5.0 ND	5.0 ND
2-METHYLNAPHTHALENE	5.0 ND	5.0 ND	5.0 ND	5.0 ND	5.0 ND
ACENAPTHYLENE	5.0 ND	7.00	5.0 ND	5.0 ND	5.0 ND
ACENAPHTHENE	5.0 ND	13.00	5.0 ND	5.0 ND	5.0 ND
PHENANTHRENE	5.0 ND	6.00	5.0 ND	5.0 ND	5.0 ND
NON-CARCINOGENIC PAH'S	ND	146.0	ND	ND	ND
INORGANICS					
ALUMINUM	3870.00	311000.00	4650.00	655.00	4880.00
ARSENIC	15.20	258.00 J	24.10	5.0 ND	9.70 [N
BARIUM	61.00 B	1490.00	79.00 B	100.0 ND	61.00 [
BERYLLIUM	2.5 ND	23.00	2.5 ND	2.5 ND	2.5 ND
CADMIUM	2.5 ND	2.5 ND	2.5 ND	2.5 ND	7.20
CALCIUM	17300.00	55200.00	33000.00	18400.00	28400.00
CHROMIUM	13.00	399.00	12.00	5.0 ND	26.00
COBALT	25.0 ND	216.00 J	25.0 ND	25.0 ND	25.0 ND
COPPER	55.00 *	587.00	20.00 B*	12.5 ND	58.00
IRON	6440.00	598000.00	10500.00	1310.00	21300.00
LEAD	2.5 ND	192.00 J	2.5 ND	11.00 *	22.00 *
MAGNESIUM	4180.00 B	80200.00	9650.00	4600.00 [	8590.00
MANGANESE	1580.00	11100.00	2490.00	25.00	1520.00
NICKEL	20.0 ND	370.00 J	20.0 ND	20.0 ND	20.0 ND
POTASSIUM	3490.00 B	33300.00 J	5270.00	3420.00 [	4980.00 [
SODIUM	41400.00	16800.00	44900.00	16800.00	31900.00

OLYMPIA: GROUNDWATER GROUNDWATER SAMPLE RESULTS
(ug/liter)

SAMPLE LOCATION	WELL OL3-01	WELL OL4-01	WELL OL5-01	WELL S76M-01	WELL S72S-01
SAMPLE NUMBER	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987
VANADIUM	25.0 ND	582.00	25.0 ND	25.0 ND	25.0 ND
ZINC	32.00	735.00 J	23.00	10.0 ND	50.00
PESTICIDES/PCB'S					
CHLORDANE	1.20 C	0.3 ND	0.3 ND	0.3 ND	0.3 ND

OLYMPIA: GROUNDWATER
METALS ONLY
(ug/liter)

METAL	JUNE,1988 OL1-01	JUNE,1988 MEAN-OL2	JUNE,1988 OL3-01	FREQ. OF DETECTION	GEOM MEAN	MAX VALUE
ARSENIC	6.8	16.4	8.8	3/3	9.9	16.4
BARIUM	55.6	21.6	16.2	3/3	26.9	55.6
CALCIUM	50900	25600	22000	3/3	30600	50900
IRON	6040	1740	714	3/3	1960	6040
MAGNESIUM	12900	4930	4330	3/3	6510	12900
MANGANESE	442	4170	1400	3/3	1370	4170
POTASSIUM	3110	3690	3250	3/3	3340	3690
SODIUM	22800	77900	51300	3/3	45000	77900
ZINC	25.4 JB	12.2 JB	20.1 JB	3/3	18.4	25.4

UNIFIRST CORPORATION

UNIFIRST SURFACE (<2') SOILS
(ug/kg)

	UC5 SS1 11/86 (0'-2')	UC6 SS1 11/86 (0'-2')	UC7 #1 11/86 (1')	UC7 #2-DUPL. 11/86 (2')
VOLATILE ORGANIC COMPOUNDS				
ACETONE	170 B	96 B	12 B	9 JB
HEXANE	2.8	1.2	NR	NR
METHYLENE CHLORIDE	NR	NR	7	13.2 B
TETRACHLOROETHENE	170	NR	61	10
TOLUENE	6	NR	NR	NR
1,1,1-TRICHLOROETHANE	12	NR	NR	NR
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	NR	NR	32	NR

UNIFIRST SUBSURFACE (>2') SOILS
(ug/kg, except UC19)

VOLATILE ORGANIC COMPOUNDS	UC4 SS1 11/86 (4'-6')	UC5 SS2 11/86 (4'-6')	UC6 SS2 11/86 (2'-4')	UC6 SS3 11/86 (4'-6')	UC6 SS5 11/86 (18'-20')	UC7 SS1(A) 11/86 (2'-4')	UC7 SS2 11/86 (4'-6')	UC7 SS3 11/86 (6'-6.5')	UC15 SOIL 9/29/87 (5'-10')	UC16 SOIL 9/30/87 (2'-5')	UC17 SOIL 10/1/87 (2'-5')
ACETONE	61 B	105 B	67 B	75 B	88 B	26 B	20 B	30 B	NT	NT	NT
BENZENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
CHLOROBENZENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	49.0 ND	51.0 ND
1,1-DICHLOROETHENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
trans-1,2-DICHLOROETHENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
cis-1,2-DICHLOROETHENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
ETHYLBENZENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	49.0 ND	51.0 ND
HEXANE	9	0.8	3	0.7	1	16	NR	NR	NT	NT	NT
METHYLENE CHLORIDE	NR	NR	NR	NR	NR	6 B	5 JB	7 B	NT	NT	NT
1,1-OXYBISETHANE	NR	NR	NR	NR	NR	10	NR	NR	NT	NT	NT
TETRACHLOROETHENE	8.8	NR	NR	NR	NR	NR	NR	NR	27 ND	24.5 ND	290.0
1,1,1-TRICHLOROETHANE	NT	NT	NT	NT	NT	NT	NT	NT	NT	1225 ND	1275 ND
TRICHLOROETHENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
TOLUENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND
TOTAL XYLENES/STYRENES	NT	NT	NT	NT	NT	NT	NT	NT	NT	24.5 ND	25.5 ND

UNIFIRST SUBSURFACE (>2') SOILS
(ug/kg, except UC19)

	UC18 SOIL 10/2/87 (2'-5')		UC18 SOIL 10/2/87 (5'-10')		UC20 SOIL 10/6/87 (3'-6')		(ug/l) UC19 AQUEOUS 10/5/87 (3'-6')	
VOLATILE ORGANIC COMPOUNDS								
ACETONE		NT		NT		NT		NT
BENZENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
CHLOROBENZENE	50.0	ND	51.0	ND	53.0	ND	1.0	ND
1,1-DICHLOROETHENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
trans-1,2-DICHLOROETHENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
cis-1,2-DICHLOROETHENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
ETHYLBENZENE	50.0	ND	51.0	ND	53.0	ND	1.0	ND
HEXANE		NT		NT		NT		NT
METHYLENE CHLORIDE		NT		NT		NT		NT
1,1-OXYBISETHANE		NT		NT		NT		NT
TETRACHLOROETHENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
1,1,1-TRICHLOROETHANE	1250	ND	1275	ND	1325	ND	25.0	ND
TRICHLOROETHENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
TOLUENE	25.0	ND	25.5	ND	26.5	ND	0.5	ND
TOTAL XYLENES/STYRENES	25.0	ND	25.5	ND	26.5	ND	0.5	ND

UNIFIRST: GROUNDWATER (ug/liter)

	APRIL 1985				MAY 1985				JUNE 1985		
SAMPLE LOCATION	S70S	S70M	S71M	S71D	S70S	S70M	S71M	S71D	S70S	S70M	S71M
SAMPLE NUMBER	12370	12371	12432	12433	12750	12759	12760	12761	13291	13290	13292
TRAFFIC REPORT NUMBER	AB332	AB333	AB505	AB534	AB829	AB828	AB827	AB826	AC439	AC438	AC436
DILUTION FACTORS ------>	1	1	10	500	1	1	10	20	1	1	25
VOLATILES											
BENZENE	2.5 ND	2.5 ND	25 ND	1700 J	2.5 ND	2.5 ND	25 ND	50 ND	2.5 ND	2.5 ND	62.5 ND
BROMOFORM	2.5 ND	2.5 ND	25 ND	3000 J	2.5 ND	2.5 ND	25 ND	50 ND	2.5 ND	2.5 ND	62.5 ND
2-BUTANONE	R	R	50 ND	NDR	5 ND	5 ND	42	110	R	5 ND	NDR
CARBON TETRACHLORIDE	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR
1,1-DICHLOROETHANE	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR
1,1-DICHLOROETHENE	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR	NDR	2.5 ND	2.5 ND	NDR
TRANS-1,2-DICHLOROETHENE	2.5 ND	2.5 ND	64	5000 J	2.5 ND	2.5 ND	110	NDR	2.5 ND	2.5 ND	115 J
ETHYLBENZENE	2.5 ND	2.5 ND	25 ND	7400 J	2.5 ND	2.5 ND	25 ND	50 ND	2.5 ND	2.5 ND	62.5 ND
TETRACHLOROETHENE	2.5 ND	4 J	1500	7300 J	2.5 ND	2.5 ND	1900	2500	2.5 ND	2.5 ND	R
TOLUENE	2.5 ND	1 J	NDR	NDR	2.5 ND	2.5 ND	NDR	NDR	R	R	NDR
1,1,1-TRICHLOROETHANE	2.5 ND	2.5 ND	91	NDR	2.5 ND	2.5 ND	130	110	2.5 ND	2.5 ND	R
TRICHLOROETHENE	2.5 ND	2.5 ND	NDR	16000 J	2.5 ND	2.5 ND	19 J	50 ND	2.5 ND	2.5 ND	NDR
TRICHLOROFLUOROMETHANE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TOTAL XYLENES	2.5 ND	2.5 ND	25 ND	2900 J	2.5 ND	2.5 ND	25 ND	50 ND	2.5 ND	2.5 ND	62.5 ND
SEMIVOLATILES/BASE NEUTRALS											
CHRYSENE	NT	NT	NT	5 ND	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	NT	NT	NT	2800	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	79	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	2.5 ND	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	74000	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	3.5 ND	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	R	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	7400	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	1 ND	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	8200	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	220	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	0.05 ND	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	R	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	8800	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	4.4 J	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	52000	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	18 ND	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	8.2	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	44	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l

SAMPLE LOCATION	S71D	S71D	S71S	UC4	UC4	UC5	UC5	UC6	UC7-1	UC7-1	UC7-1
SAMPLE NUMBER	13289	ERT	ERT	EPA	ERT	EPA	ERT	ERT	EPA	ERT	ERT
TRAFFIC REPORT NUMBER	AC445	2/3/87	2/3/87	11/30/87	2/4/87	11/30/87	2/4/87	2/4/87	11/30/87	2/3/87	8/26/87
DILUTION FACTORS ------>	10			10		1250			2500		
VOLATILES											
BENZENE	25 ND	5 ND	5 ND	5 ND	5 ND	625 ND	5 ND	5 ND	NDR	5 ND	20 ND
BROMOFORM	25 ND	5 ND	5 ND	5 ND	5 ND	625 ND	5 ND	5 ND	1250 ND	5 ND	20 ND
2-BUTANONE	50 ND	NT	NT	NDR	NT	NDR	NT	NT	NDR	NT	100 ND
CARBON TETRACHLORIDE	NDR	26	12	5 ND	5 ND	NDR	140	5 ND	NDR	54	20 ND
1,1-DICHLOROETHANE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	25	NDR
1,1-DICHLOROETHENE	NDR	5 ND	5 ND	NDR	5 ND	NDR	11	5 ND	NDR	5 ND	NDR
TRANS-1,2-DICHLOROETHENE	100	71	99	NDR	NDR	NDR	13	NDR	NDR	64	170
ETHYLBENZENE	25 ND	5 ND	5 ND	5 ND	5 ND	625 ND	5 ND	5 ND	1250 ND	5 ND	20 ND
TETRACHLOROETHENE	2450	680	1100	24	210	1500	2000	170	13000	7100	6900
TOLUENE	NDR	5 ND	5 ND	5 ND	5 ND	NDR	5 ND	5 ND	NDR	5 ND	NDR
1,1,1-TRICHLOROETHANE	180	180	76	5 ND	5 ND	NDR	1300	5 ND	NDR	420	560
TRICHLOROETHENE	13	38	28	5 ND	5 ND	NDR	25	17	NDR	110	89
TRICHLOROFLUOROMETHANE	NT	NT	NT	NDR	NT	NDR	NT	NT	NDR	NT	NT
TOTAL XYLENES	25 ND	5 ND	5 ND	10 ND	5 ND	1250 ND	5 ND	5 ND	2500 ND	5 ND	20 ND
SEMIVOLATILES/BASE NEUTRALS											
CHRYSENE	3.3 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	7230 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	223 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	5.4	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	78600 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	6.6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	46 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	18200 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	18 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	10800 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	435 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	0.35	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	11	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	4500 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	1.95 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	49900 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	40 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	16 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	R	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l

DILUTION
DUPLICATE
SEE TEXT FOR
EXPLANATION

SAMPLE LOCATION	UC7-1	UC7-2	UC-7-2	UC7-2	UC7-2	UC7-3	UC-7-3	UC7-3	UC7-3	UC7-4	UC-7-4
SAMPLE NUMBER	ERT	EPA	ERT	ERT	ERT	EPA	ERT	ERT	ERT	EPA	ERT
TRAFFIC REPORT NUMBER	1/87	11/30/87	1/87	2/3/87	8/26/87	11/30/87	1/87	2/3/87	8/26/87	11/30/87	1/87
DILUTION FACTORS ------>		5000				2500				2500	
VOLATILES											
BENZENE	NT	NDR	NT	5 ND	25 ND	NDR	NT	5 ND	5 ND	NDR	NT
BROMOFORM	2.5 ND	NDR	250 ND	5 ND	25 ND	1250 ND	250 ND	5 ND	5 ND	1250 ND	250 ND
2-BUTANONE	NT	NDR	NT	NT	NDR	NDR	NT	NT	25 ND	NDR	NT
CARBON TETRACHLORIDE	0.5 ND	NDR	NDR	230	NDR	NDR	NDR	20	5 ND	NDR	NDR
1,1-DICHLOROETHANE	31	NDR	730	320	375	NDR	810	410	390	NDR	NDR
1,1-DICHLOROETHENE	11	NDR	NDR	120	90	NDR	NDR	150	71	NDR	NDR
TRANS-1,2-DICHLOROETHENE	100	NDR	480	170	648	NDR	NDR	150	85	NDR	NDR
ETHYLBENZENE	NT	2500 ND	NT	5 ND	25 ND	1250 ND	NT	5 ND	5 ND	1250 ND	NT
TETRACHLOROETHENE	15000	14000	22000	17000	14866	20000	10000	7600	6700	18000	1300
TOLUENE	NT	NDR	NT	54	NDR	NDR	NT	78	30	NDR	NT
1,1,1-TRICHLOROETHANE	240	NDR	3200	1600	1543	NDR	50 ND	140	150	NDR	NDR
TRICHLOROETHENE	82	NDR	NDR	200	159	NDR	270	550	200	NDR	NDR
TRICHLOROFLUOROMETHANE	NT	NDR	NT	NT	NT	NDR	NT	NT	NT	NDR	NT
TOTAL XYLENES	NT	5000 ND	NT	5 ND	25 ND	2500 ND	NT	5 ND	5 ND	2500 ND	NT
SEMIVOLATILES/BASE NEUTRALS											
CHRYSENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l

SAMPLE LOCATION	UC7-4	UC7-4	UC7-5	UC-7-5	UC7-5	UC7-5	UC-7A-1	UC-7A-2	UC-7A-3	UC-7A-4	UC-7A-5
SAMPLE NUMBER	ERT	ERT	EPA	ERT	ERT	ERT	ERT	ERT	ERT	ERT	ERT
TRAFFIC REPORT NUMBER	2/3/87	8/26/87	11/30/87	1/87	2/3/87	8/26/87	2/3/87	2/3/87	2/3/87	2/3/87	2/3/87
DILUTION FACTORS ------>			50								
VOLATILES											
BENZENE	5 ND	1 ND	25 ND	NT	5 ND	1 ND	5 ND	5 ND	5 ND	5 ND	5 ND
BROMOFORM	5 ND	1 ND	25 ND	12.5 ND	5 ND	1 ND	5 ND	5 ND	5 ND	5 ND	5 ND
2-BUTANONE	NT	5 ND	NDR	NT	NT	5 ND	NT	NT	NT	NT	NT
CARBON TETRACHLORIDE	15	1 ND	NDR	2.5 ND	5 ND	1 ND	57	130	24	20	5 ND
1,1-DICHLOROETHANE	NDR	140	NDR	30	11	2.2	60	240	350	NDR	NDR
1,1-DICHLOROETHENE	5 ND	40	NDR	2.5 ND	5 ND	1 ND	18	110	160	5 ND	5 ND
TRANS-1,2-DICHLOROETHENE	56	82	NDR	26	59	2.3	160	110	110	96	NDR
ETHYLBENZENE	5 ND	1 ND	25 ND	NT	5 ND	1 ND	5 ND	5 ND	5 ND	5 ND	5 ND
TETRACHLOROETHENE	820	3800	150	180	820	95	13000	18000	13000	1500	160
TOLUENE	5 ND	8.7	380	NT	85	110	15	44	320	5 ND	82
1,1,1-TRICHLOROETHANE	110	280	NDR	2.5 ND	21	3.0	400	1600	170	120	5 ND
TRICHLOROETHENE	21	99	NDR	7.4	100	4.1	110	240	560	35	5 ND
TRICHLOROFLUOROMETHANE	NT	NT	NDR	NT	NT	NT	NT	NT	NT	NT	NT
TOTAL XYLENES	5 ND	1 ND	50 ND	NT	5 ND	1 ND	5 ND	5 ND	5 ND	5 ND	5 ND
SEMIVOLATILES/BASE NEUTRALS											
CHRYSENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l

SAMPLE LOCATION	UC9-1	UC9-2	UC9-2	UC9-3	UC9-3	UC9-4	UC9-4	UC9-6	UC9-6	UC10-1	UC10-1
		DUPLICATE							DUPLICATE BUT VALUES SAME FOR BOTH SAMPLES		
SAMPLE NUMBER	ERT	EPA	ERT	EPA	ERT	EPA	ERT	EPA	ERT	EPA	ERT
TRAFFIC REPORT NUMBER	8/27/87	12/1/87	8/26/87	12/1/87	8/26/87	12/1/87	8/26/87	12/1/87	8/26/87	12/1/87	8/26/87
DILUTION FACTORS ------>		100/50		250		250		1		50	
VOLATILES											
BENZENE	1 ND	25 ND	5 ND	125 ND	5 ND	125 ND	10 ND	0.5 ND	1 ND	25 ND	1 ND
BROMOFORM	1 ND	25 ND	5 ND	125 ND	5 ND	125 ND	10 ND	0.5 ND	1 ND	25 ND	1 ND
2-BUTANONE	5 ND	NDR	25 ND	NDR	25 ND	NDR	50 ND	12 ND	5 ND	NDR	5 ND
CARBON TETRACHLORIDE	1 ND	NDR	5 ND	NDR	5 ND	NDR	10 ND	0.5 ND	1 ND	NDR	1 ND
1,1-DICHLOROETHANE	1 ND	NDR	NDR	NDR	NDR	NDR	NDR	0.5 ND	1 ND	NDR	8.5
1,1-DICHLOROETHENE	1 ND	NDR	5 ND	NDR	5 ND	NDR	NDR	1 ND	1 ND	NDR	3.3
TRANS-1,2-DICHLOROETHENE	3.6	NDR	NDR	NDR	NDR	NDR	24	1 ND	1 ND	NDR	73
ETHYLBENZENE	1 ND	25 ND	5 ND	125 ND	5 ND	125 ND	10 ND	0.5 ND	1 ND	25 ND	1 ND
TETRACHLOROETHENE	110	404.2	300	930	490	700	1300	2	1 ND	120	490
TOLUENE	1 ND	84	74	NDR	18	NDR	10 ND	18	1 ND	NDR	47
1,1,1-TRICHLOROETHANE	5.0	NDR	5 ND	NDR	15	NDR	60	0.5 ND	1 ND	NDR	15
TRICHLOROETHENE	4	NDR	14	NDR	5 ND	NDR	NDR	0.5 ND	1 ND	NDR	87
TRICHLOROFLUOROMETHANE	NT	NDR	NT	NDR	NT	NDR	NT	2	NT	NDR	NT
TOTAL XYLENES	1 ND	50 ND	5 ND	250 ND	5 ND	250 ND	10 ND	1 ND	1 ND	50 ND	1 ND
SEMIVOLATILES/BASE NEUTRALS											
CHRYSENE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
INORGANICS											
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l

SAMPLE LOCATION	UC10-2		UC10-2		UC10-3		UC10-3		UC10-4		UC10-4		UC10-5		UC10-5		UC10-6		UC10-6		UC15	
SAMPLE NUMBER	EPA		ERT		EPA		ERT		EPA		ERT		EPA		ERT		EPA		ERT		EPA	
TRAFFIC REPORT NUMBER	12/1/87		8/26/87		12/1/87		8/26/87		12/1/87		8/26/87		12/1/87		8/26/87		12/1/87		8/26/87		10/28/87	
DILUTION FACTORS ------>	100				100				333				50				50				1000	
VOLATILES																						
BENZENE	50	ND	25	ND	50	ND	50	ND	166.5	ND	50	ND	25	ND	5	ND	25	ND	1	ND	500	ND
BROMOFORM	50	ND	25	ND	50	ND	50	ND	166.5	ND	50	ND	25	ND	5	ND	25	ND	1	ND	500	ND
2-BUTANONE		NDR		NDR		NDR		NDR		NDR		NDR		NDR	25	ND		NDR	5	ND		NDR
CARBON TETRACHLORIDE		NDR		NDR		NDR		NDR		NDR		NDR		NDR	5	ND		NDR	1.0	ND		NDR
1,1-DICHLOROETHANE		NDR		NDR		NDR		NDR		NDR		NDR		NDR		NDR		NDR	1	ND		NDR
1,1-DICHLOROETHENE		NDR		NDR		NDR		NDR		NDR		NDR		NDR	5	ND		NDR	1	ND		NDR
TRANS-1,2-DICHLOROETHENE		NDR	93			NDR		NDR		NDR		NDR		NDR		NDR		NDR	1	ND		NDR
ETHYLBENZENE	50	ND	25	ND	50	ND	50	ND	166.5	ND	50	ND	25	ND	5	ND	25	ND	1	ND	500	ND
TETRACHLOROETHENE	620		4200		950		1600		5100		5500		80		290		50		74		20000	
TOLUENE		NDR	130			NDR	120			NDR	130			NDR	49			NDR	13			NDR
1,1,1-TRICHLOROETHANE		NDR		NDR		NDR		NDR		NDR		NDR		NDR	5.0	ND		NDR	1.0	ND		NDR
TRICHLOROETHENE		NDR	160			NDR		NDR		NDR	130			NDR	5	ND		NDR	3.8			NDR
TRICHLOROFLUOROMETHANE		NDR		NT		NDR		NT		NDR		NT		NDR		NT		NDR		NT		NDR
TOTAL XYLENES	100	ND	25	ND	100	ND	50	ND	333	ND	50	ND	50	ND	5	ND	50	ND	1	ND	1000	ND
SEMIVOLATILES/BASE NEUTRALS																						
CHRYSENE		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
INORGANICS																						
ALUMINUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
BARIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
CADMIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
CALCIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
COBALT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
COPPER		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
IRON		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
LEAD		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
MAGNESIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
MANGANESE		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
MERCURY		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
NICKEL		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
POTASSIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
SILVER		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
SODIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
TIN		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
VANADIUM		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT
ZINC		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT		NT

UNIFIRST: GROUNDWATER (ug/l

SAMPLE LOCATION	UC16		UC17		UC18		UC19		UC20	
SAMPLE NUMBER		DUPLICATE								
	EPA		EPA		EPA		EPA		EPA	
TRAFFIC REPORT NUMBER	10/28/87		10/28/87		10/28/87		10/28/87		10/28/87	
DILUTION FACTORS ------>	1000		1000		1000		1		10	
VOLATILES										
BENZENE	500	ND	500	ND	500	ND	0.5	ND	5	ND
BROMOFORM	500	ND	500	ND	500	ND	0.5	ND	5	ND
2-BUTANONE		NDR		NDR		NDR	12	ND		NDR
CARBON TETRACHLORIDE		NDR		NDR		NDR	0.5	ND	10	ND
1,1-DICHLOROETHANE		NDR		NDR		NDR	0.5	ND		NDR
1,1-DICHLOROETHENE		NDR		NDR		NDR	1	ND		NDR
TRANS-1,2-DICHLOROETHENE		NDR		NDR		NDR	1	ND		NDR
ETHYLBENZENE	500	ND	500	ND	500	ND	0.5	ND	5	ND
TETRACHLOROETHENE	3050		2000		11000		0.5	ND	82	
TOLUENE		NDR		NDR		NDR	0.5	ND	5	ND
1,1,1-TRICHLOROETHANE		NDR		NDR		NDR	0.5	ND	5	ND
TRICHLOROETHENE		NDR		NDR		NDR	0.5	ND	5	ND
TRICHLOROFLUOROMETHANE		NDR		NDR		NDR	1	ND		NDR
TOTAL XYLENES	1000	ND	1000	ND	1000	ND	1	ND	10	ND
SEMIVOLATILES/BASE NEUTRALS										
CHRYSENE		NT		NT		NT		NT		NT
INORGANICS										
ALUMINUM		NT		NT		NT		NT		NT
BARIUM		NT		NT		NT		NT		NT
CADMIUM		NT		NT		NT		NT		NT
CALCIUM		NT		NT		NT		NT		NT
COBALT		NT		NT		NT		NT		NT
COPPER		NT		NT		NT		NT		NT
IRON		NT		NT		NT		NT		NT
LEAD		NT		NT		NT		NT		NT
MAGNESIUM		NT		NT		NT		NT		NT
MANGANESE		NT		NT		NT		NT		NT
MERCURY		NT		NT		NT		NT		NT
NICKEL		NT		NT		NT		NT		NT
POTASSIUM		NT		NT		NT		NT		NT
SILVER		NT		NT		NT		NT		NT
SODIUM		NT		NT		NT		NT		NT
TIN		NT		NT		NT		NT		NT
VANADIUM		NT		NT		NT		NT		NT
ZINC		NT		NT		NT		NT		NT

UNIFIRST: GROUNDWATER (ug/liter)
METALS ONLY

	APRIL 1985				MAY 1985				JUNE 1985		
SAMPLE LOCATION	S70S	S70M	S71M	S71D	S70S	S70M	S71M	S71D	S70S	S70M	S71M
SAMPLE NUMBER	12370	12371	12432	12433	12750	12759	12760	12761	13291	13290	13292
TRAFFIC REPORT NUMBER	AB332	AB333	AB505	AB534	AB829	AB828	AB827	AB826	AC439	AC438	AC436
INORGANICS											
ALUMINUM	NT	NT	NT	2800	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	79	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	2.5 ND	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	74000	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	3.5 ND	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	R	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	7400	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	1 ND	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	8200	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	220	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	0.05 ND	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	R	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	8800	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	4.4 J	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	52000	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	18 ND	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	8.2	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	44	NT	NT	NT	NT	NT	NT	NT

UNIFIRST: GROUNDWATER (ug/l
METALS ONLY

SAMPLE LOCATION	S71D	
SAMPLE NUMBER	13289	
TRAFFIC REPORT NUMBER	AC445	

INORGANICS

ALUMINUM	7230	J
BARIUM	223	J
CADMIUM	5.4	
CALCIUM	78600	J
COBALT	6.6	
COPPER	46	J
IRON	18200	J
LEAD	18	J
MAGNESIUM	10800	J
MANGANESE	435	J
MERCURY	0.35	
NICKEL	11	
POTASSIUM	4500	J
SILVER	1.95	ND
SODIUM	49900	J
TIN	40	J
VANADIUM	16	J
ZINC		R

WILDWOOD CONSERVATION CORPORATION

WILDWOOD PROPERTY: SURFACE SOILS

	WILDWOOD SURFACE SOIL SAMPLES		SOIL BORING SAMPLES (0-2 ft.)						
	OL-SS06 EBASCO DATA 1987	OL-SS07 EBASCO DATA 1987	SB1 (0'-2') EBASCO DATA 1987	SB3 (0'-2') EBASCO DATA 1987	SB4 (0'-2') GEO. MEAN DATA 1987	SB5 (0'-2') GEO. MEAN DATA 1987	SB6 (0'-2') GEO. MEAN DATA 1987	SB7 (0'-2') GEO. MEAN DATA 1987	SB8 (0'-2') EBASCO DATA 1987
ORGANICS (ug/Kg)									
VOLATILES									
METHYLENE CHLORIDE	8.00	R	4.20 J	2.50 ND	523.07	606.63	40.50	9.35	20.00
ACETONE	R	R	8.10 J	6.40 J	1102.27	1183.22	R	R	R
CHLOROFORM	R	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	1.50 ND	2.50 ND
2-BUTANONE	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	67.08	5.00 ND	5.00 ND	5.00 ND
1,1,1-TRICHLOROETHANE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.00	3.16	2.50 ND
TRANS-1,2-DICHLOROETHENE	2.50 ND	2.50 ND	4.70 J	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TRICHLOROETHENE	2.50 ND	2.50 ND	10.00 J	2.70 J	5376.80	11958.26	3.46	512.64	32.00
2-HEXANONE	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND
TETRACHLOROETHENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	18.17	2.50 ND
TOLUENE	R	R	2.50 ND	2.50 ND	2.50 ND	2.50 ND	20.45	49.64	7.00
ETHYLBENZENE	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	5.29	7.94	3.00
TOTAL XYLENES	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	22.45	24.98	4.00
SEMI-VOLATILES									
BIS(2-ETHYLHEXYL)PHTHALATE	R	R	400.00 J	360.00	646.53	1714.64	113.45 ND	165.00 ND	97.00
BUTYLBENZYL PHTHALATE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	287.23	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYLPHTHALATE	R	R	1900.00	330.00 J	1624.81	1649.24	165.00 ND	165.00 ND	165.00 ND
N-NITROSODIPHENYLAMINE (1)	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	R	R	120.00
PHENOL	165.00 ND	165.00 ND	165.00 ND	400.00 J	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)ANTHRACENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	162.48 ND	899.17	165.00 ND	165.00 ND	47.00
BENZO(a)PYRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	832.47	165.00 ND	165.00 ND	49.00
BENZO(b)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	186.15	1003.99	165.00 ND	165.00 ND	165.00 ND
BENZO(k)FLUORANTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	95.00
CHRYSENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	134.72 ND	935.15	165.00 ND	165.00 ND	61.00
INDENO(1,2,3-CD)PYRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	602.49	165.00 ND	165.00 ND	30.00
CARCINOGENIC PAHs, TOTAL	ND	ND	ND	ND	186.15	4273.27	ND	ND	282.00
ACENAPHTHENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
ACENAPHTHLYENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	497.49	165.00 ND	165.00 ND	165.00 ND
ANTHRACENE	165.00 ND	165.00 ND	96.00 J	165.00 ND	165.00 ND	513.81	165.00 ND	165.00 ND	8.00
BENZO(g,h,i)PERYLENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
FLUORANTHENE	165.00 ND	R	165.00 ND	165.00 ND	211.07	1264.91	77.07 ND	165.00 ND	96.00
2-METHYLNAPHTHALENE	165.00 ND	165.00 ND	90.00 J	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
NAPHTHALENE	165.00 ND	165.00 ND	180.00 J	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENANTHRENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	194.81	444.97	165.00 ND	165.00 ND	54.00
PYRENE	R	R	160.00 J	165.00 ND	167.48	1104.54	78.13 ND	165.00 ND	100.00
NONCARCINOGENIC PAHs, TOTAL	ND	ND	526.00	ND	573.36	3825.72	ND	ND	258.00

WILDWOOD PROPERTY: SURFACE SOILS

	WILDWOOD SURFACE SOIL SAMPLES		SOIL BORING SAMPLES (0-2 ft.)						
	OL-SS06 EBASCO DATA 1987	OL-SS07 EBASCO DATA 1987	SB1 (0'-2') EBASCO DATA 1987	SB3 (0'-2') EBASCO DATA 1987	SB4 (0'-2') GEO. MEAN DATA 1987	SB5 (0'-2') GEO. MEAN DATA 1987	SB6 (0'-2') GEO. MEAN DATA 1987	SB7 (0'-2') GEO. MEAN DATA 1987	SB8 (0'-2') EBASCO DATA 1987
PESTICIDES/PCBs									
4,4'-DDE	570.00	8.00 ND	8.00 ND	8.00 ND	28.28	25.9	8.00 ND	8.00 ND	8.00 ND
4,4'-DDD	240.00	8.00 ND	8.00 ND	8.00 ND	28.28	11.0 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDT	110.00 J	210.00	8.00 ND	8.00 ND	70.43	43.8	8.00 ND	8.00 ND	8.00 ND
CHLORDANE	R	DR	23000.00	40.00 ND	93.59	50.60	40.00 ND	40.00 ND	40.00 ND
GAMMA-BHC (LINDANE)	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND
ARACLOR-1254	80.00 ND	80.00 ND	25000.00	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND
ARACLOR-1260	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND
INORGANICS (mg/kg)									
ALUMINUM	9900.00 J	2980.00 J	4500.00 J	11200.00 J	9533.94	4632.41	7734.73	6058.76	4290.00 J
ANTIMONY	3.00 ND	3.00 ND	3.00 ND	3.00 ND	3.00 ND	3.00 ND	3.00 ND	3.00 ND	3.00 ND
ARSENIC	6.50 J	6.80 J	60.70	10.80	5.25	4.90	4.04	5.05	3.60
BARIUM	47.00 J	9.90 J	235.00	39.20	26.20	17.27	7.91	18.33	16.60 JB
BERYLLIUM	0.25 ND	0.25 ND	0.52 J	0.25 ND	0.39	0.25 ND	0.25 ND	0.25 ND	0.45 J
CADMIUM	2.90 JB	0.25 ND	27.20 J	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.55	3.40
CALCIUM	3300.00	1150.00	1780.00	532.00	287.99	483.82	150.53	425.38	778.00
CHROMIUM	535.00 J	8.30 J	306.00 J	13.60 JB	11.37	8.33	4.88	13.53	26.40 JB
COBALT	12.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND	2.50 ND
COPPER	33.00	83.00	181.00 J	17.40 J	5.92	7.48	2.65	6.78	11.60 J
IRON	14000.00 J	7560.00 J	20500.00	9300.00	5113.32	4560.99	3141.42	5051.73	5500.00
LEAD	27.00 J	8.60 J	683.00 J	24.30 J	100.00	51.00	9.59	25.40	13.50 J
MAGNESIUM	5170.00	1050.00	1570.00	658.00	867.80	715.99	384.45	677.00	1080.00
MANGANESE	262.00	43.00	130.00	73.40	34.24	39.93	21.39	39.46	76.50
MERCURY	0.01 ND	0.01 ND	5.50	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.09	0.01 ND
NICKEL	23.00 J	10.00 J	21.20 J	2.00 ND	8.45	2.00 ND	7.17	2.00 ND	2.00 ND
POTASSIUM	1590.00	639.00	424.00	222.00	266.97	224.72	255.93	222.73	329.00
SODIUM	136.00 JB	72.00 JB	134.00	NDR	105.55	NDR	94.00	NDR	62.60
VANADIUM	28.00 J	2.50 ND	21.50	30.10	9.46	9.26	4.42	10.16	9.80
ZINC	174.00 J	50.00 J	1240.00	31.00 JB	20.92	39.10	8.22	26.65	40.90 JB
CYANIDE	0.50 ND	0.50 ND	18.00	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND

	SB9 (0'-2') GEO. MEAN DATA 1987	SB10 (0'-2') EBASCO DATA 1987	SB11 (0'-2') EBASCO DATA 1987	SB12 (0'-2') EBASCO DATA 1987	SB13 (0'-2') EBASCO DATA 1987	SB14 (0'-2') EBASCO DATA 1987	SB15 (0'-2') EBASCO DATA 1987
ORGANICS (ug/Kg)							
VOLATILES							
METHYLENE CHLORIDE	2.50 ND	2.50 ND	57.00	22.00 BJ	670.00 BJ	2.50 ND	54.00
ACETONE	34.74	R	R	36.00 BJ	1200.00 BJ	19.00 B	R
CHLOROFORM	2.50 ND	2.50 ND	2.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND
2-BUTANONE	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	5.00 ND	24.00
1,1,1-TRICHLOROETHANE	2.50 ND	2.50 ND	4.00	2.50 ND	2.50 ND	2.50 ND	2.00
TRANS-1,2-DICHLOROETHENE	16.91	11.00	2.50 ND	89.00	2.50 ND	2.50 ND	3.00
TRICHLOROETHENE	216.33	42.00	370.00	520.00	3900.00	14.00	68.00
2-HEXANONE	5.00 ND	5.00 ND	5.00 ND	51.00 BJ	5.00 ND	5.00 ND	5.00 ND
TETRACHLOROETHENE	2.50 ND	2.50 ND	150.00	32.00	2000.00	21.00	2.50 ND
TOLUENE	22.45	18.00	36.00	2.50 ND	2.50 ND	2.50 ND	2.00
ETHYLBENZENE	2.50 ND	2.50 ND	5.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND
TOTAL XYLENES	2.50 ND	12.00	19.00	2.50 ND	2.50 ND	2.50 ND	2.50 ND
SEMI-VOLATILES							
BIS(2-ETHYLHEXYL)PHTHALATE	9348.80	165.00 ND	250.00	310.00 BJ	1200.00 B	500.00 B	165.00 ND
BUTYLBENZYL PHTHALATE	165.00 ND	165.00 ND	165.00 ND	250.00 B	165.00 ND	165.00 ND	165.00 ND
DI-N-BUTYLPHTHALATE	165.00 ND	165.00 ND	165.00 ND	3000.00 B	600.00 B	360.00 JB	165.00 ND
N-NITROSODIPHENYLAMINE (1)	165.00 ND	R	R	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENOL	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)ANTHRACENE	1121.61	230.00	97.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(a)PYRENE	1040.67	330.00	100.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(b)FLUORANTHENE	2227.11	450.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(k)FLUORANTHENE	165.00 ND	360.00	240.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CHRYSENE	842.32	260.00	160.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
INDENO(1,2,3-CD)PYRENE	861.68	230.00	95.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
CARCINOGENIC PAHs, TOTAL	6093.39	1860.00	692.00	ND	ND	ND	ND
ACENAPHTHENE	165.00 ND	93.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
ACENAPHTHLYENE	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
ANTHRACENE	165.00 ND	59.00	19.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
BENZO(g,h,i)PERYLENE	812.40	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
FLUORANTHENE	978.26	340.00	260.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
2-METHYLNAPHTHALENE	240.31	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
NAPHTHALENE	236.85	97.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PHENANTHRENE	559.91	210.00	150.00	165.00 ND	165.00 ND	165.00 ND	165.00 ND
PYRENE	961.25	330.00	200.00	165.00 ND	165.00 ND	83.00 J	165.00 ND
NONCARCINOGENIC PAHs, TOTAL	3788.99	1129.00	629.00	ND	ND	83.00	ND

	SB9 (0'-2') GEO. MEAN DATA 1987	SB10 (0'-2') EBASCO DATA 1987	SB11 (0'-2') EBASCO DATA 1987	SB12 (0'-2') EBASCO DATA 1987	SB13 (0'-2') EBASCO DATA 1987	SB14 (0'-2') EBASCO DATA 1987	SB15 (0'-2') EBASCO DATA 1987
PESTICIDES/PCBs							
4,4'-DDE	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDD	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
4,4'-DDT	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND	8.00 ND
CHLORDANE	40.00 ND	40.00 ND	40.00 ND	40.00 ND	40.00 ND	40.00 ND	40.00 ND
GAMMA-BHC (LINDANE)	137.11	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND	4.00 ND
ARACLOR-1254	80.00 ND	130000.00 C	80.00 ND	80.00 ND	RM	140.00 J	600.00
ARACLOR-1260	489.90	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND	80.00 ND
INORGANICS (mg/kg)							
ALUMINUM	4789.15	4820.00 J	10900.00	2640.00 J	4460.00 J	5460.00	2630.00
ANTIMONY	3.00 ND	29.40 J	3.00 ND	3.00 ND	3.00 ND	12.00 J	3.00 ND
ARSENIC	6.16	7.90 J	3.80 J	3.90 J	27.10 J	7.10 J	8.70 J
BARIUM	26.69	97.50 JB	11.00	12.20 JB	35.40 JB	636.00	886.00
BERYLLIUM	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND
CADMIUM	1.19	2.80 J	0.25 ND	0.25 ND	2.60 J	0.25 ND	0.25 ND
CALCIUM	323.01	3560.00	483.00	1480.00	1650.00	1370.00	1520.00
CHROMIUM	7.19	3060.00 J	22.80 J	31.10 JB	241.00 J	113.00 J	263.00 J
COBALT	2.50 ND	8.20 B	2.50 ND	2.50 ND	2.50 ND	4.60	2.50 ND
COPPER	15.02	180.00 J	1.25 ND	17.00 J	15.80 J	11.60 JB	68.60
IRON	7552.15	8930.00	2440.00	3000.00	4340.00	7270.00	3760.00
LEAD	94.58	80.40 J	4.20 J	27.90 J	20.00 J	13.20 J	47.50 J
MAGNESIUM	411.46	1480.00	256.00	224.00	868.00	1510.00	542.00
MANGANESE	22.47	209.00	11.90	16.30	61.80	151.00	93.60
MERCURY	0.34	0.51	0.01 ND	0.01 ND	0.01 ND	0.01 ND	1.40
NICKEL	2.00 ND	2.00 ND	2.00 ND	2.00 ND	2.00 ND	8.80 J	15.50
POTASSIUM	250.00 ND	443.00	250.00 ND	234.00	320.00	220.00	390.00
SODIUM	117.85	NDR	111.00	NDR	NDR	143.00	NDR
VANADIUM	4.36	25.30	5.60	25.60	10.80	11.80	36.70
ZINC	147.47	278.00	16.10 J	22.40	100.00	15.50 J	296.00 J
CYANIDE	0.50 ND	0.90	0.50 ND	0.50 ND	0.50 ND	0.50 ND	0.50 ND

WILDWOOD CONSERVATION CORPORATION PROPERTY
SURFACE SOIL SAMPLES
(Values in ng/g)

DIOXIN FORM	WI-SS-08	WI-SS-09	WI-SS-10	WI-SS-10	WI-SS-11	WI-SS-12	WI-SS-13
TCDD	ND	ND	ND	ND	ND	ND	ND
PeCDD	ND	ND	ND	ND	ND	ND	ND
HxCDD	ND	ND	ND	ND	ND	ND	ND
HpCDD	ND	ND	ND	ND	ND	ND	3.7
OCDD	ND	ND	ND	ND	ND	ND	38.2
TCDF	ND	ND	ND	ND	ND	ND	ND
PeCDF	ND	ND	ND	ND	ND	ND	ND
HxCDF	ND	ND	ND	ND	ND	ND	ND
HpCDF	ND	ND	ND	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND	ND	ND

WILDWOOD PROPERTY: SUBSURFACE SOILS

	SB1 (2'-4') EBASCO DATA 1987	SB2 (2'-4') EBASCO DATA 1987	SB3 (2'-4') EBASCO DATA 1987	SB4 (2'-4') EBASCO DATA 1987	SB5 (2'-4') EBASCO DATA 1987	SB6 (2'-4') EBASCO DATA 1987	SB7 (2'-4') EBASCO DATA 1987	SB8 (2'-4') EBASCO DATA 1987	SB9 (2'-4') EBASCO DATA 1987
ORGANICS (ug/Kg)									
VOLATILES									
ACETONE	6 J	5 ND	5 ND	21	380 B	R	R	R	47 B
2-BUTANONE	5 ND	5 ND	5 ND	7.3	5 ND	71	5 ND	5 ND	5 ND
TRANS-1,2-DICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	7	2.5 ND	2.5 ND
METHYLENE CHLORIDE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	20	2.5 ND
TETRACHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	27	2.5 ND	2.5 ND
TOLUENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	1.0	34	0.5	13
TRICHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	48	540	2.5 ND	270	8	27
XYLENES, TOTAL	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	3	24	5	2.5 ND
SEMI-VOLATILES									
DI-N-BUTYLPHTHALATE	165 ND	165 ND	165 ND	390 BJ	470 B	165 ND	165 ND	165 ND	320 BJ
BUTYLBENZYL PHTHALATE	1100 J	165 ND	165 ND	165 ND	340 J	165 ND	165 ND	165 ND	165 ND
BIS(2-ETHYLHEXYL)PHTHALATE	8900	165 ND	380 J	680 B	350 BJ	210	93	97	1900 B
PENTACHLOROPHENOL	800 ND	800 ND	800 ND	230 J	800 ND	800 ND	800 ND	800 ND	800 ND
CHRYSENE	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
BENZO(b)FLUORANTHENE	1600 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
BENZO(a)PYRENE	1400 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
ANTHRACENE	520 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
CARCINOGENIC PAHs, TOTAL	3520.0	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	1700 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
2-METHYLNAPHTHALENE	1300 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
FLUORANTHENE	790 J	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND	165 ND
NONCARCINOGENIC PAHs, TOTAL	3790.0	ND	ND	ND	ND	ND	ND	ND	ND
PESTICIDES/PCB'S									
CHLORDANE	96000	40 ND	40 ND	69 J	40 ND	40 ND	40 ND	40 ND	40 ND
AROCLOR-1254	81000	80 ND	80 J	81 J	80 ND	80 ND	80 ND	80 ND	130 J
INORGANICS (mg/Kg)									
ALUMINUM	5280 J	2880 E*	5970 J	7920	8450	378	5600 J	3760 J	6380
ARSENIC	5.8	2.2 N	5.1	3.4 J	3.4	0.5 ND	44 J	0.5 ND	19 J
BARIUM	11.3 B	10.1 B	13.6 JB	8.6	5.4	9.5	10 ND	8.3 JB	26.7
BERYLLIUM	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND
CADMIUM	3.3 J	0.25 ND	1.2 J	0.25 ND	0.25 ND	0.25 ND	0.25 ND	3.1 J	4.7 J
CALCIUM	319	490 B	1050	216	110	630	189	638	519

WILDWOOD PROPERTY: SUBSURFACE SOILS

	SB1 (2'-4') EBASCO DATA 1987	SB2 (2'-4') EBASCO DATA 1987	SB3 (2'-4') EBASCO DATA 1987	SB4 (2'-4') EBASCO DATA 1987	SB5 (2'-4') EBASCO DATA 1987	SB6 (2'-4') EBASCO DATA 1987	SB7 (2'-4') EBASCO DATA 1987	SB8 (2'-4') EBASCO DATA 1987	SB9 (2'-4') EBASCO DATA 1987
CHROMIUM	10.8 JB	8.9 E	12.7 JB	7.1 J	4.1 J	5.8 J	10.8 JB	13.5 JB	13.3 J
COPPER	7.3 J	13.5 E	16.3 J	1.25 ND	1.25 ND	1.25 ND	1.25 ND	9 J	8.7 JB
IRON	4220	3320	7340	4330	2150	4000	4140	4710	6190
LEAD	5.5 J	1.2 *	2.2 J	23.7 J	11.5 J	0.25 ND	1.9 J	3.1 J	126 J
MAGNESIUM	852	756 B	1850	1100	357	1060	704	1040	512
MANGANESE	34.5	30.4 *	67.3	33.8	11	40.9	28.2	48.5	33.7
MERCURY	0.1	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND	2.6
NICKEL	2 ND	18.4 X	8.1 J	2 ND	2 ND	2 ND	2 ND	2 ND	2 ND
POTASSIUM	191	234 B	656	282	250 ND	564	123	348	215
SODIUM	250 ND	250 ND	69.5	89.1	79.6	165	250 ND	66.2	86.6
VANADIUM	5.9	3.9 B	13.2	6.6	2.5 ND	6.8	6.3	7.1	6.6
ZINC	29.2 JB	17.4	15.3 JB	7.9 J	6.2 J	9.2 J	25.2	18.7 JB	290 J
CYANIDE	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND	1.1

	SB10 (2'-4') EBASCO DATA 1987	SB12 (2'-4') EBASCO DATA 1987	SB13 (2'-4') EBASCO DATA 1987	SB14 (2'-4') EBASCO DATA 1987	SB15 (2'-4') EBASCO DATA 1987
ORGANICS (ug/Kg)					
VOLATILES					
ACETONE	R	1000 BJ	990 BJ	15.7	R
2-BUTANONE	5 ND	5 ND	5 ND	5 ND	5 ND
TRANS-1,2-DICHLOROETHENE	2.5 ND	440 J	1600	2.5 ND	7
ETHYLBENZENE	13	2.5 ND	2.5 ND	2.5 ND	6
METHYLENE CHLORIDE	2.5 ND	2.5 ND	650 B	4.8 J	2.5 ND
TETRACHLOROETHENE	500	270 J	6400	57	2.5 ND
TOLUENE	11	2.5 ND	2.5 ND	2.5 ND	12
TRICHLOROETHENE	340	2700	25000	23	39
XYLENES, TOTAL	68	2.5 ND	2.5 ND	2.5 ND	9
SEMI-VOLATILES					
DI-N-BUTYLPHTHALATE	165 ND	760 B	1900 B	1700 B	165 ND
BUTYLBENZYL PHTHALATE	165 ND	165 ND	400 J	240 J	165 ND
BIS(2-ETHYLHEXYL)PHTHALATE	165 ND	310 BJ	350 JB	400 B	56
PENTACHLOROPHENOL	800 ND	800 ND	800 ND	800 ND	800 ND
CHRYSENE	165 ND	165 ND	165 ND	165 ND	39
BENZO(b)FLUORANTHENE	165 ND	165 ND	165 ND	165 ND	165 ND
BENZO(a)PYRENE	165 ND	165 ND	165 ND	165 ND	36
ANTHRACENE	165 ND	165 ND	165 ND	165 ND	165 ND
CARCINOGENIC PAHs, TOTAL	ND	ND	ND	ND	75.0
NAPHTHALENE	165 ND	165 ND	165 ND	165 ND	165 ND
2-METHYLNAPHTHALENE	165 ND	165 ND	165 ND	165 ND	165 ND
FLUORANTHENE	165 ND	165 ND	165 ND	165 ND	165 ND
NONCARCINOGENIC PAHs, TOTAL	ND	ND	ND	ND	ND
PESTICIDES/PCB'S					
CHLORDANE	40 ND	40 ND	40 ND	40 ND	40 ND
AROCLOR-1254	80 ND	80 ND	170 J	140 J	80 ND
INORGANICS (mg/Kg)					
ALUMINUM	847 J	5680 J	6180 J	5320 J	3100
ARSENIC	0.5 ND	3.7	4.2 J	1.5 J	1.6
BARIUM	10 ND	9.6 JB	8.3 JB	343	208
BERYLLIUM	0.48 J	0.25 ND	0.25 ND	0.47 J	0.25 ND
CADMIUM	0.25 ND	1.4 J	0.25 ND	1.2 J	0.25 ND
CALCIUM	397	424	700	746	703

	SB10 (2'-4') EBASCO DATA 1987	SB12 (2'-4') EBASCO DATA 1987	SB13 (2'-4') EBASCO DATA 1987	SB14 (2'-4') EBASCO DATA 1987	SB15 (2'-4') EBASCO DATA 1987
CHROMIUM	71.9 JB	18.9 JB	8.8 JB	54.5 JB	77.2 J
COPPER	1.25 ND	8.3 J	1.25 ND	10.8 J	4.6 JB
IRON	533	3420	3130	9260	2370
LEAD	2.6 J	1.7 J	2.7 J	1.5 J	2.9 J
MAGNESIUM	81	729	725	1350	673
MANGANESE	15.3	26.8	26.6	108	28.8
MERCURY	0.01 ND	0.01 ND	0.01 ND	0.01 ND	0.01 ND
NICKEL	2 ND	8.8 J	2 ND	2 ND	2 ND
POTASSIUM	83.6	170	124	512	342
SODIUM	250 ND	250 ND	250 ND	250 ND	250 ND
VANADIUM	2.5 ND	7.7	5.7	9.4	2.5 ND
ZINC	24.8 JB	16.5 JB	1 ND	104	125 J
CYANIDE	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND

WILDWOOD PROPERTY: NORTHERN SLUDGE SAMPLES

	SL-09 EBASCO DATA 1987		GEOMETRIC MEAN OF SL-10,-11	
ORGANICS (ug/L)				
VOLATILES				
CHLOROFORM	2.50	ND	3146.43	
ETHYLBENZENE	9500.00		2.50	ND
TOLUENE	2.50	ND	2391.65	
XYLENES, TOTAL	61000.00		2.50	ND
SEMI-VOLATILES				
BENZOIC ACID	80000.00		800.00	ND
BIS(2-ETHYLHEXYL)PHTHALATE	37000.00	J	165.00	ND
BUTYLBENZYL PHTHALATE	3100.00		165.00	ND
DI-N-BUTYL PHTHALATE	5600.00		165.00	ND
DIETHYL PHTHALATE	1300.00		165.00	ND
DI-N-OCTYL PHTHALATE	2200.00	J	165.00	ND
2-METHYLPHENOL	165.00	ND	1067.01	
PENTACHLOROPHENOL	6400.00		800.00	ND
PHENOL	9800.00		165.00	ND
BENZO(a)ANTHRACENE	165.00	ND	20346.99	
BENZO(b)FLUORANTHENE	1800.00		165.00	ND
BENZO(k)FLUORANTHENE	1200.00		165.00	ND
CHRYSENE	165.00	ND	38884.44	
CARCINOGENIC PAHs, TOTAL	3600.0		59231.4	
DIBENZOFURAN	165.00	ND	20396.08	
FLUORANTHENE	3500.00		12845.23	
FLUORENE	165.00	ND	60000.00	
2-METHYLNAPHTHALENE	28000.00		483735.46	
NAPHTHALENE	15000.00	J	89610.27	
PHENANTHRENE	15000.00	J	184390.89	
PYRENE	7800.00	J	114891.25	
NONCARCINOGENIC PAHs, TOTAL	69300.00		965869.18	
PESTICIDES/PCB'S				
GAMMA-BHC	1300.00	J	4.00	ND
4,4'-DDT	15000.00		8.00	ND
4,4'-DDE	4700.00	J	8.00	ND
ENDRIN	2900.00	J	8.00	ND
CHLORDANE	81000.00		540.37	
INORGANICS (mg/kg)				
ALUMINUM	1330.00	J	457.38	
ARSENIC	86.00		3.32	
BARIUM	204.00	J	422.72	
CADMIUM	13.00		0.92	
CALCIUM	7900.00		674.23	
CHROMIUM	802.00		91.02	
COBALT	279.00		2.50	ND
COPPER	77.00		16.25	
IRON	39900.00	J	2711.55	
LEAD	6180.00	J	108.47	
MAGNESIUM	1250.00	[	269.52	
MANGANESE	173.00		16.97	
MERCURY	2.30		0.06	
NICKEL	17.00	[J	12.17	
SODIUM	234.00	JB	879.96	
TIN	45.00		6.32	
VANADIUM	18.00	[J	105.12	
ZINC	742.00	J	105.34	

WILDWOOD PROPERTY: SOUTHERN SLUDGE SAMPLES

	SL-01 EBASCO DATA 1987	SL-02 EBASCO DATA 1987	SL-03 EBASCO DATA 1987	SL-04 EBASCO DATA 1987	SL-05 EBASCO DATA 1987	SL-06 EBASCO DATA 1987	SL-07 EBASCO DATA 1987	SL-08 EBASCO DATA 1987
ORGANICS (ug/kg)								
1,1,1-TRICHLOROETHANE	2.50 ND	2.50 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	11000.0
1,2-DICHLOROETHANE	2.50 ND	2.50 ND	120.0	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
2-HEXANONE	12.00	5.00 ND	5.0 ND	5.0 ND	5.0 ND	5.0 ND	5.0 ND	5.0 ND
BIS(2-ETHYLHEXYL)PHTHALATE	165.0 ND	920.0	12000.0	5200.0	165.0 ND	165.0 ND	165.0 ND	150000.0
BUTYLBENZYL PHTHALATE	165.0 ND	165.00 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	38000.0
DIETHYL PHTHALATE	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	5500.0
DI-N-BUTYL PHTHALATE	570.0	165.00 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	26000.0 J
MET2-METHYLPHENOL	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND	14000.0
PENTACHLOROPHENOL	800.00 ND	800.00 ND	800.0 ND	800.0 ND	800.0 ND	800.0 ND	800.0 ND	110000
TETRACHLOROETHENE	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	86000.0
TOLUENE	2.50 ND	2.50 ND	2.5 ND	2.5 ND	2.5 ND	R	1500.0 J	R
TRICHLOROETHENE	2.50 ND	2.50 ND	270.0	2.5 ND	2.5 ND	2.5 ND	2.5 ND	15000.0
===								
BENZO(a)PYRENE	165.0 ND	165.00 ND	165.0 ND	165.0 ND	165.00 ND	165.0 ND	3700.0	165.0 ND
INDENO(1,2,3-CD)PYRENE	5000.00	165.00 ND	9200.0	1800.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND
=====								
CARCINOGENIC PAHs, TOTAL	5000.0	ND	9200.0	1800.0	ND	ND	3700.0	ND
===								
ACENAPHTHYLENE	165.0 ND	165.0 ND	2400.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND
BENZO(g,h,i)PERYLENE	165.0 ND	165.0 ND	9200.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND
FLUORANTHENE	165.00 ND	165.00 ND	4400.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND
MET2-METHYLNAPHTHALENE	165.0 ND	165.0 ND	6500.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND	16000.0
NAPHTHALENE	165.00 ND	165.00 ND	3500.0	165.0 ND	165.0 ND	165.0 ND	165.0 ND	165.0 ND
PYRENE	3500.00	165.00 ND	12000.0	165.0 ND	165.0 ND	1000.0	3800.0	165.0 ND
===								
NONCARCINOGENIC PAHs, TOTAL	3500.00	ND	38000.0	ND	ND	1000.0	3800.0	16000.0
=								
4,4'-DDE	890.0 J	8.00 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND
4,4'-DDT	380.0 J	160.00 J	8.0 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND	320000
CHLORDANE	20000.0	R	40.0 ND	R	40.0 ND	40.0 ND	40.0 ND	40.0 ND
DIELDRIN	8.00 ND	32.00 J	8.0 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND	8.0 ND

WILDWOOD PROPERTY: SOUTHERN SLUDGE SAMPLES

	SL-01 EBASCO DATA 1987	SL-02 EBASCO DATA 1987	SL-03 EBASCO DATA 1987	SL-04 EBASCO DATA 1987	SL-05 EBASCO DATA 1987	SL-06 EBASCO DATA 1987	SL-07 EBASCO DATA 1987	SL-08 EBASCO DATA 1987
INORGANICS (mg/kg)								
ALUMINUM	21.00 SJ	6420.00 J	5250.0 J	4740.0 J	6660.0 J	3430.0 J	4230.0 J	115.0 J
ARSENIC	7.80 [J	6.80 J	82.0	6.5 J	35.0 J	2.1 [J	1.7 [J	7.0 J
BARIUM	35.00 [J	65.00 J	900.0 J	374.0 J	1520.0 J	73.0 [J	18.0 [J	77.0 [J
BERYLLIUM	0.25 ND	0.40	0.25 ND	0.25 ND	0.50 [	0.25 ND	0.25 ND	0.25 ND
CADMIUM	0.25 ND	1.30 [JB	18.0 J	0.25 ND	1.6 [JB	0.25 ND	0.25 ND	0.25 ND
CALCIUM	2.55	1030.00 [	1630.0 [	1020.0 [	1420.0 [	575.0 [	462.0 [	590.0 [
CHROMIUM	12.00 J	23.00 J	410.0 J	182.0 J	315.0 J	9.3 J	6.5 J	23.0 J
COPPER	1.25 ND	15.00	146.0	25.0	79.0	4.3 [	6.0 [	36.0
IRON	5660.00 J	10500.00 J	22400.0 J	15100.0 J	20800.0 J	4280.0 J	4270.0 J	2270.0 J
LEAD	59.00 J	3030.00 J	5680.0 J	6710.0 J	10000.0 J	292.0 J	11.0 J	125.0 J
MAGNESIUM	250.00 ND	3290.00	1910.0 [	1220.0 [	1860.0 [	949.0 [	718.0 [	415.0 [
MANGANESE	21.00	106.00	141.0	124.0	131.0	38.0	36.0	13.0
MERCURY	0.13 J	0.01 ND	3.6 J	0.01 ND	0.56 J	0.01 ND	0.01 ND	0.63 J
NICKEL	2.00 ND	8.90 [J	26.0 J	2.0 ND	16.0 [J	11.0 [J	10.0 [J	2.0 ND
POTASSIUM	2000.0 [	1080.0 [	854.0 [	577.0 [	733.0 [	529.0 [	414.0 [	250.0 ND
SODIUM	2350.00 [JB	81.00 [JB	115.0 [JB	67.0 [JB	171.0 [JB	69.0 [JB	74.0 [JB	125.0 [JB
TIN	2.00 ND	2.00 ND	25.0	2.0 ND	2.0 ND	2.0 ND	2.0 ND	2.0 ND
VANADIUM	2.50 ND	22.00 [J	23.0 [J	14.0 [J	18.0 J	45.0 J	54.0 J	2.5 ND
ZINC	14.00 [JB	51.00 J	94.0 J	171.0 J	1160.0 J	22.0 JB	20.0 J	157.0 J
CYANIDE	0.5 ND	0.5 ND	2.3 JB	0.5 ND	0.5 ND	0.5 ND	0.5 ND	0.5 ND

WILDWOOD: GROUNDWATER — APRIL 1985

SAMPLE LOCATION:	S78S	S78D	BW-1	BSW-1	BW-2	BSW-2	BW-3	BW-4	BW-5	BSW-6	BSSW-6	BW-7
SAMPLE NUMBER:	12416	12404	12417	12428	12425	12424	12413	12423	12426	12419	12418	12422
TRAFFIC REPORT NUMBER:	AB389	AB367	AB374	AB393	AB300	AB379	AB372	AB378	AB391	AB375	AB392	AB377
DILUTION FACTORS:	500	1	1	10	1	4.17	1	1	20	476	1000	1
ORGANICS (ug/liter)												
ACETONE	2500 ND	# R	5 ND	# R	# R	# R	5 ND	5 ND	# R	4569 J	NDR	# R
BENZOIC ACID	25 ND	NT	NT	25 ND	NT	NT	NT	NT	50 J	NT	25 ND	NT
BIS(2-ETHYLHEXYL) PHTHALATE	5 ND	NT	NT	5 ND	NT	NT	NT	NT	5 ND	NT	5 ND	NT
2-BUTANONE	NDR	5 ND	5 ND	NDR	5 ND	NDR	5 ND	5 ND	NDR	NDR	NDR	5 ND
CHLORDANE	0.25 ND	NT	NT	0.25 ND	NT	NT	NT	NT	0.25 ND	NT	0.25 ND	NT
CHLOROFORM	# R	2.5 ND	2.5 ND	# R	2.5 ND	10.425 ND	2.5 ND	2.5 ND	# R	2898	# R	2.5 ND
1,2-DICHLOROBENZENE	160	NT	NT	5 ND	NT	NT	NT	NT	5 ND	NT	5.6 K	NT
1,1-DICHLOROETHANE	NDR	2.5 ND	2.5 ND	NDR	2.5 ND	28	5 J	2.5 ND	NDR	NDR	NDR	2.5 ND
1,2-DICHLOROETHANE	NDR	2.5 ND	2.5 ND	NDR	2.5 ND	NDR	4 J	2.5 ND	NDR	NDR	NDR	2.5 ND
TRANS-1,2-DICHLOROETHENE	NDR	2.5 ND	2.5 ND	NDR	5 J	920	20	2.5 ND	NDR	NDR	NDR	6
ETHYLBENZENE	# R	2.5 ND	2.5 ND	25 ND	2.5 ND	10.425 ND	2.5 ND	2.5 ND	NDR	NDR	NDR	2.5 ND
METHYLENE CHLORIDE	# R	# R	# R	# R	# R	# R	# R	# R	# R	1249 J	# R	# R
TETRACHLOROETHENE	58000 J	2.5 ND	14	NDR	3 J	14 J	7	3 J	# R	NDR	NDR	2.5 ND
TOLUENE	1250 ND	2.5 ND	2.5 ND	25 ND	2.5 ND	10.425 ND	2.5 ND	2.5 ND	50 ND	1190 ND	3400 J	2.5 ND
1,1,1-TRICHLOROETHANE	NDR	2.5 ND	3 J	NDR	2.5 ND	26	8	2.5 ND	# R	3098	# R	2.5 ND
TRICHLOROETHENE	160000 J	2.5 ND	31	590 J	19	130	130	14	3500 J	104900	440000 J	37
VINYL CHLORIDE	NDR	5 ND	5 ND	NDR	5 ND	33 J	5 ND	5 ND	NDR	NDR	NDR	5 ND
XYLENES, TOTAL	6100 J	2.5 ND	2.5 ND	NDR	2.5 ND	NDR	2.5 ND	2.5 ND	NDR	3947	14000 J	2.5 ND
===												
2-METHYLNAPHTHALENE	5 ND	NT	NT	5 ND	NT	NT	NT	NT	5 ND	NT	3.1 K	NT
NAPHTHALENE	5 ND	NT	NT	5 ND	NT	NT	NT	NT	5 ND	NT	5.2 K	NT
=====												
NON-CARCINOGENIC PAH'S	ND	NT	NT	ND	NT	NT	NT	NT	ND	NT	8.3 K	NT
INORGANICS (ug/liter)												
ALUMINUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ANTIMONY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BERYLLIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MERCURY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SELENIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
THALLIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

WILDWOOD: GROUNDWATER — MAY 1985 — JUNE 1985

SAMPLE LOCATION:	BSW-7	S78S	S78D	S78S	S78D	BW-1	BSW-1	BW-2	BSW-2	BW-3	BW-4	BW-5
SAMPLE NUMBER:	12421	12801	12803	13203	13202	13201	13251	13249	13248	13200	13250	13253
TRAFFIC REPORT NUMBER:	AB390	AB912	AB914	AC457	AC437	AC441	AC225	AC223	AC222	AC456	AC224	AC227
DILUTION FACTORS:	1	1	1	1000	1	1	5	1	10	5	1	10
ORGANICS (ug/liter)												
ACETONE	5 ND	# R	# R	NDR	# R	## R	25 ND	5 ND	50 ND	25 ND	5 ND	50 ND
BENZOIC ACID	25 ND	NT	NT	25 ND	NT	NT	NT	NT	NT	25 ND	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	5 ND	NT	NT	# R	NT	NT	NT	NT	NT	# R	NT	NT
2-BUTANONE	1.3 J	5 ND	5 ND	NDR	5 ND	## R	# R	5 ND	NDR	# R	5 ND	NDR
CHLORDANE	0.25 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHLOROFORM	# R	2.5 ND	2.5 ND	NDR	2.5 ND	2.5 ND	# R	# R	# R	# R	# R	# R
1,2-DICHLOROBENZENE	5 ND	NT	NT	70 J	NT	NT	NT	NT	NT	5 ND	NT	NT
1,1-DICHLOROETHANE	2.5 ND	2.5 ND	2.5 ND	NDR	2.5 ND	2.5 ND	NDR	2.5 ND	NDR	NDR	2.5 ND	NDR
1,2-DICHLOROETHANE	2.5 ND	2.5 ND	2.5 ND	NDR	2.5 ND	2.5 ND	NDR	2.5 ND	NDR	NDR	2.5 ND	NDR
TRANS-1,2-DICHLOROETHENE	# R	2.5 ND	2.5 ND	NDR	2.5 ND	2.5 ND	NDR	# R	2100 J	NDR	2.5 ND	NDR
ETHYLBENZENE	2.5 ND	2.5 ND	2.5 ND	NDR	2.5 ND	2.5 ND	12.5 ND	2.5 ND	25 ND	12.5 ND	2.5 ND	25 ND
METHYLENE CHLORIDE	# R	# R	# R	NDR	# R	# R	# R	2.5 ND	25 ND	# R	2.5 ND	25 ND
TETRACHLOROETHENE	2.5 ND	32	2.5 ND	22000 J	2.5 ND	2.5 ND	NDR	1 J	NDR	NDR	2.5 ND	NDR
TOLUENE	# R	2.5 ND	2.5 ND	2500 ND	2.5 ND	2.5 ND	12.5 ND	2.5 ND	25 ND	12.5 ND	2.5 ND	25 ND
1,1,1-TRICHLOROETHANE	2.5 ND	2.5 ND	2.5 ND	NDR	2.5 ND	# R	# R	2.5 ND	# R	# R	2.5 ND	# R
TRICHLOROETHENE	23 J	110	2.5 ND	80000 J	2.5 ND	2.5 ND	480 J	32 J	200 J	80	6.2	2300
VINYL CHLORIDE	5 ND	5 ND	5 ND	NDR	5 ND	5 ND	25 ND	5 ND	300 J	25 ND	5 ND	NDR
XYLENES, TOTAL	2.5 ND	3 J	2.5 ND	1824 J	2.5 ND	2.5 ND	NDR	2.5 ND	NDR	NDR	2.5 ND	NDR
2-METHYLNAPHTHALENE	5 ND	NT	NT	5 ND	NT	NT	NT	NT	NT	5 ND	NT	NT
NAPHTHALENE	5 ND	NT	NT	5 ND	NT	NT	NT	NT	NT	5 ND	NT	NT
NON-CARCINOGENIC PAH'S	ND	NT	NT	ND	NT	NT	NT	NT	NT	ND	NT	NT
INORGANICS (ug/liter)												
ALUMINUM	NT	NT	NT	2290 J	NT	NT	NT	NT	NT	# R	NT	NT
ANTIMONY	NT	NT	NT	# R	NT	NT	NT	NT	NT	# R	NT	NT
ARSENIC	NT	NT	NT	# R	NT	NT	NT	NT	NT	7.75 ND	NT	NT
BARIUM	NT	NT	NT	# R	NT	NT	NT	NT	NT	# R	NT	NT
BERYLLIUM	NT	NT	NT	0.3 ND	NT	NT	NT	NT	NT	0.3 ND	NT	NT
CADMIUM	NT	NT	NT	6.5	NT	NT	NT	NT	NT	0.95 ND	NT	NT
CALCIUM	NT	NT	NT	30300 J	NT	NT	NT	NT	NT	26200 J	NT	NT
CHROMIUM	NT	NT	NT	5.4 J	NT	NT	NT	NT	NT	1.45 ND	NT	NT
COBALT	NT	NT	NT	3.7	NT	NT	NT	NT	NT	1.65 ND	NT	NT
COPPER	NT	NT	NT	# R	NT	NT	NT	NT	NT	# R	NT	NT
IRON	NT	NT	NT	2220 J	NT	NT	NT	NT	NT	# R	NT	NT
LEAD	NT	NT	NT	4.25 ND	NT	NT	NT	NT	NT	4.25 ND	NT	NT
MAGNESIUM	NT	NT	NT	7560 J	NT	NT	NT	NT	NT	5620 J	NT	NT
MANGANESE	NT	NT	NT	2810 J	NT	NT	NT	NT	NT	538 J	NT	NT
MERCURY	NT	NT	NT	0.21	NT	NT	NT	NT	NT	0.2	NT	NT
NICKEL	NT	NT	NT	6.3	NT	NT	NT	NT	NT	2.5 ND	NT	NT
POTASSIUM	NT	NT	NT	2300 J	NT	NT	NT	NT	NT	2300 J	NT	NT
SELENIUM	NT	NT	NT	2.4 ND	NT	NT	NT	NT	NT	2.4 ND	NT	NT
SILVER	NT	NT	NT	7.5 J	NT	NT	NT	NT	NT	8.2 J	NT	NT
SODIUM	NT	NT	NT	27900 J	NT	NT	NT	NT	NT	33100 J	NT	NT
THALLIUM	NT	NT	NT	5.8	NT	NT	NT	NT	NT	2.3 ND	NT	NT
TIN	NT	NT	NT	4.85 ND	NT	NT	NT	NT	NT	4.85 ND	NT	NT
VANADIUM	NT	NT	NT	9.9 J	NT	NT	NT	NT	NT	5.9 J	NT	NT
ZINC	NT	NT	NT	# R	NT	NT	NT	NT	NT	# R	NT	NT

WILDWOOD: GROUNDWATER 1987 DATA

SAMPLE LOCATION:	BSW-6	BSSW-6	BW-7	BSW-7	BOW9-01	BOW14-01	BCW13-01	BSW1-01	BSW2-01	BSW6-01	BSW7-01	BSSW6-01
SAMPLE NUMBER:	13247	13252	13199	13198								
TRAFFIC REPORT NUMBER:	AC221	AC226	AC455	AC454	1987	1987	1987	1987	1987	1987	1987	1987
DILUTION FACTORS:	500	1000	1	5								
ORGANICS (ug/liter)												
ACETONE	2500 ND	NDR	5 ND	25 ND	# R	# R	# R	# R	# R	# R	# R	#
BENZOIC ACID	NT	NT	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25
BIS(2-ETHYLHEXYL) PHTHALATE	NT	NT	# R	# R	5 ND	5 ND	5 ND	5 ND	5 ND	3.8	5 ND	5
2-BUTANONE	NDR	NDR	5 ND	# R	# R	# R	# R	# R	# R	# R	# R	#
CHLORDANE	NT	NT	NT	NT	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.25 ND	0.03
CHLOROFORM	# R	# R	# R	# R	92	76	2.5 ND	5.9	54	2.5 ND	2.5 ND	4453
1,2-DICHLOROBENZENE	NT	NT	5 ND	5 ND	5 ND	5.7	5 ND	5 ND	5 ND	5 ND	5 ND	8.7
1,1-DICHLOROETHANE	NDR	NDR	2.5 ND	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5
1,2-DICHLOROETHANE	NDR	NDR	2.5 ND	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5
TRANS-1,2-DICHLOROETHENE	NDR	NDR	80 J	NDR	2.5 ND	4508	286	4.4	3693	2.5 ND	0.9	2.5
ETHYLBENZENE	NDR	NDR	2.5 ND	12.5 ND	2.5 ND	2.5 ND	12	2.5 ND	2.5 ND	78	2.5 ND	971
METHYLENE CHLORIDE	1250 ND	NDR	2.5 ND	# R	# R	# R	# R	# R	# R	# R	# R	#
TETRACHLOROETHENE	NDR	NDR	3 J	NDR	2.5 ND	2.5 ND	2.5 ND	9.6	2.5 ND	2.5 ND	0.8	2.5
TOLUENE	1250 ND	2500 ND	2.5 ND	12.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	#
1,1,1-TRICHLOROETHANE	7800 J	NDR	2.5 ND	# R	40	2.5 ND	2.5 ND	2.5 ND	100	911	2.5 ND	2187
TRICHLOROETHENE	140000 J	180000 J	13 J	NDR	1738	13514	4177	814	1651	36272	3.0	177765
VINYL CHLORIDE	NDR	NDR	5 ND	25 ND	5 ND	5 ND	5 ND	5 ND	73	5 ND	5 ND	5
XYLENES, TOTAL	2000 J	NDR	2.5 ND	NDR	2.5 ND	2.5 ND	29	2.5 ND	2.5 ND	2.5 ND	2.5 ND	1961
===												
2-METHYLNAPHTHALENE	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	1.8
NAPHTHALENE	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	2
=====												
NON-CARCINOGENIC PAH'S	NT	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8
INORGANICS (ug/liter)												
ALUMINUM	NT	NT	# R	# R	3450 *	28800	117 [	4540	189 [*	24100 *	638	11600
ANTIMONY	NT	NT	172.5 ND	# R	30 ND	68 N	# R	30 ND	30 ND	172 N	30 ND	30
ARSENIC	NT	NT	# R	# R	2.3 [	8.2 [	5 ND	6.0 [N	5 ND	44	3.4 [N	19
BARIUM	NT	NT	# R	# R	24 [	53 [E	15 [E	31 [	45 [	265	20 [	79
BERYLLIUM	NT	NT	0.3 ND	0.3 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5
CADMIUM	NT	NT	5	0.95 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	6.3	2.5 ND	6.1
CALCIUM	NT	NT	31400 J	27100 J	25600	21500	38500	22500 *	13400	21000	15600 *	16300
CHROMIUM	NT	NT	1.45 ND	1.45 ND	5 ND	5 ND	5 ND	5 ND	5 ND	31	8.7 [	5
COBALT	NT	NT	12	3.8	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25
COPPER	NT	NT	# R	11.25 ND	13 [N	13 [N	12.5 ND	15 [N	12.5 ND	143 N	12.5 ND	37
IRON	NT	NT	16400 J	3520 J	4310	5350 E	441 E	5650	117	56200	2180	35600
LEAD	NT	NT	4.25 ND	17 J	5.6	19 st*	1.7 [	90 s	2.9 [	29	3.7 [	21
MAGNESIUM	NT	NT	6920 J	5080 J	5840	6200	8000	6380	3190 [	11500	2830 [	6560
MANGANESE	NT	NT	728 J	500 J	48 E	380	248	430	142 E	894 E	796	797
MERCURY	NT	NT	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1
NICKEL	NT	NT	2.5 ND	5.4	22 [	9.7 [	9.1 [	23 [	20 ND	50	20 ND	20
POTASSIUM	NT	NT	4000 J	4300 J	2170 [E	3560 [E	3620 [E	3010 [	1830 [E	6500 E	2380 [	3080
SELENIUM	NT	NT	2.4 ND	2.4 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	1.7 [	1.8 [	2.5 ND	2.5
SILVER	NT	NT	1.95 ND	1.95 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5
SODIUM	NT	NT	30300 J	17600 J	29000	23500	31400	22100	17300	32700	23100	30100
THALLIUM	NT	NT	2.3 ND	2.3 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5
TIN	NT	NT	4.85 ND	19 J	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND	20
VANADIUM	NT	NT	1.55 ND	4.6 J	25 ND	25 ND	25 ND	25 ND	25 ND	53	25 ND	25
ZINC	NT	NT	# R	# R	32 E	111 *	10 ND	36 *	348 E	113 E	215 *	67

WILDWOOD: GROUNDWATER

SAMPLE LOCATION:	BSSW6-02		BSSW6-03		BW9-01		BW10-01		S78S-01		S95D-01	
SAMPLE NUMBER:												
TRAFFIC REPORT NUMBER:	1987		1987		1987		1987		1987		1987	
DILUTION FACTORS:												
ORGANICS (ug/liter)												
ACETONE	R	#	R	#	R	#	R	#	R	#	R	#	R
BENZOIC ACID	ND	25	ND	25	ND	25	ND	25	ND	25	ND	25	ND
BIS(2-ETHYLHEXYL) PHTHALATE	ND	4	J	2	J	5	ND	5	ND		NT	5	ND
2-BUTANONE	R	5	ND	5	ND	#	R	#	R	5	ND	5	ND
CHLORDANE	J	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND
CHLOROFORM	J	5400		6000		207		115	J	2.5	ND	2.5	ND
1,2-DICHLOROBENZENE	J	5	ND	9	J	5	ND	5	ND		NT	5	ND
1,1-DICHLOROETHANE	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND
1,2-DICHLOROETHANE	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND
TRANS-1,2-DICHLOROETHENE	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND
ETHYLBENZENE		1000		1000		2.5	ND	2.5	ND	2.5	ND	2.5	ND
METHYLENE CHLORIDE	R	#	R	#	R	#	R	#	R	#	R	#	R
TETRACHLOROETHENE	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	11000		2.5	ND
TOLUENE	R	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	#	R
1,1,1-TRICHLOROETHANE		2600		2800		154		6.2		2.5	ND	2.2	
TRICHLOROETHENE		180000		190000		6727		291.2		57000		4.4	
VINYL CHLORIDE	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND
XYLENES, TOTAL		2500		6800		2.5	ND	2.5	ND	910		2.5	ND
===													
2-METHYLNAPHTHALENE	J	5	ND	5	ND	5	ND	5	ND		NT	5	ND
NAPHTHALENE	J	5	ND	5	ND	5	ND	5	ND		NT	5	ND
=====													
NON-CARCINOGENIC PAH'S	J		ND		ND		ND		ND		NT		ND
INORGANICS (ug/liter)													
ALUMINUM	*	13800		18600		3630	*	864		3890		45400	
ANTIMONY	ND	30	ND	30	ND	30	ND	#	R	30	ND	242	N
ARSENIC		20	SN	5	ND	5	ND	5	ND	5	ND	42	Ns
BARIUM	[	128	[	137	[	19	[	31	[E	100	ND	276	
BERYLLIUM	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	2.5	ND	1.3	[
CADMIUM		2.5	ND	4.4	[	2.5	ND	2.5	ND	29		11	
CALCIUM		21600		22400		27600		34400		26900		36400	*
CHROMIUM	ND	21		22		5	ND	5	ND	10		62	
COBALT	ND	14	[	17	[	25	ND	25	ND	25	ND	51	
COPPER	N	63		71		12.5	ND	27	N	50		177	N
IRON		25300		31700		2400		2170	E	2880		67400	
LEAD		55	*	71		9.9		9.2	s	96		36	s
MAGNESIUM		8050		8890		6560		8410		6100		25000	
MANGANESE	E	723		793		149	E	172		2680		1100	
MERCURY	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
NICKEL	ND	20	ND	14	[	16	[	20	ND	20	ND	85	85
POTASSIUM	[E	3040	[	5780		1940	[E	3290	[E	3330	[	10100	
SELENIUM	ND	2.5	ND	2.5	ND	2.4	[	2.5	ND	2.5	ND	2.5	ND
SILVER	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND
SODIUM		31900		32300		31500		28700		24600		24300	
THALLIUM	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5	ND
TIN	ND	20	ND	20	ND	20	ND	20	ND	20	ND	20	ND
VANADIUM	ND	24	[	41	[	25	ND	25	ND	15	[	113	
ZINC	E	81		95		42	E	54	*	58		197	

WILDWOOD: GROUNDWATER

METALS ONLY	1985		1985		1985		1985							
SAMPLE LOCATION:	S78S		BW-3		BW-7		BSW-7							
SAMPLE NUMBER:	13203		13200		13199		13198		JUNE,1988		JUNE,1988		JUNE,1988	
TRAFFIC REPORT NUMBER:	AC457		AC456		AC455		AC454		BSW6		S95D		S78S	
METALS														
ALUMINUM	2290	J	#	R	#	R	#	R	100	ND	638		2160	
ARSENIC	#	R	7.75	ND	#	R	#	R	4.8		5	ND	5	ND
BARIUM	#	R	#	R	#	R	#	R	30		9		9.7	
CADMIUM	6.5		0.95	ND	5		0.95	ND	2.5	ND	2.5	ND	8.1	
CALCIUM	30300	J	26200	J	31400	J	27100	J	24400		27300		26500	
CHROMIUM	5.4	J	1.45	ND	1.45	ND	1.45	ND	5	ND	5	ND	5	ND
COBALT	3.7		1.65	ND	12		3.8		25	ND	25	ND	25	ND
IRON	2220	J	#	R	16400	J	3520	J	11300		42.5		122	
LEAD	4.25	ND	4.25	ND	4.25	ND	17	J	2.5	ND	2.5	ND	2.5	ND
MAGNESIUM	7560	J	5620	J	6920	J	5080	J	6730		6240		4570	
MANGANESE	2810	J	538	J	728	J	500	J	476		99.4		2200	
MERCURY	0.21		0.2		0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND
NICKEL	6.3		2.5	ND	2.5	ND	5.4		20	ND	20	ND	20	ND
POTASSIUM	2300	J	2300	J	4000	J	4300	J	1690		2030		2010	
SILVER	7.5	J	8.2	J	1.95	ND	1.95	ND	5	ND	5	ND	5	ND
SODIUM	27900	J	33100	J	30300	J	17600	J	36400		22900		21500	
THALLIUM	5.8		2.3	ND	2.3	ND	2.3	ND	5	ND	5	ND	5	ND
TIN	4.85	ND	4.85	ND	4.85	ND	19	J		NT		NT		NT
VANADIUM	9.9	J	5.9	J	1.55	ND	4.6	J	25	ND	25	ND	25	ND
ZINC	#	R	#	R	#	R	#	R	21.9	JB	21.5	JB	44.4	JB

NONSOURCE AREA

CENTRAL AREA: SURFACE SOILS

	CN-SS01 EBASCO DATA 1987	
ORGANICS (ug/L)		
VOLATILES		
ACETONE	41	RB
CHLOROFORM	5	RJB
METHYLENE CHLORIDE	8	RB
SEMI-VOLATILES		
PYRENE	2,300	J
2-METHYLNAPHTHALENE		ND
1,2-DICHLOROBENZENE		ND
PESTICIDES/PCB'S		
CHLORDANE	530	B
INORGANICS (mg/Kg)		
ALUMINUM	7,020	J
ANTIMONY		ND
ARSENIC	[5.0]	J
BARIUM	[56]	J
BERYLLIUM	[0.5]	
CADMIUM	2.5	JB
CALCIUM	3,300	
CHROMIUM	13	J
COBALT		ND
COPPER	29	
IRON	8,570	J
LEAD	161	J
MAGNESIUM	[1600]	
MANGANESE	293	
MERCURY	0.12	J
NICKEL	[13]	J
POTASSIUM	[758]	
SELENIUM		ND
SILVER		ND
SODIUM	[109]	JB
THALLIUM		ND
VANADIUM	[24]	J
ZINC	85	J
CYANIDE		ND

CENTRAL AREA GROUNDWATER (ug/liter)	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	MAY 1985	MAY 1985	MAY 1985
SAMPLE LOCATION	S68S	S68M	S84S	S84M	S84D	S85S	S85M	S86S	S86M	S68S	S68M	S84S
SAMPLE NUMBER	12477	12478	12472	12471	12437	12397	12398	12410	12409	12753	12754	12741
TRAFFIC REPORT NUMBER	AB533	AB542	AB509	AB508	AB507	AB361	AB362	AB387	AB386	AB730	AB731	AB720
DILUTION FACTORS ----->	500	1	1	1	1	1	1	1	1	1	1	1
VOLATILES												
ACETONE	NDR	5 ND	5 ND	5 ND	# R	# R	5 ND	# R	# R	5 ND	5 ND	5 ND
1,1-DICHLOROETHENE	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1-DICHLOROETHANE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR
TRANS-1,2-DICHLOROETHENE	NDR	# R	10	7	8	68	22	2.5 ND	2.5 ND	29	36.5	10
CHLOROFORM	# R	NDR	NDR	NDR	NDR	NDR	NDR	# R	# R	NDR	NDR	NDR
1,1,1-TRICHLOROETHANE	1700 J	15 J	2.5 ND	2.5 ND	2.5 ND	8	34	17 J	2.5 ND	6	12.5	2.5 ND
TRICHLOROETHENE	NDR	# R	24	17	23	110	48	18 J	17 J	54	87	21
TETRACHLOROETHENE	NDR	# R	20	11	10	56	150	56 J	48 J	47	85.5	18
TOLUENE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR
CHLOROBENZENE	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES												
PHENOL	5 ND	5 ND	NT	NT	NT	NT	NT	5 ND	2.5 K	NT	NT	NT
1,2-DICHLOROBENZENE	5 ND	3 K	NT	NT	NT	NT	NT	5 ND	5 ND	NT	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	5 ND	5 K	NT	NT	NT	NT	NT	5 ND	5 ND	NT	NT	NT
INORGANICS												
ALUMINUM	1000	5800	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	30	70	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BERYLLIUM	0.25 ND	0.6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	2.5 ND	5.9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	37000	75000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	7.4	5.7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	3.5 ND	23	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	# R	49	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	2900	7400	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	1 ND	1 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	8400	16000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	100	1100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	# R	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	2500	4400	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SELENIUM	1 ND	## R	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	27000	27000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
THALLIUM	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	18 ND	18 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	11	27	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	56	72	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
N-NITROSODIPHENYLAMINE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

CENTRAL AREA GROUNDWATER (ug/liter)	MAY 1985	MAY 1985	MAY 1985	MAY 1985	MAY 1985	MAY 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985
SAMPLE LOCATION	S84M	S84D	S85S	S85M	S86S	S86M	S68S	S68M	S84S	S84M	S84D	S85S
SAMPLE NUMBER	12742	12743	12738	12739	12752	12757	13188	13187	13197	13196	13182	13217
TRAFFIC REPORT NUMBER	AB721	AB722	AB711	AB712	AB729	AB734	AC453	AC452	AC435	AC432	AC443	AB929
DILUTION FACTORS ----->	1	1	10	10	5	1	1	1	1	1	1	1
VOLATILES												
ACETONE	5 ND	5 ND	NDR	NDR	NDR	5 ND	5 ND	5 ND	## R	## R	## R	# R
1,1-DICHLOROETHENE	2.5 ND	2.5 ND	NDR	NDR	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1-DICHLOROETHANE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR
TRANS-1,2-DICHLOROETHENE	2.5 ND	11	62	NDR	NDR	2.5 ND	55	80 J	# R	# R	# R	76.5
CHLOROFORM	NDR	NDR	NDR	13 J	NDR	NDR	# R	NDR	NDR	# R	NDR	NDR
1,1,1-TRICHLOROETHANE	2.5 ND	2.5 ND	NDR	NDR	NDR	2.5 ND	# R	29 J	# R	# R	# R	13
TRICHLOROETHENE	16	26	92	39 J	3 J	3 J	50 J	73 J	# R	# R	# R	140
TETRACHLOROETHENE	11	9	22 J	170	12	13	50	85 J	# R	# R	# R	83.5
TOLUENE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	# R	NDR	NDR	NDR
CHLOROBENZENE	2.5 ND	2.5 ND	NDR	NDR	NDR	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	2.5 ND	2.5 ND	NDR	NDR	NDR	2.5 ND	2.5 ND	2.5 ND	5 J	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES												
PHENOL	NT	NT	5 ND	5 ND	NT	NT	5 ND	5 ND	NT	NT	NT	NT
1,2-DICHLOROBENZENE	NT	NT	5 ND	5 ND	NT	NT	5 ND	5 ND	NT	NT	NT	NT
BIS(2-ETHYLHEXYL) PHTHALATE	NT	NT	5 ND	79 J	NT	NT	5 ND	# R	NT	NT	NT	NT
INORGANICS												
ALUMINUM	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
ARSENIC	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
BERYLLIUM	NT	NT	NT	NT	NT	NT	0.3 ND	0.3 ND	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	0.95 ND	0.95 ND	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	33600 J	53300 J	NT	NT	NT	NT
CHROMIUM	NT	NT	NT	NT	NT	NT	1.45 ND	1.45 ND	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	1.65 ND	1.65 ND	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	11.25 ND	11.25 ND	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	8960 J	13200 J	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	17 J	352 J	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	2.5 ND	2.5 ND	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	2000 J	4300 J	NT	NT	NT	NT
SELENIUM	NT	NT	NT	NT	NT	NT	2.4 ND	2.4 ND	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	4.9 J	4.2 J	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	27900 J	27900 J	NT	NT	NT	NT
THALLIUM	NT	NT	NT	NT	NT	NT	2.3 ND	2.3 ND	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	4.85 ND	14 J	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	10	13 J	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	# R	# R	NT	NT	NT	NT
N-NITROSODIPHENYLAMINE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

CENTRAL AREA
GROUNDWATER (ug/liter)

SAMPLE LOCATION	S85M	S86S	S86M	S68S-01	S89S-01	S89S-02	S89M-01	S89D-01	S85-01	S87	S86S
SAMPLE NUMBER	13219	13224	13225	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO	EBASCO
TRAFFIC REPORT NUMBER	AB930	AB935	AB936	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987	DATA 1987
	JUNE 1985	JUNE 1985	JUNE 1985								
DILUTION FACTORS ----->	1.12	1	1								
VOLATILES											
ACETONE	# R	# R	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	# R
1,1-DICHLOROETHENE	2.7	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
1,1-DICHLOROETHANE	NDR	NDR	NDR	NDR	NDR	NDR	NDR	2	NDR	NDR	NDR
TRANS-1,2-DICHLOROETHENE	23	2.5 ND	2.5 ND	28	4	4	3	3	12	2.5 ND	2.5 ND
CHLOROFORM	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR
1,1,1-TRICHLOROETHANE	35.3	3	2.5 ND	5	2.5 ND	2.5 ND	2.5 ND	4	24	2.5 ND	2.5 ND
TRICHLOROETHENE	47.5	4	3	47	6	6	21	21	23	2.5 ND	2.5 ND
TETRACHLOROETHENE	180	12	8	47	NDR	NDR	3	24	110	NDR	10
TOLUENE	NDR	NDR	NDR	# R	NDR	NDR	4	3	NDR	NDR	NDR
CHLOROBENZENE	2.8 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2	2.5 ND	2.5 ND	2.5 ND	2.5 ND
TOTAL-XYLENE	2.8 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SEMIVOLATILES											
PHENOL	NT	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
1,2-DICHLOROBENZENE	NT	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
BIS(2-ETHYLHEXYL) PHTHALATE	NT	NT	NT	5	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
INORGANICS											
ALUMINUM	NT	NT	NT	240	100 ND	100 ND	100 ND	100 ND	100 ND	100 ND	100 ND
ARSENIC	NT	NT	NT	20 N	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
BARIUM	NT	NT	NT	210	100 ND	100 ND	100 ND	100 ND	100 ND	100 ND	100 ND
BERYLLIUM	NT	NT	NT	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
CADMIUM	NT	NT	NT	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
CALCIUM	NT	NT	NT	36500	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND
CHROMIUM	NT	NT	NT	20	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
COBALT	NT	NT	NT	18 [	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND
COPPER	NT	NT	NT	42	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND	12.5 ND
IRON	NT	NT	NT	50 ND	50 ND	50 ND	50 ND	50 ND	50 ND	50 ND	50 ND
LEAD	NT	NT	NT	58 *	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
MAGNESIUM	NT	NT	NT	16300	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND
MANGANESE	NT	NT	NT	205	7.5 ND	7.5 ND	7.5 ND	7.5 ND	7.5 ND	7.5 ND	7.5 ND
NICKEL	NT	NT	NT	36 [	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND
POTASSIUM	NT	NT	NT	8770 A	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND
SELENIUM	NT	NT	NT	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND	2.5 ND
SILVER	NT	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
SODIUM	NT	NT	NT	30500	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND	2500 ND
THALLIUM	NT	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND
TIN	NT	NT	NT	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND	20 ND
VANADIUM	NT	NT	NT	9.9 [	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND	25 ND
ZINC	NT	NT	NT	104	10 ND	10 ND	10 ND	10 ND	10 ND	10 ND	10 ND
N-NITROSODIPHENYLAMINE	NT	NT	NT	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND	5 ND

CENTRAL AREA
GROUNDWATER (ug/liter)

SAMPLE LOCATION	S86D-01		S84S-01	
SAMPLE NUMBER	EBASCO		EBASCO	
TRAFFIC REPORT NUMBER	DATA 1987		DATA 1987	
DILUTION FACTORS ----->				
VOLATILES				
ACETONE	#	R	#	R
1,1-DICHLOROETHENE	2.5	ND	2.5	ND
1,1-DICHLOROETHANE		NDR		NDR
TRANS-1,2-DICHLOROETHENE	2.5	ND	4	
CHLOROFORM		NDR		NDR
1,1,1-TRICHLOROETHANE	2.5	ND	2.5	ND
TRICHLOROETHENE	3		7	
TETRACHLOROETHENE	14		4	
TOLUENE		NDR		NDR
CHLOROBENZENE	2.5	ND	2.5	ND
TOTAL-XYLENE	2.5	ND	2.5	ND
SEMIVOLATILES				
PHENOL	5	ND	5	ND
1,2-DICHLOROBENZENE	5	ND	5	ND
BIS(2-ETHYLHEXYL) PHTHALATE	5	ND	5	ND
INORGANICS				
ALUMINUM	100	ND	100	ND
ARSENIC	5	ND	5	ND
BARIUM	100	ND	100	ND
BERYLLIUM	2.5	ND	2.5	ND
CADMIUM	2.5	ND	2.5	ND
CALCIUM	2500	ND	2500	ND
CHROMIUM	5	ND	5	ND
COBALT	25	ND	25	ND
COPPER	12.5	ND	12.5	ND
IRON	50	ND	50	ND
LEAD	2.5	ND	2.5	ND
MAGNESIUM	2500	ND	2500	ND
MANGANESE	7.5	ND	7.5	ND
NICKEL	20	ND	20	ND
POTASSIUM	2500	ND	2500	ND
SELENIUM	2.5	ND	2.5	ND
SILVER	5	ND	5	ND
SODIUM	2500	ND	2500	ND
THALLIUM	5	ND	5	ND
TIN	20	ND	20	ND
VANADIUM	25	ND	25	ND
ZINC	10	ND	10	ND
N-NITROSODIPHENYLAMINE	5	ND	5	ND

CENTRAL AREA
METALS ONLY

GROUNDWATER (ug/liter)	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	APRIL 85	MAY 1985	MAY 1985	MAY 1985
SAMPLE LOCATION	S68S	S68M	S84S	S84M	S84D	S85S	S85M	S86S	S86M	S68S	S68M	S84S
SAMPLE NUMBER	12477	12478	12472	12471	12437	12397	12398	12410	12409	12753	12754	12741
TRAFFIC REPORT NUMBER	AB533	AB542	AB509	AB508	AB507	AB361	AB362	AB387	AB386	AB730	AB731	AB720
INORGANICS												
ALUMINUM	1000	5800	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ARSENIC	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BARIUM	30	70	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
BERYLLIUM	0.25 ND	0.6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CADMIUM	2.5 ND	5.9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CALCIUM	37000	75000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CHROMIUM	7.4	5.7	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COBALT	3.5 ND	23	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COPPER	# R	49	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
IRON	2900	7400	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
LEAD	1 ND	1 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MAGNESIUM	8400	16000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MANGANESE	100	1100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
NICKEL	# R	# R	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
POTASSIUM	2500	4400	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SELENIUM	1 ND	## R	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SILVER	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
SODIUM	27000	27000	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
THALLIUM	2 ND	2 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TIN	18 ND	18 ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
VANADIUM	11	27	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
ZINC	56	72	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

CENTRAL AREA
METALS ONLY
GROUNDWATER (ug/liter)

	MAY 1985	MAY 1985	MAY 1985	MAY 1985	MAY 1985	MAY 1985	JUNE 1985		JUNE 1985		JUNE 1985	JUNE 1985	JUNE 1985	JUNE 1985
SAMPLE LOCATION	S84M	S84D	S85S	S85M	S86S	S86M	S68S		S68M		S84S	S84M	S84D	S85S
SAMPLE NUMBER	12742	12743	12738	12739	12752	12757	13188		13187		13197	13196	13182	13217
TRAFFIC REPORT NUMBER	AB721	AB722	AB711	AB712	AB729	AB734	AC453		AC452		AC435	AC432	AC443	AB929
INORGANICS														
ALUMINUM	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT
ARSENIC	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT
BARIUM	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT
BERYLLIUM	NT	NT	NT	NT	NT	NT	0.3	ND	0.3	ND	NT	NT	NT	NT
CADMIUM	NT	NT	NT	NT	NT	NT	0.95	ND	0.95	ND	NT	NT	NT	NT
CALCIUM	NT	NT	NT	NT	NT	NT	33600	J	53300	J	NT	NT	NT	NT
CHROMIUM	NT	NT	NT	NT	NT	NT	1.45	ND	1.45	ND	NT	NT	NT	NT
COBALT	NT	NT	NT	NT	NT	NT	1.65	ND	1.65	ND	NT	NT	NT	NT
COPPER	NT	NT	NT	NT	NT	NT	11.25	ND	11.25	ND	NT	NT	NT	NT
IRON	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT
LEAD	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT
MAGNESIUM	NT	NT	NT	NT	NT	NT	8960	J	13200	J	NT	NT	NT	NT
MANGANESE	NT	NT	NT	NT	NT	NT	17	J	352	J	NT	NT	NT	NT
NICKEL	NT	NT	NT	NT	NT	NT	2.5	ND	2.5	ND	NT	NT	NT	NT
POTASSIUM	NT	NT	NT	NT	NT	NT	2000	J	4300	J	NT	NT	NT	NT
SELENIUM	NT	NT	NT	NT	NT	NT	2.4	ND	2.4	ND	NT	NT	NT	NT
SILVER	NT	NT	NT	NT	NT	NT	4.9	J	4.2	J	NT	NT	NT	NT
SODIUM	NT	NT	NT	NT	NT	NT	27900	J	27900	J	NT	NT	NT	NT
THALLIUM	NT	NT	NT	NT	NT	NT	2.3	ND	2.3	ND	NT	NT	NT	NT
TIN	NT	NT	NT	NT	NT	NT	4.85	ND	14	J	NT	NT	NT	NT
VANADIUM	NT	NT	NT	NT	NT	NT	10		13	J	NT	NT	NT	NT
ZINC	NT	NT	NT	NT	NT	NT	#	R	#	R	NT	NT	NT	NT

CENTRAL AREA
METALS ONLY

GROUNDWATER (ug/liter)	JUNE 1985	JUNE 1985	JUNE 1985
SAMPLE LOCATION	S85M	S86S	S86M
SAMPLE NUMBER	13219	13224	13225
TRAFFIC REPORT NUMBER	AB930	AB935	AB936
INORGANICS			
ALUMINUM	NT	NT	NT
ARSENIC	NT	NT	NT
BARIUM	NT	NT	NT
BERYLLIUM	NT	NT	NT
CADMIUM	NT	NT	NT
CALCIUM	NT	NT	NT
CHROMIUM	NT	NT	NT
COBALT	NT	NT	NT
COPPER	NT	NT	NT
IRON	NT	NT	NT
LEAD	NT	NT	NT
MAGNESIUM	NT	NT	NT
MANGANESE	NT	NT	NT
NICKEL	NT	NT	NT
POTASSIUM	NT	NT	NT
SELENIUM	NT	NT	NT
SILVER	NT	NT	NT
SODIUM	NT	NT	NT
THALLIUM	NT	NT	NT
TIN	NT	NT	NT
VANADIUM	NT	NT	NT
ZINC	NT	NT	NT

APPENDIX F

SPECIES OBSERVED AND SPECIES THAT MAY BE FOUND AT THE WELLS G & H SITE

TABLE F-1 PLANTS OBSERVED AT THE WELLS G & H SITE[a]

Common name	Type[b]	Latin name
red maple	FAC	Acer rubrum
shadbush	FAC	Amelanchier canadensis
swamp milkweed	OBL	Asclepias incarnata
sedges	FAC/OBL	Carex spp.
tussock sedge	OBL	Carex stricta
buttonbush	OBL	Cephalanthus occidentalis
silky dogwood	FACW	Cornus amomum
dodder	-	Cuscuta gronovii
hayscented fern	-	Dennstaedtia punctilobula
field horsetail	FAC	Equisetum arvense
wood horsetail	FACW	Equisetum sylvaticum
grasses	-	Graminae
winterberry	FACW	Ilex verticillata
spotted jewelweed	FACW	Impatiens capensis
purple loosestrife	FACW	Lythrum salicaria
mosses	-	Musci
sensitive fern	FACW	Onoclea sensibilis
cinnamon fern	FACW	Osmunda cinnamomea
royal fern	OBL	Osmunda regalis
reed	FACW	Phragmites communis
clearweed	FACW	Pilea pumila
smartweed	-	Polygonum sp.
black cherry	-	Prunus serotina
buckthorn	-	Rhamnus frangula
swamp azalea	OBL	Rhododendron viscosum
staghorn sumac	-	Rhus typhina
poison ivy	FAC	Rhus radicans
poison sumac	OBL	Rhus vernix
marsh cress	-	Rorippa islandica
swamp rose	OBL	Rosa palustris
bramble	-	Rubus sp.
arrowhead	OBL	Sagittaria sp.
black willow	FACW	Salix nigra
elderberry	FACW	Sambucus canadensis
rushes	FACW/OBL	Scirpus spp.
common nightshade	-	Solanum nigrum
steeplebush	FACW	Spiraea tomentosa
skunk cabbage	OBL	Symplocarpus foetidus
meadow-rue	-	Thalictrum polyganum
cattail	OBL	Typha latifolia
elm	-	Ulmus sp.
highbush blueberry	FACW	Vaccinium corymbosum
hobble bush	FAC	Viburnum alnifolium
arrowwood	FAC	Viburnum dentatum
grape	-	Vitis sp.

[a]Based on field observations conducted in June 1986.
[b]Classification from Reed, 1986:
OBL = obligate weland species (must live in wetlands).
FAC = facultative wetland species (may live in wetlands or uplands).
FACW = facultative wetland species that prefers wetlands.
- = not classified in Reed.

TABLE F-2 MAMMALS THAT MAY BE FOUND AT THE WELLS G & H SITE[a]

Common Name	Latin Name
big brown bat	Eptesicus fuscus
hoary bat	Lasiurus cinereus
red bat	Lasiurus borealis
silver-haired bat	Lasionycteris noctivagans[1]
eastern chipmunk*	Tamias striatus
eastern cottontail	Sylvilagus floridanus
New England cottontail	Sylvilagus transitionalis
short-tailed weasel	Mustela erminea cicognanii
red fox	Vulpes vulpes
hairy-tailed mole	Parascalops breweri
starnosed mole	Condylura cristata
house mouse	Mus musculus
meadow jumping mouse	Zapus husonius[1]
white-footed mouse	Peromyscus hudsonius
muskrat	Ondatra zibethicus
little brown myotis	Myotis lucifugus
opossum	Didelphis marsupialis[1]
eastern pipstrelle	Pipistrellus subflavus obscurus[1]
raccoon*	Procyon lotor[1]
Norway rat	Rattus norvegicus
masked shrew	Sorex cinereus cinereus[1]
short-tailed shrew	Blarina brevicauda
water shrew	Sorex palustris albibarbus[1]
striped skunk	Mephitis mephitis nigra
grey squirrel*	Sciurus carolinensis
red squirrel	Tamiasciurus hudsonicus
southern flying squirrel	Glaucomys volans
meadow vole	Microtus pennsylvanicus[1]
woodchuck*	Marmota monax

[a]Source: Godin, 1977.

*Indicates species (or sign) observed.

[1]Species associated with wetlands.

TABLE F-3 BIRDS THAT MAY BE FOUND AT THE WELLS G & H SITE[a]

Common Name	Latin Name
american bittern	Botaurus lentiginosus
least bittern	Ixobrychus exilis
redwing blackbird*	Agelains phoeniceus
black-capped chickadee*	Parus atricapillus
common crow*	Corvus brachyrhynchos
black-billed cuckoo	Coccyzus erythropthalmus
yellow-billed cuckoo	Coccyzus americanus
mourning dove	Zenaidura macroura
yellow-shafted flicker*	Colaptes auratus
great crested flycatcher	Myiarchus crinitus
least flycatcher	Empidonax minimus
common gallinule	Gallinula chloropus
american goldfinch*	Spinus tristus
canada goose*	Branta canadensis
common grackle*	Quiscalus quiscula
evening grosbreak	Hesperiphona vespertina
rose-breasted grosbeak	Pheucticus melanocephalus
ruffed grouse	Bonasa umbellus
herring gull*	Larus argentatus
broad-winged hawk*	Buteo platytpterus
red-shouldered hawk	Buteo lineatus
red-tailed hawk*	Buteo jamaicensis
great blue heron	Ardea herodias
green heron	Butorides striatus
black-crowned night heron	Nycticorax nycticorax
ruby-throated hummingbird	Archilochus colubris
blue jay*	Cyanocitta cristata
slate-colored junco	Junco hyemalis
kestrel	Falco sparverius
killdeer	Charadrius vocifer
eastern kingbird*	Tyrannus tyrannus
belted kingfisher	Megaceryle alcyon
mallard*	Anas platyrhynchos
mockingbird	Mimus polyglottos
common nighthawk	Chordeiles minor
red-breasted nuthatch	Sitta canadensis
white-breasted nuthatch*	Sitta carolinensis
barred owl	Strix varia
great horned owl	Bubo virginianus
long-eared owl	Asio otus
saw-whet owl	Aegolius acadicus
screech owl	Otus asio
short-eared owl	Asio flammeus

(continued)

TABLE F-3 (Continued)

Common Name	Latin Name
eastern wood pewee	Contopus virens
ringneck pheasant*	Phasianus colchicus
eastern phoebe	Sayornis phoebe
pigeon	Columba livia
american redstart	Setophaga ruticilla
robin	Turdus migratorius
spotted sandpiper	Actitis macularia
yellow-bellied sapsucker	Sphyrapicus varius
sora	Porzana carolina
chipping sparrow	Spizella passerina
field sparrow	Spizella pusilla
house sparrow	Passer domestica
song sparrow*	Melospiza melodia
white-crowned sparrow	Zonotrichia levcophrys
white-throated sparrow	Zonotrichia albicollis
starling*	Sturnus vulgaris
barn swallow*	Hirundo rustica
tree swallow	Iridoprocne bicolor
chimney swift	Chaetura pelagica
hermit thrush	Hylocichla guttata
Swainson's thrush	Hylocichla ustulata
wood thrush	Hylocichla mustelina
tufted titmouse*	Parus bicolor
rufous-sided towhee	Pipilo erythropthalmus
veery	Hylocichla fuscescens
red-eyed vireo	Vireo olivaceous
turkey vulture	Cathartes aura
black-and-white warbler	Mniotilta raria
nashville warbler	Vermivora ruficapilla
yellow warbler	Dendroica petechia
cedar waxwing	Bombycilla cedrorum
whip-poor-will	Caprimulgus vociferus
american woodcock	Philohela minor
downy woodpecker	Dendrocopus pubescens
hairy woodpecker	Dendrocopus villosus
yellowthroat	Geothlypis trichas

[a]Source: adapted from Mass. Audubon Bird Checklist.

*Indicates species (or sign) observed.

TABLE F-4 REPTILES THAT MAY BE FOUND AT THE WELLS G & H SITE[a]

Common Name	Latin Name
northern black racer	Coluber constrictor constrictor
northern brown snake	Storeria dekayi dekayi
eastern garter snake*	Thamnophis sirtalis sirtalis
eastern smooth green snake	Opheodrys vernalis vernalis
eastern milk snake	Lampropeltis triangula triangula
northern red-bellied snake	Storeria occipitomo occipitomo
eastern ribbon snake	Thamnophis sauritus sauritus
northern ringneck snake	Diadophis punctatus edwardsi
northern water snake	Nerodia sipedon sipedon[1]
stinkpot	Stemotherus odoratus[1]
eastern painted turtle*	Chrysemys picta picta[1]
midland painted turtle	Chrysemys picta marginata[1]
common snapping turtle	Chelydra serpentina[1]
wood turtle	Clemmys insculpta

[a]Source: DeGraaf and Rudis, 1983.

*Indicates species (or sign) observed.

[1]Species associated with wetlands.

TABLE F-5 AMPHIBIANS THAT MAY BE FOUND AT THE WELLS G & H SITE[a,1]

Common Name	Latin Name
bullfrog*	Rana catesbeiana
green frog*	Rana clamitans melanota
northern leopard frog	Rana pipiens
pickerel frog	Rana palustris
wood frog	Rana sylvatica
spring peeper	Hyla crucifer
mudpuppy	Necturus maculosus
red-spotted newt	Notophthalmus viridescens
dusky salamander	Desmognathus fuscus
four-toed salamander	Hemidactylium scutatum
red-backed salamander	Plyethodon cinereus
spotted salamander	Ambystoma maculatum
spring salamander	Gyrinophilus porphyriticus
two-lined salamander	Eurycea bislineata
grey treefrog	Hyla versicolor
american toad*	Bufo americanus

[a]Source: DeGraaf and Rudis, 1983.

*Indicates species (or sign) observed.

[1]All species are associated with wetlands.

TABLE F-6 INVERTEBRATE TAXA IDENTIFIED AT THE WELLS G & H SITE[a]

Common Name	Latin Name/Taxon
water boatman	Corixa sp.
Kirby's backswimmer	Notenecta Kirbyi
backswimmer	Notonecta undulata
diving beetle	Thermonectes sp.
water strider	Gerris sp.
dragonfly (skimmer)	Libellula sp.
watermite	Limnochares sp.
damselfly	Argia sp.
gastropod	Gyraulus sp.
gastropod	Physa sp.
fresh water clam	Sphaeriidae
isopod	Asellus sp.
dragonfly nymph	Anisoptera larvae
midge larvae	Chironomidae
leech	Hirudinea sp.
crayfish	Decapoda (Orconectes sp.)
scud	Amphipoda (Gammarus sp.)
mosquito larvae	Culicinae
aquatic earthworms	Oligochaeta
flatworm	Planariidae
rotifer	Ascomorpha sp.
cladoceran	Hyocryptus sordidus
cladoceran	Chydorus sp.
daphnid	Daphnidae
cyclopoid copepod	Mesocyclops sp.
cyclopoid copepod	Cyclopoidae
stonefly larvae	Plecoptera
caddisfly larvae	Trichoptera
round worms	Nematoda

[a]based on field observations conducted in June 1986.

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