previously occupied by above ground storage tanks, which were removed by the USEPA prior to the Ebasco sampling activities. The second sample, designated SS-2, was taken from an area slightly east of the first. Both samples consisted of a composite of the first 6 inches of soil, which were analyzed for volatile and semivolatile organic compounds, PCBs/pesticides, and inorganic constituents. The samples for the volatile organic analyses were collected prior to the composition of the soil.

Results of surface soil sample SS-1 analyses indicate traces of three volatile organics. Chloroform, 1,1,1-trichloroethane, and tetrachloroethene were found at estimated concentrations of 2 ug/kg, 3 ug/kg, and 4 ug/kg, respectively. Semivolatile organic compounds present were butylbenzylphthalate at 360 ug/kg, and bis[2-ethylhexyl]phthalate at 1,300 ug/kg. The PCB Arochlor 1260 was detected at a concentration of 280 ug/kg. Inorganic analytes were also detected in sample SS-1. The majority of these were present at concentrations consistent with expected background levels (see Table 8-3). The exceptions were aluminum, mercury, and zinc, which were found at concentrations of 1,620 mg/kg, 0.15 mg/kg, and 41.5 mg/kg, respectively.

Low concentrations of two volatile organics were present in surface soil sample SS-2. These compounds were chloroform and tetrachloroethene which were both detected at 1 ug/kg. No semivolatile organics were found in the sample. The PCB Arochlor 1248 was present at a concentration of 1,200 ug/kg. Inorganic analyses indicated the presence of elevated levels of some metals, including copper (5,060 mg/kg) and aluminum (3,280 mg/kg). The remainder of the inorganic compounds were detected at concentrations consistent with the background soil concentration ranges of Table 8-3.

Summary

The contamination of the site's surface soil in the rear of the building primarily consists of 1,1,1-trichloroethane, bis[2-ehtylhexyl]phthalate, PCBs and several metals. Since the Circuitron property was formerly used as farmland, the presence of the PCBs Arochlor 1260 and Arochlor 1248 might be attributed to the former agricultural activities performed at the site as well as Circuitron activities. On the other hand, the presence and usage of the above ground tanks containing unknown liquids at these locations is probably the source of volatile, semivolatile and inorganic surface soil contamination.

6.4.2 Subsurface Soil

In order to characterize and determine the vertical and horizontal extent of subsurface soil contamination at the Circuitron Corporation Site, samples were obtained at various locations both on and off site (Figure 4-1). The samples were taken from six soil borings (SB-1 through SB-6) and four deep monitoring wells (MW-1D, MW-2D, MW-3D and MW-4D) at various depths. The samples and were analyzed for TCL volatile organics, semivolatile organics, pesticide/PCBs, inorganics, hexavalent chromium and total organic carbon. Analytical results are summarized in Tables 6-10, 6-11, 6-12 and 6-13. Inorganic results have been evaluated with respect to expected background soil concentrations (Table 8-3, from Kabata-Pendias and Pendias (1984) and Brown et al (1983)).

6.4.2.1 Soil Borings

The six soil borings are designated SB-1 through SB-6 and are all located on-site with the exception of SB-6. SB-1 was drilled in the paved area in front of the building, in the vicinity of the SPDES authorized leaching pool LP-1. Four of the borings are located inside the building, in the drilling and silkscreening area (SB-2) and in the plating room (SB-3 through SB-5). The remaining boring, SB-6, is located to the south of the building in the vicinity of the underground oil-storage tank UT-5. Unless otherwise noted, soil samples were taken at five foot intervals to a depth of 40 feet below the ground surface (approximately 15 feet below the groundwater table).

SB-1

Volatile organic compounds detected in the soil samples of boring SB-1 consisted of toluene and 4-methyl-2-pentanone. Toluene was found in all the soil samples at concentrations ranging from 2.0 ug/kg at the depth of 15 to 17 feet below grade to 13 ug/kg at 5 to 7 and 35 to 37 feet below grade. 4-methyl-2-pentanone was detected at 15 ug/kg at 25 to 27 feet and 14 ug/kg at 40 to 42 feet below the ground surface. The only semivolatile compound found in the soils of SB-1 was bis(2-ethylhexyl)phthalate. The estimated concentration ranged from 87 ug/kg to 690 ug/kg at the depth intervals of 40 to 42 feet and 10 to 13 feet below grade, respectively, and appeared to decrease in concentration with increased depth. No pesticides/PCBs were detected in the soil samples of boring SB-1.

All inorganic analytes were present at concentrations consistent with expected background levels, with the exception of aluminum. This inorganic compound exceeded the maximum background concentration of 10 mg/kg (see Table 8-3) at all depth intervals from the ground surface to 37 feet below grade. The aluminum concentration ranged from 99.3 mg/kg at 30-32 feet to 1,580 mg/kg at 0-2 feet (see Table 6-12), and generally decreased with depth.

Cyanide was detected only at a depth of 10-12 feet below grade and had a concentration of 2.2 mg/kg (see Table 6-13).

SB-2

Samples were taken from soil boring SB-2 as outlined above, but no soil was obtained from the 10-12 foot depth interval. Five volatile organic compounds were detected in the SB-2 samples. The most frequently encountered was toluene, which was present at all depths from 0-2 foot interval to the 25-27 foot interval at concentrations ranging from 0.6 ug/kg (5-7 feet) to 6 ug/kg (0-2 and 25-27 feet). Acetone was detected at depths of 20-22 and 25-27 feet at estimated concentrations of 22 ug/kg and 49 ug/kg, respectively; 1,1,1-trichloroethane was present at 0-2 feet (31 ug/kg) and 30-32 feet (4 ug/kg). Both trichloroethene and tetrachloroethene were detected once in the shallow sample (0-2 feet) at levels of 2 ug/kg and 24 ug/kg, respectively. One volatile organic TIC was also detected in the shallow sample at a concentration of 7.3 ug/kg.

Semivolatile organics present in SB-2 samples consisted of butylbenzylphthalate, with a concentration of 2,500 ug/kg at the 0-2 foot depth, and bis[2-ethylhexyl]phthalate, with a concentration of 700 ug/kg at the 20-22 foot depth. Semivolatile TICs were detected at depths of 5-7 and 15-17 feet, with total concentrations of 530 ug/kg and 2,800 ug/kg, respectively. Pesticides were present in the shallow samples; endosulfan sulfate was found at concentrations of 18 ug/kg (0-2 feet) and 240 ug/kg (5-7 feet), and 4-4-DDT was present at levels of 41 ug/kg (0-2 feet) and 20 ug/kg (5-7 feet). No PCBs were detected.

All inorganic analytes were present at concentrations consistent with expected background levels (see Table 8-3), with the exception of aluminum. This metal exceeded its ambient level expected concentration of 10 mg/kg at all sample depths. Concentrations of aluminum ranged from 5,240 mg/kg at the surface to 416 mg/kg at 30-32 feet, and generally decreased with depth.

Cyanide was found only at the depth of 0-2 feet at a concentration of 2.9 mg/kg.

In addition to the subsurface soil samples, a core sample of the concrete slab was taken at the location of SB-2. This is designated as CC-SB2-C001 in Tables 6-10, 6-11 and 6-12. Three volatiles were detected. Acetone (1,200 ug/kg), chloroform (1 ug/kg) and toluene (4 ug/kg). Semivolatiles were not found. Aluminum and arsenic were detected at concentrations of 5,780 mg/kg and 6.6 mg/kg, respectively. Their presence can be attributed to the former activities performed in this room when the facility was in operation.

above its maximum expected background concentration of 10 mg/kg, with levels ranging from 2,510 mg/kg (0-2 feet) to 207 mg/kg (40-42 feet). Copper, with a maximum expected concentration of 70 mg/kg, was found at a concentration of 890 mg/kg at 0-2 feet and 76 mg/kg at 10-12 feet below grade. Lead also has a maximum expected background concentration of 70 mg/kg, and was detected at 0-2 and 5-7 feet at levels of 84 mg/kg and 109 mg/kg, respectively.

Cyanide was not found at any sampling depths of this soil boring.

A core sample of the concrete slab from the plating room was obtained from the location of soil boring SB-4 and is designated in Tables 6-10, 6-11 and 6-12 as CC-SB4-C001. Two volatile compounds were detected; toluene at 3 ug/kg and total xylenes at 20 ug/kg. In addition, pentachlorophenol (the only semivolatile compound detected in this slab) was found at an estimated concentration of 43 ug/kg. Pesticide hits were detected at a range from 7.9 ug/kg (aldrin) to 97 ug/kg (endosulfan sulfate). The inorganic analyses of the slab sample detected high concentrations of several metals, including aluminum, copper, lead and mercury. Their presence was expected since the slab of this room had significant staining, is corroded and badly damaged by the chemicals used when the facility was in operation.

SB-5

Volatile organics found in the SB-5 samples consisted of chloroform, tetrachloroethene, and toluene. Chloroform was detected at an estimated concentration of 2 ug/kg at depths of 30-32 feet, 35-35 feet, and 40-42 feet. Tetrachloroethene was present at a depth of 3-5 feet (7 ug/kg), and toluene was present at 35-37 feet (2 ug/kg). Two semivolatile organics were detected. The most frequently encountered was bis[2-ethylhexyl]phthalate, which was found at depths between 3-5, 5-7 feet and 40-42 feet with concentrations of 140 ug/kg, 8,000 ug/kg and 130 ug/kg, respectively. Butylbenzylphthalate was present at a depth of 5-7 feet, with level of 83 ug/kg. No pesticides or PCBs were detected.

Aluminum and copper were the only inorganics that were present above their respective maximum expected background ranges of 10 mg/kg and 70 mg/kg, respectively. Aluminum was detected at all depths with levels ranging from 176 mg/kg (40-42 feet) to 881 mg/kg (3-5 feet). Copper was found to exhibit an elevated concentration of 173 mg/kg at a depth of 5-7 feet.

SB-6

The predominant volatile organic compound found in the SB-6 soil samples was toluene. Concentrations ranged from 2 ug/kg to 13 ug/kg at the depth intervals of 35-37 feet and 5-7 feet, respectively. Tetrachloroethene was found only in the surface

SB-3

Volatile organic compounds detected in the SB-3 soils consisted of chloroform, 1-1-1-trichloroethane and tetrachloroethene. Chloroform was present at several depths at concentrations ranging from 1 ug/kg to 2 ug/kg. 1,1,1-Trichloroethane was detected at a depth of 5-7 feet at 6 ug/kg. Tetrachlorotehene was found at the depth of 5-7 feet at 2 ug/kg. Semivolatile organic contamination was limited to bis[2-ethylhexyl]phthalate, with a concentration of 180 ug/kg at the 0-2 foot depth and 2,100 ug/kg at the 20-22 foot depth interval. Several semivolatile TICs were reported at depths between 0-2 and 15-17 feet, with total concentrations ranging from 210 ug/kg to 1,060 ug/kg, respectively. The TIC levels increased with depth. No pesticide or PCB contamination was found at this location.

A total of three inorganic constituents were detected at levels exceeding maximum expected background concentrations (see Table 8-3). Aluminum was present at concentrations ranging from 103 mg/kg (20-22 feet) to 3,850 mg/kg (5-7 feet). Copper was found at concentration levels of 527 mg/kg at 0-2 feet and 1,950 mg/kg at 5-7 feet below grade. In addition, lead was present at the depth interval of 5-7 feet at an estimated concentration of 278 mg/kg.

SB-4

Volatile organic compounds were detected at all depths in SB-4 samples. The most frequently encountered compound was chloroform, which was found at depths from 5-7 to 40-42 feet at concentrations ranging from 1 ug/kg to 3 ug/kg. Toluene was present at various depths between 5-7 feet and 40-42 feet, with levels of 1 ug/kg (20-22 and 25-27 feet) to 7 ug/kg (40-42 feet). The only reported hit of 1,1,1-trichloroethane was from the surface sample (0-2 feet) which contained a concentration of 6 ug/kg. One volatile organic TIC was present at a depth of 15-17 feet at an estimated concentration of 8.3 ug/kg.

A total of three semivolatile organic compounds were detected. Bis[2-ethylhexyl]phthalate was present at all depths from the 15-17 foot interval and below, at concentrations ranging from 44 ug/kg (35-37 feet) to 450 ug/kg (40-42 feet). Benzoic acid was detected at depths of 5-7 feet and 10-12 feet at estimated levels of 94 ug/kg and 65 ug/kg respectively. Semivolatile organic TICs were present at all depths except the 10-12 foot level, with total concentrations ranging from 680 ug/kg (0-2 feet) to 2,100 ug/kg (20-22 feet). One pesticide, 4-4-DDT was detected in the surface sample (0-2 feet) at 24 ug/kg. The PCB Arochlor 1260 was found at a depth of 25-27 feet, at a concentration of 170 ug/kg.

Inorganic analytes were present at concentrations consistent with expected background ranges, with the exceptions of aluminum, copper, and lead. Aluminum was detected at all depths sample (0-2 feet below grade) at a concentration of 10 ug/kg. 1,1,1-Trichloroethane was present at the 30-32 feet depth interval and had an estimated concentration of 5 ug/kg.

Bis(2-ethylhexyl)phthalate was detected at 5-7 feet below the ground surface at an estimated value of 120 ug/kg. No other semivolatile organics were present in the SB-6 soil samples.

Pesticides/PCBs were not detected in any of the samples from soil boring SB-6.

All inorganic data from soil boring SB-6 were detected at concentrations consistent with the background concentration range for sandy U.S. soils (see Table 8-3), with the exception of aluminum. Its concentration ranged from 380 mg/kg at 25-27 feet to 2,750 mg/kg at 0-2 feet and seemed to decrease with depth.

6.4.2.2 Well Borings

Soil samples were obtained from four deep monitoring wells, designated MW-1D through MW-4D. Monitoring well MW-1D is located upgradient of the site, across from the northwestern corner of the building on the northern side of Milbar Boulevard. Monitoring well MW-2D is located on-site, in front of the building in the northeastern portion of the parking lot. Monitoring well MW-3D is not on-site, but is in the vicinity of the site's eastern edge, approximately half way between Milbar Boulevard and the southeastern corner of the building. The last monitoring well sampled, MW-4D, is located near the southwestern corner of the building. The locations of these wells are also shown in Figure 4-1. Soil samples from the wells were taken at 5-foot intervals to a depth of 10 feet below the groundwater table, with the exception of MW-1D, for which no sample was taken at the 15-17 foot depth interval. The screened interval of each well (95-97 feet) was also sampled. Each sample consisted of a two foot soil composite.

Monitoring Well MW-1D

Volatile organic compounds were detected in the MW-1D soils at all depths. Chloroform was present in concentrations ranging from 1 ug/kg to 3 ug/kg, with the exception of the 25-27 foot level. Both toluene and chlorobenzene were detected in the screened interval sample (95-97 feet) at a concentration of 2 ug/kg for each compound. Acetone was found at the 30-32 foot depth interval having an estimated concentration of 420 ug/kg. Semivolatile organic compounds detected included bis[2-ethylhexyl]phthalate, which was present at depths of 0-2 feet and 95-97 feet at concentrations of 37 ug/kg and 42 ug/kg, respectively. Several TICs were also detected at concentrations ranging from 720 ug/kg (2 compounds) at the 10-12 foot depth, to 10,780 ug/kg (4 compounds) at the 5-7 foot depth. No pesticides or PCBs were found in the samples.

The concentrations of inorganic compounds present in the soil samples were consistent with expected background levels, with the exception of aluminum, which was present at all depths above the maximum background level of 10 ppm. Subsequent samples indicated a general decrease in aluminum concentration with depth.

Hexavalent chromium was detected at the 5-7 and 10-12 foot intervals at estimated concentrations of 6.5 ug/kg and 7 ug/kg, respectively.

Monitoring Well MW-2D

Three volatile organics, chloroform, toluene, and acetone, were detected in the MW-2D samples. Chloroform was present at the 0-2 and 5-7 foot depths at a concentration of 2 ug/kg at both locations. Toluene was present at all depths, with the exception of the 15-17 foot level, with concentrations ranging from 1 ug/kg (20-22 feet) to 34 ug/kg (0-2 feet). Acetone was detected only in the screened interval (95-97 feet) at a concentration of 33 ug/kg. Volatile organic TICs were present in the two shallow samples (0-2 and 5-7 feet) at levels of 31.4 ug/kg and 13 ug/kg, respectively. One semivolatile organic compound and several semivolatile organic TICS were also detected. Bis[2-ethylhexyl]phthalate was present in samples from all depths except the 30-32 foot and 95-97 foot levels, and concentrations range from 35 ug/kg (10-12 feet) to 450 ug/kg (15-17 feet). The TICs were detected at all levels except the 25-27, 30-32 foot and 95-97 foot depths, at concentrations of 270 ug/kg (5-7 feet) to 7,810 ug/kg (0-2 feet).

Pesticide 4-4-DDT was present in the shallow soils (0-2 feet) at a concentration of 40 ug/kg. The PCB Arochlor 1254 was detected at the 25-27 foot level at a concentration of 170 ug/kg.

The only inorganic present at concentrations exceeding expected background concentrations was aluminum, which was present at all depths above the maximum level of 10 ppm. The shallow sample (0-2 feet) exhibited an aluminum concentration of 3,330 ppm, which decreased with depth to a concentration of 350 ppm at the 30-32 foot level; however, the screened interval sample, taken at a depth of 95-97 feet, exhibited an aluminum concentration of 1,650 mg/kg.

Hexavalent chromium was detected at the depth intervals of 5-7 and 10-12 feet at an estimated concentration of 6.5 ug/kg.

Monitoring Well MW-3D

Only one volatile organic hit was reported for the MW-3D soil samples. Toluene was detected at a level of 5 ug/kg at the screened interval of 95-97 feet and chloroform at a level of 12 ug/kg at the depth interval of 5-7 feet below grade. In addition, two volatile organic TICs were present at a total estimated concentration of 16.1 ug/kg in the sample taken at a depth of 0-2 feet. One semivolatile organic compound was detected. Bis[2-ethylhexyl]phthalate was present at concentrations ranging from 130 ug/kg (20-22 feet) to 42 ug/kg (10-12 feet). Hexachloroethane was detected at a depth of 5-7 feet at a level of 340 ug/kg. This hit is considered spurious, since hexachloroethane was not detected anywhere else. Semivolatile organic TICs were found in samples from all depths, with the exception of the screened interval (95-97 feet). Total TIC concentrations ranged from 1,240 ug/kg (10-12 feet) to 7,620 ug/kg (20-22 feet). No Pesticides or PCBs were detected.

Aluminum was the only metal present above its maximum expected background level of 10 ppm, and was detected at all depths in the MW-3D samples. Concentrations ranged from 578 mg/kg (20-22 feet) to 1,060 ppm (5-7 feet).

Hexavalent chromium was present a the depth intervals of 5-7 foot and 10-12 foot at estimated concentration of 6.5 ug/kg.

Monitoring Well MW-4D

In general, soil samples from MW-4D exhibited a greater degree of contamination than samples taken from the other wells. Several volatile organic compounds were detected. The most highly concentrated was 1,1,1-trichloroethane, which was present at extremely high levels at depths of 15-17 feet (3,000 ug/kg), 20-22 feet (100,000 ug/kg), and 30-32 feet (17,000 ug/kg). The shallow samples contained concentrations of 99 ug/kg and 8 ug/kg at depths of 5-7 and 10-12 feet, respectively. Tetrachloroethene was detected at depths between 15-17 and 30-32 feet at concentrations ranging from 7 ug/kg to 100 ug/kg, respectively, and toluene was detected at depths between 5-7 feet and 25-27 feet at concentrations ranging from 87 ug/kg and 8 ug/kg, respectively. Trichloroethene, 1,1,2-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethene were also present in concentrations significantly low compared to the 1,1,1-TCA ones. Volatile organic TICs were also detected at a maximum total concentration of 167 ug/kg (5-7 feet).

Semivolatile organics were also present in the MW-4D soils. Bis[2-ethylhexyl]phthalate was most frequently encountered and was detected in all samples except the screened interval soil (95-97 feet). The maximum concentration of this compound was 20,000 ug/kg and occurred at a depth of 20-22 feet; the sample taken at a depth of 30-32 feet contained a concentration of 9,700 ug/kg. Di-n-butylphthalate was detected at depths of 15-17 and 30-32 feet at concentrations of 91 ug/kg and 120 ug/kg, respectively. Acenaphthylene and butylbenzylphthalate were also detected at concentrations of 160 ug/kg (20-22 feet) and 5 ug/kg (95-99 feet), respectively. Semivolatile organic TICs were detected at all depths, with the maximum total concentration of 243,360 ug/kg encountered at a depth of 5-7 feet. No pesticide or PCB hits were reported.

Aluminum was the only inorganic detected above its maximum expected background concentration of 10 ppm. This metal was present at all sample depths at concentrations ranging from 435 mg/kg (20-22 feet) to 1,150 mg/kg (5-7 feet). In general, aluminum levels tended to decrease with depth.

Hexavalent chromium was detected at a depth of 5-12 feet at an estimated concentration of 6.5 ug/kg.

Summary

The analytical results of the subsurface soil samples collected from the deep upgradient well boring MW-1D indicate the presence of bis[2-ethylhexyl]phthalate only at the top 2 feet of the Upper Glacial Aquifer and the upper portion of the Magothy Aquifer (95-97 feet below grade).

Evaluation of the analytical results of the subsurface soil samples collected from beneath the Circuitron building indicate the presence of soil contamination. Volatile organic compounds and copper were detected throughout the top 12 feet of soil, while bis[2-ethylhexyl]phthalate was detected at all depths to the groundwater table. The elevated levels of the contaminants beneath the Circuitron building appears to be attributable to the illegal discharge of untreated wastes in the authorized and unauthorized leaching pools of the site during the operation of the plating facility.

The soils in the southwest corner of the site (deep well boring MW-4D) were found to be the most contaminated on-site. Volatile organic compounds were detected at all depths throughout the top 40 feet of soil. The predominant volatile organic contaminant is 1,1,1-trichloroethane which was detected at a concentration of 100,000 ug/kg at the depth of 20-22 feet below grade and just 3 feet above the groundwater table. In addition, semivolatile organics were encountered at almost all depths, with bis[2-ethylhexyl]phthalate as the predominant compound. The higher level of contamination detected at this portion of the site appear to be caused from the illegal discharge of wastes and the drainage of solvents from the old plating bath into storm drain SD-3 located just upgradient of MW-4D.

The dominant contaminants, in the slab of the silkscreening and plating rooms are aluminum, copper, lead and mercury. The plating room slab was detected to have much higher contamination than the silkscreening room one. This can be attributed to the large amount of debris that used to be in the plating room, as well as to the chemicals used when the plating facility was in operation. The analytical results also indicate the presence of several volatile and semivolatile contaminants.

6.5 GROUNDWATER

6.5.1 Previous Investigations

Groundwater in the vicinity of the Circuitron Corporation Site was studied by the Suffolk County Department of Health Services (SCDHS) prior to the initiation of remediation activities. Monitoring wells installed on site by Circuitron Corporation and local off-site municipal and private wells were sampled by the SCDHS. The on-site monitoring wells were also sampled once by Circuitron Corporation.

6.5.1.1 On Site Wells

In early 1985, five monitoring wells were installed on the site, at locations approved by the SCDHS (Figure 4-1). Circuitron Corporation sampled the wells in April 1985. No organic contaminants were found, but the concentration of cadmium was found to increase from 0.01 mg/l in the upgradient samples to 0.65 mg/l in the downgradient samples. The SCDHS sampled the wells in September, 1985. Analytical results indicate the presence of the 1,1,1-trichloroethane downgradient of the site at concentrations of 60 ug/l, 120 ug/l, and 520 ug/l in MW-10, MW-11, and MW-12 respectively. The two upgradient wells, MW-8 and MW-9, did not seem to contain any contaminants.

6.5.1.2 Municipal and Private Wells

Data is available for one municipal and one private well. The East Farmingdale Water District well S-20042, located on Gazza Boulevard and screened at the depth of 585 feet below grade, is sampled routinely. Results from analyses performed between January, 1981, and December 1984 did not indicate the presence of any contaminants.

The cooling water diffusion well S-22003 at the House of Plastics, screened at the depth of 226.5 feet below grade, was sampled in January, 1979, and several volatile organic compounds were detected. These included 1,1,1-trichloroethane, methylene chloride, and 1,1-dichloroethylene, which were detected at concentrations of 59 ug/l, 9 ug/l, and 5 ug/l, respectively. In addition, 1,1,1,2-tetrachloroethane (5 ug/l), trichloroethylene (7 ug/l), and 1,1-dichloroethane (2 ug/l) were present. Cis-1,2-dichloroethylene and 1,2-dichloroethane were also found, each at a concentration of 2 ug/l.

Both wells are located at an approximate distance of 1,500 feet downgradient of the site.

6.5.2 Ebasco Investigations

For the purposes of the Ebasco remedial investigation, groundwater samples from both existing and newly installed monitoring wells were analyzed for volatile and semivolatile organic compounds, pesticides, PCBs, inorganics and hexavalent chromium. The existing wells were those installed by Circuitron Corporation in 1985, are designated MW-8 through MW-12 and are screened at the water table according to documentation provided with the Site Inspection Report (EA, 1987). Seven additional well clusters were installed both on and off-site by Ebasco in 1989, and are designated MW-1 through MW-7. Each consists of a deep well (screened interval of 90 to 100 feet) and a shallow well (screened interval of 25 to 35 feet). The locations of all the above wells are shown on Figure 4-1. Two private wells were also sampled; PW-1 is the East Farmingdale Water District municipal well S-20042, and PW-2 is the House of Plastics diffusion cooling water well S-22003. These wells are shown on Figure 1-4.

The newly installed wells were sampled in two rounds for TCL organic compounds, TAL inorganic analysis and hexavalent chromium. The second round of sampling incorporated the expanded volatile organics list at lower detection limits (i.e., EPA Method 524.2) which is required for all remedial investigations at hazardous waste sites in the New York State. The expanded list of volatile analytes was also requested through the CLP-SAS program for the round I samples, however due to laboratory error the Routine Analytical Services (RAS) volatile list of compounds (i.e., EPA Method 624) was analyzed.

Ebasco sampling took place on several occasions throughout 1989. Existing wells MW-8 through MW-12 were sampled in July, 1989. The Ebasco clusters, MW-1 through MW-7, were the subject of two consecutive rounds of sampling, which took place during September and October of 1989, respectively. The municipal well PW-1 was also sampled in October, while private well PW-2 was sampled in December 1989.

Results of the groundwater samples analyses are summarized in Tables 6-14 thru 6-19. Relevant standards and criteria are contained in Table 8-4. Figures 6-5 and 6-6 present only the contaminants of concern hits in the groundwater analytical results of the shallow and the deep wells, respectively.

6.5.2.1 Volatile Organics - shallow aquifer

Table 6-20 summarizes the frequency of occurrence and concentration ranges of the volatile organics detected in the monitoring wells. Ten volatile organics were identified in the Round I samples while eighteen were identified in the Round II samples. Review of Table 6-20 shows that of the eight volatile compounds present in both rounds, the frequency of occurrence and concentration ranges were fairly comparable. This would suggest that there is a constant input of contaminants to the groundwater such as from contaminated soil. A varying input term such as due to intermittent discharges to holding basins or wells would result in spikes in the chemical concentration profiles in the monitoring wells.

DATE: 08/01/90
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TABLE 6-14
CIRCUITRON CORPORATION SITE
LOWER DETECTION LIMIT VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW10-GW01	CC-MW11-GW01	CC-MW12-GW01	CC-MW1D-GW02	CC-MW1S-GW02	CC-MW2D-GW02	CC-MW2D-GWD2
DEPTH INTERVAL (FT)	23.9 - 28.9	25.1 - 30.1	25.1 - 30.1	90.0 -100.0	25.0 - 35.0	90.0 -100.0	90.0 -100.0
**VOLATILE PARAMETERS:							
DICHLORODIFLUOROMETHANE	---	---	---	---	20.000	---	---
1,1-DICHLOROETHENE	1.000	2.000	23.000J	3.700	8.100	7.500	9.500
1,1-DICHLOROETHANE	---	1.000	10.000	1.000	6.600	1.800	2.000
1,1,1-TRICHLOROETHANE	20.000	43.000J	380.000J	23.000	1,181.000J	35.000	42.000
1,2-DICHLOROETHANE	---	---	1.000	---	---	---	---
TRICHLOROETHENE	---	---	4.000	10.000	---	8.700	8.900
TETRACHLOROETHENE	---	2.000	33.000J	20.000	---	24.000	30.000
1,2,3-TRICHLOROPROPANE	4.000J	0.500R	0.500R	---	---	---	---
ACETONE	---	8.000J	13.000J	1.000R	1.000R	1.000R	1.000R
TOTAL TICS	NR	NR	NR	NR	NR	NR	NR
TIC CONCENTRATION	NR	NR	NR	NR	NR	NR	NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-14 (CON'T)
CIRCUITRON CORPORATION SITE
LOWER DETECTION LIMIT VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID DEPTH INTERVAL (FT)	CC-MW2S-GW02 25.0 - 35.0	CC-MW3D-GW02 90.0 -100.0	CC-MW3S-GW02 28.0 - 38.0	CC-MW4D-GW02 90.0 -100.0	CC-MW4S-GW02 24.0 - 34.0	CC-MW5D-GW02 90.0 -100.0	CC-MW5S-GW02 24.0 - 34.0
**VOLATILE PARAMETERS:							
DICHLORODIFLUOROMETHANE	---	---	---	---	---	---	---
1,1-DICHLOROETHENE	---	11.000	---	4.200	---	1.600	0.800J
1,1-DICHLOROETHANE	---	0.900J	0.600J	2.000	---	1.000	4.200
1,1,1-TRICHLOROETHANE	5.400	61.000	78.000	19.000	---	6.600	115.000J
1,2-DICHLOROETHANE	---	---	---	---	25.000	---	---
TRICHLOROETHENE	---	2.800	---	27.000	7.400	9.300	0.900J
TETRACHLOROETHENE	---	9.300	0.800J	28.000	87.000	13.000	8.900
1,2,3-TRICHLOROPROPANE	---	---	---	---	---	---	---
ACETONE	1.000R	1.000R	1.000R	1.000R	1.000R	1.000R	1.000R
TOTAL TICS	NR	NR	NR	NR	1	NR	1
TIC CONCENTRATION	NR	NR	---	---	1,900.000NJ	---	4.000J

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-14 (CON'T)
CIRCUITRON CORPORATION SITE
LOWER DETECTION LIMIT VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW5S-GWD2	CC-MW6D-GW02	CC-MW6S-GW02	CC-MW7D-GW02	CC-MW7S-GW02	CC-MW8-GW01	CC-MW9-GW01
DEPTH INTERVAL (FT)	24.0 - 34.0	90.0 -100.0	24.8 - 34.8	90.0 -100.0	27.0 - 37.0	24.8 - 29.8	24.1 - 29.1
**VOLATILE PARAMETERS:							
DICHLORODIFLUOROMETHANE	---	---	---	---	---	6.000	---
1,1-DICHLOROETHENE	1.100	5.800	1.200	5.500	---	6.000	---
1,1-DICHLOROETHANE	4.900	1.600	1.000J	0.900J	---	11.000J	---
1,1,1-TRICHLOROETHANE	134.000J	19.000	97.000	19.000	---	110.000J	2.000
1,2-DICHLOROETHANE	---	---	---	---	---	---	---
TRICHLOROETHENE	1.100	27.000	---	13.000	---	---	---
TETRACHLOROETHENE	10.000	38.000	0.700J	18.000	---	---	---
1,2,3-TRICHLOROPROPANE	---	---	---	---	---	0.500R	0.500R
ACETONE	1.000R	1.000R	1.000R	1.000R	1.000R	---	---
TOTAL TICS	1	1	NR	NR	NR	1	NR
TIC CONCENTRATION	5.000NJ	8.000NJ	---	---	---	0.600J	NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-14 (CON'T)
CIRCUITRON CORPORATION SITE
LOWER DETECTION LIMIT VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

AMPLE ID	CC-MW9-GWD1	CC-PW01-GW01	CC-PW02-GW01
EPTH INTERVAL (FT)	24.1 - 29.1	575.0 -585.0	216.3 -226.3
*VOLATILE PARAMETERS:			
ICHLORODIFLUOROMETHANE	---	---	1.000R
,1-DICHLOROETHENE	---	---	1.000
,1-DICHLOROETHANE	---	---	---
,1,1-TRICHLOROETHANE	3.000	---	7.000
,2-DICHLOROETHANE	---	---	---
RICHLOROETHENE	---	0.600J	21.000
ETRACHLOROETHENE	---	---	4.000
,2,3-TRICHLOROPROPANE	0.500R	---	---
CETONE	---	1.000R	1.000R
OTAL TICS	NR	NR	NR
IC CONCENTRATION	NR	---	---

XPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-15
CIRCUITRON CORPORATION SITE
VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUND 1 OF GROUNDWATER SAMPLING (IN UG/L)

MPLE ID	CC-MW1D-GW01	CC-MW1S-GW01	CC-MW2D-GW01	CC-MW2S-GW01	CC-MW3D-GW01	CC-MW3S-GW01	CC-MW4D-GW01
REENED INTERVAL (FT)	90.0 -100.0	25.0 - 35.0	90.0 -100.0	25.0 - 35.0	90.0 -100.0	28.0 - 38.0	90.0 -100.0
L VOLATILE PARAMETERS:							
1-DICHLOROETHENE	3.000J	---	5.000	1.000R	6.000J	---	0.900J
1-DICHLOROETHANE	1.000J	---	2.000	0.400J	1.000R	---	1.000
ANS-1,2-DICHLOROETHENE	5.000J	---	4.000	1.000R	1.000R	---	6.000
LOROFORM	24.000J	---	---	1.000R	1.000R	---	5.000
,2-DICHLOROETHANE	---	---	---	2.000J	---	---	---
-BUTANONE	---	---	---	1.000J	1.000R	---	---
,1,1-TRICHLOROETHANE	28.000J	760.000	33.000	2.000J	38.000J	8.000J	8.000
RICHLOROETHENE	18.000J	---	10.000	1.000R	3.000J	---	12.000
ENZENE	---	---	---	1.000R	1.000R	3.000J	---
ETRACHLOROETHENE	29.000J	---	25.000	1.000R	7.000J	---	11.000
OTAL TICS	NR	NR	NR	NR	NR	NR	1
IC CONCENTRATION	---	---	---	---	---	---	2.000J

XPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-15 (CON'T)
CIRCUITRON CORPORATION SITE
VOLATILE ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUND 1 OF GROUNDWATER SAMPLING (IN UG/L)

AMPLE ID CREENED INTERVAL (FT)	CC-MW4S-GW01 24.0 - 34.0	CC-MW5D-GW01 90.0 -100.0	CC-MW5S-GW01 24.0 - 34.0	CC-MW6D-GW01 90.0 -100.0	CC-MW6S-GW01 24.8 - 34.8	CC-MW7D-GW01 90.0 -100.0	CC-MW7S-GW01 27.0 - 37.0
CL VOLATILE PARAMETERS:							
,1-DICHLOROETHENE	12.000J	---	0.600J	2.000	1.000R	7.000J	---
,1-DICHLOROETHANE	17.000J	---	6.000	1.000	1.000R	1.000J	---
RANS-1,2-DICHLOROETHENE	---	---	---	9.000	1.000R	5.000J	---
HLOROFORM	---	31.000	---	---	1.000R	2.000J	---
,2-DICHLOROETHANE	---	---	1.000J	---	1.000R	---	---
-BUTANONE	---	---	---	---	1.000R	---	---
,1,1-TRICHLOROETHANE	4,600.000D	---	91.000 J	12.000	95.000J	37.000J	---
RICHLOROETHENE	14.000J	0.900J	1.000	18.000	1.000R	17.000J	---
ENZENE	---	---	---	---	1.000R	---	---
ETRACHLOROETHENE	110.000	---	11.000	31.000	1.000R	31.000J	---
OTAL TICS	NR	NR	NR	1	NR	NR	NR
IC CONCENTRATION	---	---	---	9.000J	---	---	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-16
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW10-GW01	CC-MW11-GW01	CC-MW12-GW01	CC-MW1D-GW01	CC-MW1D-GW02	CC-MW1S-GW01	CC-MW1S-GW02
SCREENED INTERVAL (FT)	23.9 - 28.9	25.1 - 30.1	25.1 - 30.1	90.0 -100.0	90.0 -100.0	25.0 - 35.0	25.0 - 35.0
BASE/NEUTRAL PARAMETERS:							
PHENANTHRENE	---	---	---	---	---	---	---
DI-n-BUTYLPHTHALATE	---	---	---	---	---	---	---
FLUORANTHRENE	---	---	---	---	---	---	---
PYRENE	---	---	---	---	---	---	---
CHRYSENE	---	---	---	---	---	---	---
DI-n-OCTYL PHTHALATE	---	---	---	---	---	---	---
TOTAL TICS	NR	NR	NR	NR	1	2	NR
TIC CONCENTRATION	0.000X	0.000X	0.000X	0.000X	8.000J	17.000J	0.000X
**PESTICIDE/PCB PARAMETERS:							

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-16 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW2D-GW01	CC-MW2D-GW02	CC-MW2D-GWD2	CC-MW2S-GW01	CC-MW2S-GW02	CC-MW3D-GW01	CC-MW3D-GW02
SCREENED INTERVAL (FT)	90.0 -100.0	90.0 -100.0	90.0 -100.0	25.0 - 35.0	25.0 - 35.0	90.0 -100.0	90.0 -100.0
BASE/NEUTRAL PARAMETERS:							
PHENANTHRENE	---	---	---	---	---	---	---
DI-n-BUTYLPHTHALATE	2.000J	---	---	---	---	---	---
FLUORANTHRENE	---	---	---	---	---	---	---
PYRENE	---	---	---	---	---	---	---
CHRYSENE	---	---	---	---	---	---	---
DI-n-OCTYL PHTHALATE	---	---	---	---	---	---	---
TOTAL TICS	3	2	2	NR	NR	1	1
TIC CONCENTRATION	39.000J	30.000J	28.000J	0.000X	0.000X	8.000J	10.000J

**PESTICIDE/PCB PARAMETERS:

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-16 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW3S-GW01	CC-MW3S-GW02	CC-MW4D-GW01	CC-MW4D-GW02	CC-MW4S-GW01	CC-MW4S-GW02	CC-MW5D-GW01
SCREENED INTERVAL (FT)	28.0 - 38.0	28.0 - 38.0	90.0 -100.0	90.0 -100.0	24.0 - 34.0	24.0 - 34.0	90.0 -100.0
BASE/NEUTRAL PARAMETERS:							
PHENANTHRENE	---	---	---	---	---	---	---
DI-n-BUTYLPHTHALATE	---	---	---	---	---	---	---
FLUORANTHRENE	---	---	---	---	---	---	---
PYRENE	---	---	---	---	---	---	---
CHRYSENE	---	---	---	---	---	---	---
DI-n-OCTYL PHTHALATE	---	---	---	---	---	---	---
TOTAL TICS	NR	1	NR	2	1	2	1
TIC CONCENTRATION	0.000X	8.000J	0.000X	30.000J	12.000J	60.000J	11.000J

**PESTICIDE/PCB PARAMETERS:

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-16 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW5D-GW02	CC-MW5D-GWD1	CC-MW5S-GW01	CC-MW5S-GW02	CC-MW5S-GWD2	CC-MW6D-GW01	CC-MW6D-GW02
SCREENED INTERVAL (FT)	90.0 -100.0	90.0 -100.0	24.0 - 34.0	24.0 - 34.0	24.0 - 34.0	90.0 -100.0	90.0 -100.0
BASE/NEUTRAL PARAMETERS:							
PHENANTHRENE	---	---	---	---	---	---	---
DI-n-BUTYLPHTHALATE	---	---	---	---	---	---	---
FLUORANTHRENE	---	---	---	---	---	---	---
PYRENE	---	---	---	---	---	---	---
CHRYSENE	---	---	---	---	---	---	---
DI-n-OCTYL PHTHALATE	---	---	---	---	---	---	---
TOTAL TICS	1	2	NR	1	1	NR	1
TIC CONCENTRATION	30.000J	19.000J	0.000X	20.000J	10.000J	0.000X	20.000J

**PESTICIDE/PCB PARAMETERS:

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-16 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER
DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW6S-GW01	CC-MW6S-GW02	CC-MW7D-GW01	CC-MW7D-GW02	CC-MW7D-GWD1	CC-MW7S-GW01	CC-MW7S-GW02
SCREENED INTERVAL (FT)	24.8 - 34.8	24.8 - 34.8	90.0 -100.0	90.0 -100.0	90.0 - 0.0	27.0 - 37.0	27.0 - 37.0
BASE/NEUTRAL PARAMETERS:							
PHENANTHRENE	---	---	---	---	---	---	---
DI-n-BUTYLPHTHALATE	---	---	2.000J	---	1.000J	1.000J	---
FLUORANTHRENE	---	---	---	---	---	---	---
PYRENE	---	---	---	---	---	---	---
CHRYSENE	---	---	---	---	---	---	---
DI-n-OCTYL PHTHALATE	---	---	---	---	---	---	---
TOTAL TICS	NR	NR	1	3	1	1	NR
TIC CONCENTRATION	0.000X	0.000X	9.000J	90.000J	9.000J	9.000J	0.000X

**PESTICIDE/PCB PARAMETERS:

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-16 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

AMPLE ID	CC-MW8-GW01	CC-MW9-GW01	CC-MW9-GWD1	CC-PW01-GW01	CC-PW02-GW01
CREENED INTERVAL (FT)	24.8 - 29.8	24.1 - 29.1	24.1 - 29.1	575.0 -585.0	216.3 -226.3
ASE/NEUTRAL PARAMETERS:					
HENANTHRENE	---	---	---	---	---
I-n-BUTYLPHTHALATE	---	---	---	95.000B	---
LUORANTHRENE	---	---	---	---	---
YRENE	---	---	---	---	---
HRYSENE	---	---	---	---	---
I-n-OCTYL PHTHALATE	---	---	---	---	---
OTAL TICS	NR	NR	NR	NR	NR
IC CONCENTRATION	0.000X	0.000X	0.000X	---	---

*PESTICIDE/PCB PARAMETERS:

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-17
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

AMPLE ID	CC-MW10-GW01	CC-MW10-GW01	CC-MW11-GW01	CC-MW11-GW01	CC-MW12-GW01	CC-MW12-GW01	CC-MW1D-GW01
EPTH INTERVAL (FT)	23.9 - 28.9	23.9 - 28.9	25.1 - 30.1	25.1 - 30.1	25.1 - 30.1	25.1 - 30.1	90.0 -100.0
NALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
LUMINUM	---	2,840.000	---	8,450.000	1,290.000	2,860.000	---
NTIMONY	---	---	---	---	---	---	---
RSENIC	---	---	2.200B	6.600B	2.800B	2.700B	---
BARIUM	---	49.300B	35.000B	89.200B	32.000B	46.500B	96.400BJ
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	38,000.000	35,900.000	42,500.000J	35,700.000J	21,900.000	20,300.000	11,500.000
CHROMIUM	---	12.800J	---	18.100J	---	---	---
COBALT	---	---	---	---	---	---	---
COPPER	225.000	538.000	25.000R	25.000R	25.000R	25.000R	12.000B
IRON	---	6,880.000	---	13,100.000	100.000R	4,250.000	181.000J
LEAD	---	5.000R	---	5.000R	5.000R	20.500J	2.400BJ
MAGNESIUM	5,370.000	5,540.000	7,220.000	7,200.000	3,310.000B	3,600.000B	3,760.000B
MANGANESE	84.100	178.000J	87.300	576.000J	566.000	628.000J	33.900
MERCURY	0.350 J	0.300 J	---	---	---	---	---
NICKEL	34.200B	43.700	30.200B	32.500B	74.500	70.200	10.700B
POTASSIUM	1,800.000B	2,300.000B	2,200.000B	2,700.000B	1,200.000B	---	3,850.000BJ
SELENIUM	---	---	---	---	---	---	1.300B J
SILVER	---	---	---	---	---	---	---
SODIUM	19,500.000J	20,700.000	19,600.000J	18,300.000	5,000.000R	5,000.000R	18,700.000
VANADIUM	---	---	---	---	---	---	---
ZINC	20.000R	20.000R	20.000R	20.000R	20.000R	20.000R	42.300J
CYANIDE	10.000NR	---	10.000NR	---	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW1D-GW01	CC-MW1D-GW02	CC-MW1D-GW02	CC-MW1S-GW01	CC-MW1S-GW01	CC-MW1S-GW02	CC-MW1S-GW02
DEPTH INTERVAL (FT)	90.0 -100.0	90.0 -100.0	90.0 -100.0	25.0 - 35.0	25.0 - 35.0	25.0 - 35.0	25.0 - 35.0
ANALYSIS	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:							
ALUMINUM	42.500B	36.100B	173.000BJ	---	864.000	---	34.200B
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	2.600B	---	---	4.500B	5.200B	4.800B	5.100B
BARIUM	98.300B	87.100B	94.300B	123.000BJ	121.000B	115.000B	117.000B
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	12,200.000	11,600.000	12,500.000	61,300.000	59,700.000	60,800.000	59,900.000
CHROMIUM	---	---	---	---	17.600J	---	---
COBALT	---	---	1.100B	---	---	---	---
COPPER	15.300B	---	10.200B	---	---	1.500B	---
IRON	100.000R	48.900B	303.000	17,900.000J	19,300.000	13,900.000	14,900.000
LEAD	5.000R	---	11.100	---	1.200B	---	---
MAGNESIUM	3,970.000B	3,700.000B	3,940.000B	4,950.000B	5,050.000	4,950.000B	4,950.000B
MANGANESE	37.800	36.500	41.800	468.000	470.000	393.000	389.000
MERCURY	---	0.200R	0.200R	---	---	0.200R	0.200R
NICKEL	---	---	---	---	---	---	---
POTASSIUM	2,320.000B	4,330.000BJ	4,340.000BJ	4,660.000BJ	3,330.000B	4,740.000BJ	4,710.000BJ
SELENIUM	1.300B	---	---	1.600B J	---	---	---
SILVER	---	---	---	---	---	---	---
SODIUM	18,100.000	20,700.000	19,700.000	10,000.000	9,570.000	9,910.000	9,780.000
VANADIUM	---	2.500B	3.000B	---	---	2.500B	3.900B
ZINC	20.000R	20.000R	20.000R	20.400J	75.600	12.500B	9.400B
CYANIDE	25.000	10.000NR	---	10.000NR	---	10.000NR	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING
ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

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SAMPLE ID	CC-MW2D-GW01	CC-MW2D-GW01	CC-MW2D-GW02	CC-MW2D-GW02	CC-MW2D-GWD2	CC-MW2D-GWD2	CC-MW2S-GW01
DEPTH INTERVAL (FT)	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	25.0 - 35.0
ANALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
ALUMINUM	200.000R	200.000R	---	246.000J	14.900B	165.000BJ	---
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	---	2.700B	---	---	---	---	---
BARIUM	162.000BJ	148.000B	140.000B	146.000B	146.000B	140.000B	26.000B
BERYLLIUM	---	---	---	---	---	---	2.000B
CALCIUM	11,200.000	11,000.000	10,300.000	10,200.000	10,600.000	10,100.000	26,700.000
CHROMIUM	---	---	---	21.300J	---	6.900BJ	---
COBALT	---	---	---	---	---	---	---
COPPER	---	10.700B	8.600B	8.600B	6.300B	7.800B	10.000B
IRON	290.000J	246.000J	232.000	583.000J	100.000R	352.000J	5,130.000
LEAD	1.700BJ	6.800	6.800	12.700	5.800	9.300	5.200J
MAGNESIUM	2,220.000B	2,060.000	1,760.000B	2,010.000B	1,840.000B	1,880.000B	2,880.000B
MANGANESE	416.000	403.000	382.000	385.000	396.000	374.000	486.000
MERCURY	---	---	0.200R	0.200R	0.200R	0.200R	---
NICKEL	---	---	---	---	---	---	24.000B
POTASSIUM	4,860.000BJ	3,230.000B	4,720.000BJ	4,320.000BJ	4,870.000BJ	4,390.000BJ	3,100.000B
SELENIUM	---	3.000B	---	---	---	---	---
SILVER	---	---	---	---	---	---	10.000R
SODIUM	17,800.000J	15,900.000J	16,300.000	16,600.000	16,900.000	15,900.000	7,190.000
VANADIUM	---	---	---	---	2.000B	---	---
ZINC	54.100J	43.200J	20.000R	20.000R	20.000R	20.000R	---
CYANIDE	10.000NR	10.000	10.000NR	---	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW2S-GW01	CC-MW2S-GW02	CC-MW2S-GW02	CC-MW3D-GW01	CC-MW3D-GW01	CC-MW3D-GW02	CC-MW3D-GW02
DEPTH INTERVAL (FT)	25.0 - 35.0	25.0 - 35.0	25.0 - 35.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0
ANALYSIS	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:							
ALUMINUM	321.000	12.800B	100.000B	48.800B	425.000	17.700B	146.000B
ANTIMONY	50.000R	---	---	---	---	---	---
ARSENIC	5.300B	1.800B	4.900B	---	---	---	---
BARIUM	29.000B	21.600B	26.200B	121.000BJ	116.000B	115.000B	118.000B
BERYLLIUM	3.000B	---	---	---	---	---	---
CALCIUM	25,100.000	22,900.000	22,700.000	20,300.000	21,100.000	20,400.000	20,500.000
CHROMIUM	6.000BJ	---	---	---	14.400J	---	11.300
COBALT	---	3.400B	---	---	---	7.900B	8.200B
COPPER	124.000	4.400B	64.100	8.900B	9.300B	---	5.600B
IRON	12,400.000	4,090.000	10,700.000	157.000J	515.000	100.000R	325.000
LEAD	---	---	---	2.800BJ	5.200	3.000J	14.400J
MAGNESIUM	2,900.000B	2,540.000BJ	2,570.000BJ	4,290.000B	4,400.000B	4,340.000BJ	4,140.000BJ
MANGANESE	460.000	356.000	351.000	1,610.000	1,640.000	1,490.000	1,510.000
MERCURY	---	0.200R	0.200R	---	---	0.200R	0.200R
NICKEL	15.000B	---	---	---	---	---	---
POTASSIUM	2,750.000B	2,740.000B	2,470.000B	4,330.000BJ	2,620.000B	3,460.000B	3,440.000B
SELENIUM	---	---	---	---	---	---	---
SILVER	10.000R	---	---	---	---	---	---
SODIUM	7,360.000	6,550.000	6,730.000	26,200.000	24,200.000	24,500.000	24,700.000
VANADIUM	---	---	---	---	---	---	---
ZINC	18.000B	34.100	53.300	50.700J	61.500	54.100	76.100
CYANIDE	---	10.000NR	---	10.000NR	17.500	10.000NR	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING
ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW3S-GW01	CC-MW3S-GW01	CC-MW3S-GW02	CC-MW3S-GW02	CC-MW4D-GW01	CC-MW4D-GW01	CC-MW4D-GW02
DEPTH INTERVAL (FT)	28.0 - 38.0	28.0 - 38.0	28.0 - 38.0	28.0 - 38.0	90.0 -100.0	90.0 -100.0	90.0 -100.0
ANALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
ALUMINUM	---	---	---	105.000B	---	---	19.800B
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	---	2.500B	1.400B	---	---	---	---
BARIUM	15.000B	16.000B	11.600B	14.600B	91.000BJ	88.400B	88.300B
BERYLLIUM	2.000B	3.000B	---	---	---	---	---
CALCIUM	23,300.000	22,300.000	21,400.000	22,400.000	12,000.000	12,700.000	12,700.000
CHROMIUM	---	8.000BJ	---	3.900B	---	---	---
COBALT	---	---	2.000B	3.600B	---	---	---
COPPER	13.000B	36.000	5.600B	33.800	---	9.300B	2.400B
IRON	6,890.000	12,000.000	8,200.000	14,900.000	48.500B	317.000	68.700B
LEAD	---	---	---	---	1.400BJ	5.000R	---
MAGNESIUM	3,020.000B	3,020.000B	2,470.000BJ	2,580.000BJ	3,810.000B	3,880.000B	3,840.000B
MANGANESE	502.000	474.000	449.000	480.000	30.400	32.500	30.100
MERCURY	---	---	0.200R	0.200R	---	---	0.200R
NICKEL	23.000B	22.000B	---	---	---	---	---
POTASSIUM	2,500.000B	2,470.000B	2,210.000B	2,440.000B	4,660.000BJ	3,250.000B	4,800.000BJ
SELENIUM	---	---	---	---	---	---	---
SILVER	10.000R	10.000R	---	---	---	---	---
SODIUM	10,300.000	10,700.000	7,480.000	7,490.000	19,600.000	18,500.000	18,900.000
VANADIUM	---	7.000B	---	---	---	---	3.100B
ZINC	10.000B	---	8.900B	10.200B	84.000J	110.000	20.000R
CYANIDE	10.000NR	---	10.000NR	---	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW4D-GW02	CC-MW4S-GW01	CC-MW4S-GW01	CC-MW4S-GW02	CC-MW4S-GW02	CC-MW5D-GW01	CC-MW5D-GW01
DEPTH INTERVAL (FT)	90.0 -100.0	24.0 - 34.0	24.0 - 34.0	24.0 - 34.0	24.0 - 34.0	90.0 -100.0	90.0 -100.0
ANALYSIS	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:							
ALUMINUM	126.000BJ	---	140.000B	18.600B	95.200B	374.000	512.000
ANTIMONY	---	50.000B	---	---	---	---	---
ARSENIC	1.400B	---	---	---	---	---	---
BARIUM	92.400B	33.000BJ	34.000BJ	47.800B	49.300B	70.300BJ	68.500B
BERYLLIUM	---	3.000B	3.000B	---	---	---	---
CALCIUM	13,400.000	17,900.000	17,400.000	23,600.000	24,100.000	10,500.000	10,500.000
CHROMIUM	5.900B	8.000BJ	16.000J	---	10.200	---	---
COBALT	---	---	---	1.300B	---	---	---
COPPER	7.000B	19.000B	29.000	11.000B	25.300	321.000	332.000
IRON	318.000	240.000	760.000	---	922.000	155.000J	256.000J
LEAD	10.600	---	---	---	3.400 J	5.000R	5.000R
MAGNESIUM	3,840.000B	2,060.000B	2,160.000B	2,970.000BJ	2,940.000BJ	2,770.000B	2,680.000B
MANGANESE	32.900	59.000	58.000	40.700	46.100	83.100	83.100
MERCURY	0.200R	---	---	0.200R	0.200R	---	---
NICKEL	---	15.000B	22.000B	---	17.200B	18.400B	---
POTASSIUM	5,810.000J	2,950.000B	2,780.000B	5,320.000	6,030.000	4,580.000BJ	2,580.000B
SELENIUM	---	---	---	---	---	---	1.300B
SILVER	---	10.000R	10.000R	---	---	---	---
SODIUM	18,900.000	6,410.000	6,510.000	11,400.000	11,700.000	20,900.000	19,600.000
VANADIUM	2.500B	8.000B	---	---	---	---	---
ZINC	20.000R	12.000B	18.000B	51.500	99.600	56.800J	56.300
CYANIDE	---	10.000NR	---	10.000NR	---	10.000NR	15.000

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW5D-GW02	CC-MW5D-GW02	CC-MW5D-GWD1	CC-MW5D-GWD1	CC-MW5S-GW01	CC-MW5S-GW01	CC-MW5S-GW02
DEPTH INTERVAL (FT)	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	24.0 - 34.0	24.0 - 34.0	24.0 - 34.0
ANALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
ALUMINUM	358.000J	520.000J	410.000	517.000	251.000	229.000	420.000
ANTIMONY	---	---	---	---	60.000R	---	---
ARSENIC	---	---	---	---	---	---	1.700B
BARIUM	66.400B	67.500B	69.500BJ	69.600B	38.000BJ	40.000BJ	40.100B
BERYLLIUM	---	---	---	---	2.000B	2.000B	---
CALCIUM	10,000.000	10,100.000	10,400.000	10,900.000	26,900.000	28,900.000	29,000.000
CHROMIUM	---	3.100B	---	15.200J	7.000BJ	10.000J	---
COBALT	---	---	---	---	---	---	2.600B
COPPER	275.000	287.000	317.000	366.000	49.000	48.000	69.300
IRON	95.400B	215.000	194.000J	384.000J	---	140.000	59.300B
LEAD	8.400	13.000	6.100J	5.000R	---	---	---
MAGNESIUM	2,560.000B	2,560.000B	2,730.000B	2,760.000B	3,510.000B	3,590.000B	4,300.000BJ
MANGANESE	81.000	82.600	83.200	85.600	294.000J	358.000J	204.000
MERCURY	0.200R	0.200R	---	---	---	---	0.200R
NICKEL	---	---	16.900B	26.000B	28.000B	---	28.500B
POTASSIUM	4,540.000BJ	4,440.000BJ	4,610.000BJ	3,060.000B	3,390.000B	2,890.000B	2,880.000B
SELENIUM	---	---	---	---	---	---	---
SILVER	---	---	---	---	10.000R	10.000R	---
SODIUM	19,100.000	19,200.000	20,300.000	19,400.000	12,700.000	12,400.000	14,500.000
VANADIUM	2.600B	3.100B	---	---	---	7.000B	---
ZINC	20.000R	20.000R	61.700J	73.100	15.000B	---	28.100
CYANIDE	10.000NR	---	10.000NR	15.000	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

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TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW5S-GW02	CC-MW5S-GWD2	CC-MW5S-GWD2	CC-MW6D-GW01	CC-MW6D-GW01	CC-MW6D-GW02	CC-MW6D-GW02
DEPTH INTERVAL (FT)	24.0 - 34.0	24.0 - 34.0	24.0 - 34.0	90.0 -100.0	90.0 -100.0	90.0 -100.0	90.0 -100.0
ANALYSIS	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:							
ALUMINUM	503.000	446.000J	613.000	---	148.000B	29.400B	367.000
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	2.000B	1.300B	1.200B	---	---	1.300B	1.000B
BARIUM	43.100B	43.000B	44.700B	87.700BJ	91.600B	89.400B	96.700B
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	29,800.000	28,200.000	29,300.000	12,300.000	13,900.000	11,700.000	12,100.000
CHROMIUM	16.200	3.100B	15.900	---	10.000R	---	6.200B
COBALT	3.300B	---	2.000B	---	---	4.300B	6.100B
COPPER	75.600	80.100	88.200	10.600B	29.800	---	---
IRON	203.000	65.500B	214.000	44.100B	100.000R	30.100B	311.000
LEAD	---	---	2.600B J	2.600BJ	26.600	---	---
MAGNESIUM	4,290.000BJ	4,390.000B	4,260.000BJ	3,480.000B	3,620.000B	3,480.000BJ	3,730.000BJ
MANGANESE	215.000	201.000	209.000	108.000	125.000	119.000	125.000
MERCURY	0.200R	0.200R	0.200R	---	---	0.200R	0.200R
NICKEL	36.700B	38.900B	36.700B	12.200B	24.500B	---	18.700B
POTASSIUM	2,930.000B	3,100.000B	2,770.000B	5,540.000J	3,930.000BJ	2,910.000B	2,970.000B
SELENIUM	---	---	---	---	1.300B	---	---
SILVER	---	---	---	---	---	---	---
SODIUM	15,000.000	14,600.000	14,900.000	26,200.000	24,800.000	25,600.000	25,500.000
VANADIUM	---	3.000B	---	---	---	---	---
ZINC	29.500	20.000R	37.100	20.000R	20.000R	24.500J	17.200BJ
CYANIDE	---	10.000NR	---	10.000NR	10.000	10.000NR	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW6S-GW01	CC-MW6S-GW01	CC-MW6S-GW02	CC-MW6S-GW02	CC-MW7D-GW01	CC-MW7D-GW01	CC-MW7D-GW02
DEPTH INTERVAL (FT)	24.8 - 34.8	24.8 - 38.4	24.8 - 34.8	24.8 - 34.8	90.0 -100.0	90.0 -100.0	90.0 -100.0
ANALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
ALUMINUM	---	1,680.000	72.600B	731.000	---	---	---
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	---	2.200B	---	---	---	---	---
BARIUM	24.600B	30.200B	16.600B	23.100B	126.000BJ	125.000B	118.000B
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	15,500.000	16,700.000	13,400.000	14,100.000	15,100.000	16,000.000	15,400.000
CHROMIUM	8.800B	10.000R	---	14.500	---	22.700J	---
COBALT	---	---	1.300B	---	---	---	---
COPPER	---	---	---	---	9.300B	---	---
IRON	68.100B	3,000.000	8.700B	1,110.000	126.000J	264.000	62.600B
LEAD	---	2.600B	---	---	---	3.500	---
MAGNESIUM	1,830.000B	2,080.000B	1,590.000BJ	1,610.000BJ	5,380.000	5,570.000	5,180.000
MANGANESE	26.900	103.000	18.100	44.200	30.400	34.900	28.100
MERCURY	---	---	0.200R	0.200R	---	---	0.200R
NICKEL	---	16.400B	---	---	---	17.500B	---
POTASSIUM	2,710.000B	1,220.000B	2,470.000B	2,450.000B	4,130.000BJ	2,670.000B	3,900.000BJ
SELENIUM	1.300B J	1.300B	---	---	1.600B J	1.300B	---
SILVER	---	---	---	---	---	---	---
SODIUM	8,810.000	8,160.000	5,160.000	5,360.000	14,900.000	14,200.000	14,700.000
VANADIUM	---	---	---	---	---	---	3.000B
ZINC	20.000R	20.000R	22.200	31.200	36.200J	27.600J	20.000R
CYANIDE	10.000NR	10.000	10.000NR	---	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW7D-GW02	CC-MW7D-GWD1	CC-MW7D-GWD1	CC-MW7S-GW01	CC-MW7S-GW01	CC-MW7S-GW02	CC-MW7S-GW02
DEPTH INTERVAL (FT)	90.0 -100.0	90.0 -100.0	90.0 -100.0	27.0 - 37.0	27.0 - 37.0	27.0 - 37.0	27.0 - 37.0
ANALYSIS	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:							
ALUMINUM	188.000BJ	---	---	---	---	---	14.000B
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	---	---	---	---	---	---	---
BARIUM	120.000B	121.000BJ	128.000B	57.300BJ	55.300B	55.800B	55.800B
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	15,600.000	15,600.000	16,400.000	18,000.000	18,500.000	18,400.000	18,000.000
CHROMIUM	4.200B	---	21.300J	---	---	---	---
COBALT	---	---	---	---	---	---	---
COPPER	3.900B	---	---	---	---	---	---
IRON	239.000	116.000J	299.000	37.900B	188.000	19.400B	44.000B
LEAD	14.600	1.400BJ	5.000R	---	---	---	---
MAGNESIUM	5,240.000	5,170.000	5,690.000	3,070.000B	3,150.000B	3,160.000B	3,180.000B
MANGANESE	30.100	29.600	34.100	77.400	114.000	22.700	30.500
MERCURY	0.200R	---	---	---	---	0.200R	0.200R
NICKEL	---	---	10.000B	---	---	---	---
POTASSIUM	3,650.000BJ	4,200.000BJ	2,820.000B	5,650.000J	4,160.000BJ	6,000.000J	5,660.000J
SELENIUM	---	1.300B J	1.300B	---	---	---	---
SILVER	---	---	---	---	---	---	---
SODIUM	14,400.000	14,700.000	14,500.000	18,700.000	18,000.000	17,800.000	17,800.000
VANADIUM	2.400B	---	---	---	---	2.000B	2.000B
ZINC	20.000R	14.500BJ	19.400B	28.700J	19.600BJ	20.000R	5.500B
CYANIDE	---	10.000NR	---	10.000NR	---	10.000NR	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-MW8-GW01	CC-MW8-GW01	CC-MW9-GW01	CC-MW9-GW01	CC-MW9-GWD1	CC-MW9-GWD1	CC-PW01-GW01
DEPTH INTERVAL (FT)	24.8 - 29.8	24.8 - 29.8	24.1 - 29.1	24.1 - 29.1	24.1 - 29.1	24.1 - 29.1	575.0 -585.0
ANALYSIS	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED	TOTAL	DISSOLVED
**INORGANIC PARAMETERS:							
ALUMINUM	---	4,300.000	180.000B	3,990.000	---	4,330.000	---
ANTIMONY	---	---	---	---	---	---	---
ARSENIC	---	4.000B	---	3.400B	---	2.600B	---
BARIUM	47.500B	85.500B	---	35.000BJ	---	269.000J	---
BERYLLIUM	---	---	---	---	---	---	---
CALCIUM	18,800.000	22,500.000	7,260.000	7,380.000	7,330.000	7,630.000	1,210.000B
CHROMIUM	59.400	870.000	45.400J	71.200	---	62.100	---
COBALT	---	---	---	---	---	---	---
COPPER	---	107.000	39.100J	84.200	24.600B	85.000	68.000J
IRON	152.000	17,300.000	435.000J	13,300.000	---	13,900.000	106.000
LEAD	5.000R	61.400J	5.000R	5.000R	---	104.000J	5.000R
MAGNESIUM	3,250.000B	4,580.000B	1,410.000B	2,210.000B	1,530.000B	2,220.000B	458.000B
MANGANESE	---	164.000J	19.700J	168.000J	---	181.000J	---
MERCURY	---	---	0.400J	---	0.700J	---	---
NICKEL	---	---	---	---	---	34.100B	---
POTASSIUM	2,900.000B	3,000.000B	1,300.000B	1,900.000B	1,200.000B	1,900.000B	---
SELENIUM	---	---	---	---	---	---	---
SILVER	---	---	---	---	---	---	---
SODIUM	31,800.000J	23,900.000J	5,000.000R	5,000.000R	5,000.000R	5,000.000R	2,850.000B
VANADIUM	---	---	---	---	---	---	---
ZINC	20.000R	20.000R	20.000R	20.000R	20.000R	20.000R	35.500
CYANIDE	10.000NR	---	10.000NR	---	10.000NR	---	10.000NR

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-17 (CON'T)
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER DURING ROUNDS 1 AND 2 OF GROUNDWATER SAMPLING (IN UG/L)

SAMPLE ID	CC-PW01-GW01	CC-PW02-GW01	CC-PW02-GW01
DEPTH INTERVAL (FT)	575.0 -585.0	216.3 -226.3	216.3 -226.3
ANALYSIS	TOTAL	DISSOLVED	TOTAL
**INORGANIC PARAMETERS:			
ALUMINUM	---	477.000J	130.000BJ
ANTIMONY	---	---	16.700B
ARSENIC	5.000R	---	---
BARIUM	25.600B	41.800B	33.500B
BERYLLIUM	---	---	---
CALCIUM	2,730.000B	5,620.000	5,300.000
CHROMIUM	---	3.000	---
COBALT	---	---	---
COPPER	88.400J	37.000	101.000
IRON	293.000	---	87.800BJ
LEAD	12.800J	1.900B J	2.100B J
MAGNESIUM	830.000B	2,410.000B	2,290.000B
MANGANESE	---	73.600	70.200
MERCURY	---	---	---
NICKEL	---	---	---
POTASSIUM	---	1,620.000B	1,320.000B
SELENIUM	---	---	1.200B J
SILVER	13.400	---	---
SODIUM	2,860.000B	7,280.000	6,780.000
VANADIUM	---	---	---
ZINC	42.000	29.500J	22.600J
CYANIDE	---	10.000NR	---

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-18
CIRCUITRON CORPORATION SITE
HEXAVALENT CHROMIUM AND CYANIDE DETECTED DURING ROUND 1 OF GROUNDWATER SAMPLING

SAMPLE ID	DEPTH INTERVAL (FEET)	HEXAVALENT CHROMIUM (MG/L)	CYANIDE (UG/L)
CC-MW8 -GW01	24.8 - 29.8	0.0050 U	ND
CC-MW9 -GW01	24.1 - 29.1	0.0050 U	ND
CC-MW10-GW01	23.9 - 28.9	0.0050 U	ND
CC-MW11-GW01	25.1 - 30.1	0.0153 J	ND
CC-MW12-GW01	25.1 - 30.1	0.0065 UJ	ND
CC-MW1D-GW01	90.0 - 100.0	0.0100 U	25.0
CC-MW1S-GW01	25.0 - 35.0	0.0100 R	ND
CC-MW2D-GW01	90.0 - 100.0	0.0100 U	10.0
CC-MW2S-GW01	25.0 - 35.0	0.0100 U	ND
CC-MW3D-GW01	90.0 - 100.0	0.0100 U	17.5
CC-MW3S-GW01	28.0 - 38.0	0.0100 U	ND
CC-MW4D-GW01	90.0 - 100.0	0.0100 U	ND
CC-MW4S-GW01	24.0 - 34.0	0.0100 U	ND
CC-MW5D-GW01	90.0 - 100.0	0.0100 U	15.0
CC-MW5S-GW01	24.0 - 34.0	0.0100 U	ND
CC-MW6D-GW01	90.0 - 100.0	0.0100 U	10.0
CC-MW6S-GW01	24.8 - 38.4	0.0100 U	10.0
CC-MW7D-GW01	90.0 - 100.0	0.0100 U	ND
CC-MW7S-GW01	27.0 - 37.0	0.0100 U	ND
CC-PW01-GW01	575.0 - 585.0	0.0200 R	ND
CC-PW02-GW01	216.3 - 226.3	0.5000 R	ND

NOTES:
ND = NOT DETECTED
R = REJECTED VALUE
U = BELOW THE DETECTION LIMIT
J = ESTIMATED VALUE

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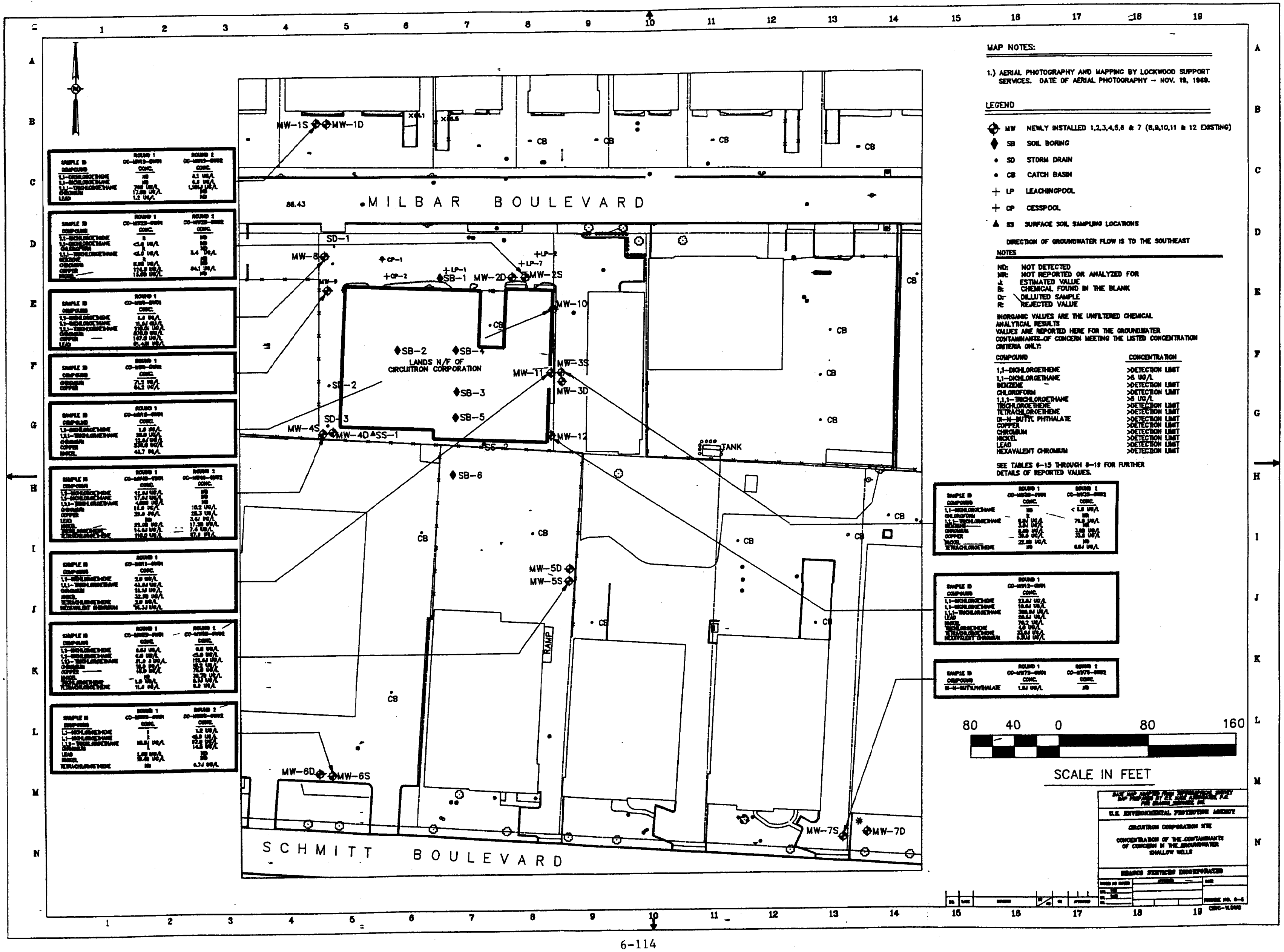
TABLE 6-19
CIRCUITRON CORPORATION SITE
HEXAVALENT CHROMIUM AND CYANIDE DETECTED DURING ROUND 2 OF GROUNDWATER SAMPLING

SAMPLE ID	DEPTH INTERVAL (FEET)	HEXAVALENT CHROMIUM (MG/L)	CYANIDE (UG/L)
CC-MW1D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW1S-GW02	25.0 - 35.0	20.000 R	ND
CC-MW2D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW2S-GW02	25.0 - 35.0	20.000 R	ND
CC-MW3D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW3S-GW02	28.0 - 38.0	20.000 R	ND
CC-MW4D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW4S-GW02	24.0 - 34.0	20.000 R	ND
CC-MW5D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW5S-GW02	24.0 - 34.0	20.000 R	ND
CC-MW6D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW6S-GW02	24.8 - 38.4	20.000 R	ND
CC-MW7D-GW02	90.0 - 100.0	20.000 R	ND
CC-MW7S-GW02	27.0 - 37.0	20.000 R	ND

NOTES:
ND = NOT DETECTED
R = REJECTED VALUE
U = BELOW THE DETECTION LIMIT
J = ESTIMATED VALUE

1

REVISION NO.
07/27/90



MAP NOTES:

1.) AERIAL PHOTOGRAPHY AND MAPPING BY LOCKWOOD SUPPORT SERVICES. DATE OF AERIAL PHOTOGRAPHY – NOV. 19, 1989.

LEGEND

⊕	MW	NEWLY INSTALLED 1,2,3,4,5,6 & 7 (8,9,10,11 & 12 EXISTING)
◆	SB	SOIL BORING
•	SD	STORM DRAIN
•	CB	CATCH BASIN
+	LP	LEACHINGPOOL
+	CP	CESSPOOL
▲	SS	SURFACE SOIL SAMPLING LOCATIONS

DIRECTION OF GROUNDWATER FLOW IS TO THE SOUTHEAST

NOTES

ND: NOT DETECTED
NR: NOT REPORTED OR ANALYZED FOR
J: ESTIMATED VALUE
B: CHEMICAL FOUND IN THE BLANK
D: DILLUTED SAMPLE
R: REJECTED VALUE

INORGANIC VALUES ARE THE UNFILTERED CHEMICAL ANALYTICAL RESULTS

VALUES ARE REPORTED HERE FOR THE GROUNDWATER CONTAMINANTS OF CONCERN MEETING THE LISTED CONCENTRATION CRITERIA ONLY:

COMPOUND	CONCENTRATION
1,1-DICHLOROETHENE	>DETECTION LIMIT
1,1-DICHLOROETHANE	>5 UG/L
BENZENE	>DETECTION LIMIT
CHLOROFORM	>DETECTION LIMIT
1,1,1-TRICHLOROETHANE	>5 UG/L
TRICHLOROETHENE	>DETECTION LIMIT
TETRACHLOROETHENE	>DETECTION LIMIT
DI-N-BUTYL PHTHALATE	>DETECTION LIMIT
COPPER	>DETECTION LIMIT
CHROMIUM	>DETECTION LIMIT
NICKEL	>DETECTION LIMIT
LEAD	>DETECTION LIMIT
HEXAVALENT CHROMIUM	>DETECTION LIMIT

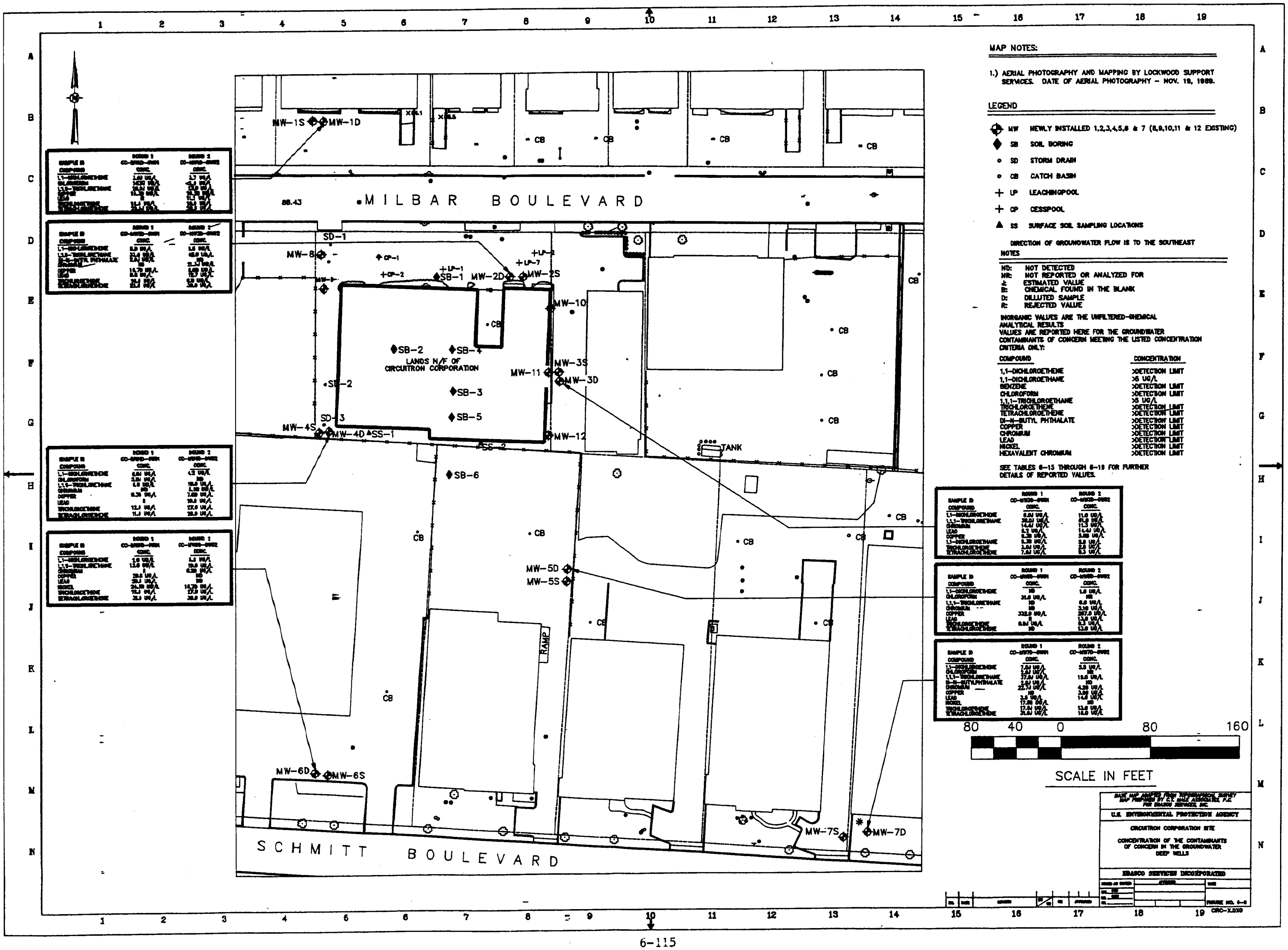
SEE TABLES 6-15 THROUGH 6-19 FOR FURTHER DETAILS OF REPORTED VALUES.

U.S. ENVIRONMENTAL PROTECTION AGENCY

CIRCUITRON CORPORATION SITE

CONCENTRATION OF THE CONTAMINANTS
OF CONCERN IN THE GROUNDWATER
SHALLOW WELLS

EBASCO SERVICES INCORPORATED



SAMPLE ID COMPOUND	ROUND 1 CO-MW1D-GW01 CONC.	ROUND 2 CO-MW1D-GW02 CONC.
1,1-DICHLOROETHENE	3.0J UG/L	3.7 UG/L
CHLOROFORM	[illegible] UG/L	<5.0 UG/L
1,1,1-TRICHLOROETHANE	28.0J UG/L	23.0 UG/L
COPPER	11.70 UG/L	16.70 UG/L
LEAD	R	11.1 UG/L
TRICHLOROETHENE	11.4 UG/L	10.4 UG/L
TETRACHLOROETHENE	[illegible] UG/L	[illegible] UG/L

SAMPLE ID COMPOUND	ROUND 1 CO-MW2D-GW01 CONC.	ROUND 2 CO-MW2D-GW02 CONC.
1,1-DICHLOROETHENE	5.0 UG/L	1.5 UG/L
1,1,1-TRICHLOROETHANE	31.4 UG/L	42.0 UG/L
DI-N-BUTYL PHTHALATE	2.0J UG/L	ND
CHROMIUM	ND	21.3J UG/L
COPPER	15.70 UG/L	6.60 UG/L
LEAD	5.8 UG/L	12.7 UG/L
TRICHLOROETHENE	14.4 UG/L	6.0 UG/L
TETRACHLOROETHENE	23.0 UG/L	30.0 UG/L

SAMPLE ID COMPOUND	ROUND 1 CO-MW4D-GW01 CONC.	ROUND 2 CO-MW4D-GW02 CONC.
1,1-DICHLOROETHENE	6.0J UG/L	4.2 UG/L
CHLOROFORM	3.0J UG/L	ND
1,1,1-TRICHLOROETHANE	4.0 UG/L	10.0 UG/L
CHROMIUM	ND	5.30 UG/L
COPPER	8.30 UG/L	7.00 UG/L
LEAD	R	10.0 UG/L
TRICHLOROETHENE	12.0 UG/L	27.0 UG/L
TETRACHLOROETHENE	11.0 UG/L	26.0 UG/L

SAMPLE ID COMPOUND	ROUND 1 CO-MW6D-GW01 CONC.	ROUND 2 CO-MW6D-GW02 CONC.
1,1-DICHLOROETHENE	2.0 UG/L	5.0 UG/L
1,1,1-TRICHLOROETHANE	13.0 UG/L	19.0 UG/L
CHROMIUM	R	6.20 UG/L
COPPER	29.5 UG/L	ND
LEAD	26.1 UG/L	ND
NICKEL	24.30 UG/L	14.70 UG/L
TRICHLOROETHENE	15.0 UG/L	27.0 UG/L
TETRACHLOROETHENE	31.0 UG/L	36.0 UG/L

MAP NOTES:

1.) AERIAL PHOTOGRAPHY AND MAPPING BY LOCKWOOD SUPPORT SERVICES. DATE OF AERIAL PHOTOGRAPHY – NOV. 19, 1989.

LEGEND

⊕	MW	NEWLY INSTALLED 1,2,3,4,5,6 & 7 (8,9,10,11 & 12 EXISTING)
◆	SB	SOIL BORING
○	SD	STORM DRAIN
○	CB	CATCH BASIN
+	LP	LEACHINGPOOL
+	CP	CESSPOOL
▲	SS	SURFACE SOIL SAMPLING LOCATIONS

DIRECTION OF GROUNDWATER FLOW IS TO THE SOUTHEAST

NOTES

ND:	NOT DETECTED
NR:	NOT REPORTED OR ANALYZED FOR
J:	ESTIMATED VALUE
B:	CHEMICAL FOUND IN THE BLANK
D:	DILLUTED SAMPLE
R:	REJECTED VALUE

INORGANIC VALUES ARE THE UNFILTERED-CHEMICAL ANALYTICAL RESULTS

VALUES ARE REPORTED HERE FOR THE GROUNDWATER CONTAMINANTS OF CONCERN MEETING THE LISTED CONCENTRATION CRITERIA ONLY:

COMPOUND	CONCENTRATION
1,1-DICHLOROETHENE	>DETECTION LIMIT
1,1-DICHLOROETHANE	>5 UG/L
BENZENE	>DETECTION LIMIT
CHLOROFORM	>DETECTION LIMIT
1,1,1-TRICHLOROETHANE	>5 UG/L
TRICHLOROETHENE	>DETECTION LIMIT
TETRACHLOROETHENE	>DETECTION LIMIT
DI-N-BUTYL PHTHALATE	>DETECTION LIMIT
COPPER	>DETECTION LIMIT
CHROMIUM	>DETECTION LIMIT
LEAD	>DETECTION LIMIT
NICKEL	>DETECTION LIMIT
HEXAVALENT CHROMIUM	>DETECTION LIMIT

SEE TABLES 6-15 THROUGH 6-19 FOR FURTHER DETAILS OF REPORTED VALUES.

SAMPLE ID COMPOUND	ROUND 1 CO-MW3D-GW01 CONC.	ROUND 2 CO-MW3D-GW02 CONC.
1,1-DICHLOROETHENE	8.0J UG/L	11.0 UG/L
1,1,1-TRICHLOROETHANE	38.0J UG/L	61.0 UG/L
CHROMIUM	14.4J UG/L	11.3 UG/L
LEAD	6.2 UG/L	14.4J UG/L
COPPER	9.30 UG/L	5.00 UG/L
1,1-DICHLOROETHANE	9.30 UG/L	5.0 UG/L
TRICHLOROETHENE	3.0J UG/L	2.8 UG/L
TETRACHLOROETHENE	7.0J UG/L	8.3 UG/L

SAMPLE ID COMPOUND	ROUND 1 CO-MW5D-GW01 CONC.	ROUND 2 CO-MW5D-GW02 CONC.
1,1-DICHLOROETHENE	ND	1.6 UG/L
CHLOROFORM	31.0 UG/L	NR
1,1,1-TRICHLOROETHANE	ND	6.0 UG/L
CHROMIUM	ND	3.10 UG/L
COPPER	332.0 UG/L	287.0 UG/L
LEAD	R	13.0 UG/L
TRICHLOROETHENE	0.8J UG/L	9.3 UG/L
TETRACHLOROETHENE	ND	13.0 UG/L

SAMPLE ID COMPOUND	ROUND 1 CO-MW7D-GW01 CONC.	ROUND 2 CO-MW7D-GW02 CONC.
1,1-DICHLOROETHENE	7.0J UG/L	5.5 UG/L
CHLOROFORM	2.0J UG/L	NR
1,1,1-TRICHLOROETHANE	37.0J UG/L	19.0 UG/L
DI-N-BUTYLPHTHALATE	2.0J UG/L	ND
CHROMIUM	22.7J UG/L	4.20 UG/L
COPPER	ND	3.90 UG/L
LEAD	3.5 UG/L	14.6 UG/L
NICKEL	17.90 UG/L	ND
TRICHLOROETHENE	17.0J UG/L	13.0 UG/L
TETRACHLOROETHENE	31.0J UG/L	18.0 UG/L

BASE MAP ADAPTED FROM TOPOGRAPHICAL SURVEY MAP PREPARED BY C.T. MALE ASSOCIATES, P.C. FOR EBASCO SERVICES, INC.

U.S. ENVIRONMENTAL PROTECTION AGENCY

CIRCUITRON CORPORATION SITE

CONCENTRATION OF THE CONTAMINANTS OF CONCERN IN THE GROUNDWATER DEEP WELLS

EBASCO SERVICES INCORPORATED

FIGURE NO. 6-6

CIRC-X.DXG

TABLE 6-20

CIRCUITRON CORPORATION SITE

CONCENTRATION RANGES AND FREQUENCY OF OCCURRENCE OF VOLATILE ORGANICS IN GROUNDWATER

	ROUND 1		ROUND 2	
COMPOUND	FREQUENCY OF OCCURRENCE	CONCENTRATION RANGE[1/]	FREQUENCY OF OCCURRENCE	CONCENTRATION RANGE[1/]
1,1-Dichloroethene	0.67	0.6 - 12.0	0.70	0.8 - 23.0
1,1-Dichloroethane	0.67	0.4 - 17.0	0.70	0.6 - 11.0
Trans-1,2-dichloroethene	0.45	4.0 - 9.0	0.22	3.0 - 9.8
Chloroform	0.36	2.0 - 31.0	0.22	1.2 - 207.0
1,2-Dichloroethane	0.15	1.0 - 2.0	0.09	1.0 - 25.0
2-Butanone	0.08	1.0	- [2/]	
1,1,1-Trichloroethane	0.86	2.0 - 4600.0	0.87	2.0 - 1181.0
Trichloroethene	0.75	0.9 - 18.0	0.57	0.7 - 27.0
Benzene	0.09	3.0	-	
Tetrachloroethene	0.67	7.0 - 110.0	0.65	0.7 - 87.0

Notes: [1/] Units are ug/l
[2/] "-" indicates that compound was not detected in this round

The two compounds (benzene and 2-butanone) present in the round I samples only were detected in on-site wells MW-3S and MW-2S, respectively, at low concentrations. The remaining ten analytes in the Round II samples were all expanded volatiles list analytes. All of these compounds were found infrequently (range: 4 to 13%) in the monitoring wells sampled. Two freon compounds (chlorodifluoromethane and dichlorofluoromethane) represented the dominant contaminants in this expanded list on a concentration basis; most of the remaining contaminants in this group were present at concentrations less than 5 ug/l.

Seven volatile organic compounds were the most abundant from both a concentration and frequency of occurrence basis. These include: 1,1-dichloroethene, 1,1-dichloroethane, trans-1,2-dichloroethene, chloroform, 1,1,1-trichloroethane, trichloroethene and tetrachloroethene. 1,1,1-Trichloroethane was present at the greatest concentrations relative to the other volatile organics analyzed.

Spatial Variation

Total volatile concentrations varied widely in the twelve shallow wells and even between wells in close proximity (e.g., MW-8 and MW-9). The greatest total volatile concentrations in the wells located north of the building (MW-1S, MW-2S, MW-8, MW-9 and MW-10) was in MW-1S (760 ug/l) which was located north of the property across Milbar Boulevard. This was an unexpected result since this well was located to represent the upgradient, off-site (and presumed uncontaminated) well. Among the four wells located on the eastern side of the Circuitron building (MW-3S, MW-10, MW-11 and MW-12), the maximum volatile concentration (464 ug/l) was present in MW-12. The four remaining wells south of the building (see Figure 4-1) (MW-4S, MW-5S, MW-6S and MW-7S) included both the maximum volatiles concentration of all wells (MW-4S, 4,753 ug/l) and the only uncontaminated groundwater sample (MW-7S). The total volatiles analysis of the shallow wells suggests that the site is contributing to groundwater contamination but that it does not appear to be the only source of this contamination, since several of the contaminants detected on-site were also detected in the upgradient and downgradient wells at concentrations somewhat lower.

The compound which dominated the total volatile concentration in all shallow wells sampled was 1,1,1-trichloroethane (111-TCA); this compound was the only contaminant identified in three monitoring wells (MW-1S, MW-6S, and MW-9). The evaluation of whether the site contributed contamination to the groundwater is complicated by the fact that there was such a wide variation in 111-TCA concentrations in the shallow wells. The following discussion evaluates the potential contribution of the site to groundwater contamination and whether multiple plumes may exist below the Circuitron Corporation Site. To assist in this evaluation, the following wells or well groupings will be emphasized in the analyses:

either the discharge rate to this pool was not sufficient to provide contamination to the groundwater or the well placement was not close enough to assess the plume. The discharge rate to this SPDES pool was not available to conclusively evaluate which of these conclusions was valid.

MW-4S, installed by Ebasco, was located on the southwest corner of the Circuitron building near the old rinse tank. This well was the most contaminated of all the shallow wells sampled. The very high concentrations of volatiles in this monitoring well boring, most notably 111-TCA, suggest that the spent solutions have been discharged directly to the ground from this tank. The maximum 111-TCA soil concentration (100,000 ug/kg) was located at the water table which probably resulted in the large 111-TCA concentrations observed in the well water sample (4,600 ug/l).

To evaluate off-site contaminant migration, the suite of compounds identified in MW-5S was compared to those found in MW-4S and MW-12 (both of which are upgradient of MW-5S); the compounds found at MW-5S appear to be a hybrid of those found at MW-4S and MW-12 which would suggest that the plumes from these two areas of the site are mixing in the general area of MW-5S.

Based upon the interpretation of these three well grouping results and the data from the remaining wells, the following conclusions can be made of the shallow well aquifer contamination at Circuitron:

(1) Based upon the presence of 111-TCA in MW-1S, there is existing contamination of the shallow aquifer upgradient of the site. The 1,1,1-TCA concentration levels increase beneath the site, indicating the presence of on-site contamination sources, and then decreases significantly downgradient of the site.

(2) Discharge to the sanitary cesspool CP-1 on the northwest corner of the building has resulted in contamination of the shallow aquifer at this location (MW-8); a similar discharge to the SPDES authorized leaching pool LP-1 at the northeast corner of the building does not appear to have influenced the shallow aquifer at that location (MW-2S) significantly.

(3) Probable surficial draining of spent solvents from the storm drain SD-3 at the southwest corner of the site has resulted in excessive soil contamination by 111-TCA in that area which clearly has resulted in shallow aquifer contamination by this compound at that location (MW-4S).

(4) Discharge to the unauthorized leaching pools beneath the Circuitron building has resulted in contamination of the shallow aquifer (MW-10, MW-11 and MW-12) which appear to have migrated off-site (MW-5S). However, the horizontal migration of contaminants has not extended to MW-7S, located approximately 1,500 feet downgradient of the site.

- MW-8, MW-9, MW-10, MW-11, MW-12 - these wells were installed by Circuitron to determine whether the site activity contributed to groundwater contamination;
- MW-2 and MW-3 - these well clusters are located near the authorized SPDES pool located north of the Circuitron building and to the east of the building, respectively;
- MW-4 - the soil boring from this well cluster had the greatest concentrations of 111-TCA and other contaminants relative to the other soil borings; and
- MW-5, MW-6 and MW-7 - off-site well clusters.

Two wells (MW-8, MW-9) were installed north of the building and three wells (MW-10, MW-11, MW-12) were installed along the eastern portion of the building by Circuitron Corporation at the request of the SCDHS in 1985. All of these wells were installed at the water table, constructed of PVC, and appeared intact during the Ebasco sampling. The "upgradient" wells were MW-8 and MW-9, whereas MW-10 through MW-12 were installed to determine whether discharges to the authorized SPDES pool or the unauthorized SPDES pool beneath the building were contributing to groundwater contamination.

Both of the two "upgradient" wells showed contamination by volatile compounds, although 1,1,1-TCA concentrations were greater in MW-8 than MW-9. MW-8 was located in the vicinity of an authorized SPDES pool (LP-1) and storm drain (SD-1) and may have received discharge from the Circuitron operation which may have caused the elevated concentrations of volatiles in this well. The downgradient wells also showed contamination by 1,1,1-TCA (and other volatile contaminants), with concentrations increasing as the wells progressed south along the building. MW-12 is along the line of groundwater flow which has passed beneath the building (and contacted discharges from the authorized SPDES pool) which may have resulted in the elevated 1,1,1-TCA concentrations in this well. MW-12 also contained a larger suite of volatile contaminants which would also support the introduction of contaminants from a source such as industrial discharges. Unfortunately, the rate and volume of discharge to the unauthorized pools beneath the building is not known. Furthermore, the migration of contaminants from the pools to the water table (a distance of approximately 25 feet) would be a function of the discharge rate only, since migration assisted by rainfall percolation is not possible under the building. The plume from this discharge is probably extremely narrow since MW-3S, installed by Ebasco, was located 5 feet to the west of MW-11 and it showed much lower contamination (approximately five times) by 1,1,1-TCA.

MW-2S, installed by Ebasco, is located just downgradient of the authorized SPDES pool LP-1 on the northeast corner of the Circuitron building. Three volatile compounds were identified, including 1,1,1-TCA, but all concentrations were less than 2 ug/l. Analysis of sediments in this SPDES pool did show evidence of contamination by volatiles. The results would suggest that

A very interesting point is that since 1,1,1-TCA was found in high concentrations in the groundwater sampled from all the shallow monitoring wells, one would expect high levels of this contaminant to be also present in the soil matrix. However, the laboratory results do not indicate this. Chlorinated volatile organics, such as 1,1,1-TCA, have high mobility, which causes a substantial decrease in their concentration in the various matrices with time, as long as there is no additional imput of these compounds. In addition, 1,1,1-TCA is highly soluble (1.5x10E+3 mg/l), has high volatility and low adsorption to soils. These are some hypothesis that may explain the absence of 1,1,1-TCA from the soil (with the exception of the southwest corner of the site) and its significant presence in the groundwater. For further information on the behavior and physical/cehmical properties of these compounds refer to Section 7.0 of this report.

6.5.2.2 Volatile Compounds - deep aquifer

Seven wells installed by Ebasco were screened at a depth of 90 to 100 feet below the ground surface, or approximately 70 feet below the water table. A larger suite of contaminants were found in the deep aquifer relative to the shallow aquifer. Up to seven volatile compounds were identified. These included: 1,1-dichloroethene, 1,1-dichloroethane, <u>trans</u>-1,2-dichloroethene, chloroform, 1,1,1-trichloroethane, trichloroethene and tetrachloroethene.

<u>Spatial Variation</u>

Total volatile concentrations in the seven deep monitoring wells (all installed by Ebasco) also showed widely ranging concentrations. The two wells with the greatest total volatile concentrations were MW-1D (106 ug/l) and MW-7D (duplicate samples of 100 and 111 ug/l each). The upgradient off-site well (MW-1D) proved to be contaminated. The other interesting result is that MW-7D, which as a shallow well contained no detectable contaminants, yielded higher total volatile concentrations relative to the other wells (with the exception of MW-1D). This would suggest that there is not a significant exchange of contaminants between the shallow and deep portions of the Upper Glacial Aquifer. This was also suggested by the fact that MW-4S was the most contaminated shallow well (4,753 ug/l), while MW-4D was one of the least contaminated (43.9 ug/l). However, the vertical hemogenicity of contamination is greatly influenced by the horizontal velocities of groundwater flow. This effect is most easily determined by examining contaminant-specific distributions.

As was observed with the shallow aquifer wells, the upgradient and presumed non-contaminated well (MW-1D) exhibited all seven volatile compounds with concentrations of individual contaminants at or near the maximum concentration observed in the deep wells. Thus, there is a source of contaminants upgradient from the Circuitron Corporation Site which has contaminated the deep portion of the Upper Glacial aquifer and upper portion of the Magothy aquifer.

Comparison of the contaminant concentrations in the deep wells does not indicate that the site is contributing significantly to the groundwater contamination in the deep portions of the aquifer, since relatively comparable concentrations were observed in all the deep wells.

It is also important to note that the deep aquifer contamination had extended to MW-7D. Recall that the sample from the shallow portion of the aquifer (MW-7S) exhibited no contamination.

6.5.2.3 Semi-Volatile Compounds - shallow and deep aquifer

No semi-volatile compounds, pesticide and PCBs, were detected in the shallow or deep well samples with the exception of two phthalate compounds. Although these compounds may be released from the plastic constituents of circuit boards, their general infrequency and ubiquitous occurrence as contaminants in laboratories might suggest that their presence at the concentrations observed can be discussed as artifacts of the analysis.

It should also be noted, that bis(2-ethylhexyl)phthalate was found beneath the Circuitron Corporation Site. However, it was not found in any of the groundwater samples collected from the shallow wells during rounds 1 and 2 of sampling. This could be attributed to the fact that this semivolatile compound is relatively persistent to the soil matrices. This is primarily due to its: (a) high affinity for organic matter and soil particles (high organic carbon-water coefficient of 2xE+9, low octanol-water partition coefficient of 9.61); (b) low water solubility of 0.4 mg/l; (c) resistance to photolytic, oxidative and hydrolytic degradation; and (d) low volatilization rate. For further information on the physical and chemical properties of this contaminant, refer to Section 7.0 of this report.

6.5.2.4 Inorganics - shallow and deep wells

Review of the inorganic concentrations from the shallow aquifer wells showed that nearly all results were below federal or state drinking water or groundwater standards with the exception of chromium (MW-8, MW-9) and nickel (MW-4S, MW-6S, MW-10, MW-11, MW-12). Copper was a constituent of the discharge from Circuitron operations and the company was cited on several instances for exceeding SPDES regulations (EA, 1987). Copper was elevated in samples from three wells (MW-2S, MW-8, MW-9) relative to values in other sampled wells, although the concentrations were below the federal or state standards. These three wells are located near the receiving basins for these discharges and it is clear that copper has migrated from these basins to the groundwater.

The horizontal migration of the inorganics from these contaminated areas does not appear to be significant. MW-5S, which is located downgradient from the contaminated wells (MW-8, MW-9, MW-2S, MW-10, MW-11, MW-12) shows elevated levels of copper relative to the other wells south of the Circuitron building. However, just as with the volatile compounds in the shallow wells, the contamination do not appear to have not extended to MW-7S.

The elevated concentrations of nickel in MW-4S and MW-6S do not appear to be related to site discharges since these wells are located west of the groundwater flow which flows in a southeast direction beneath the site. MW-4S is located near the old plating bath which was apparently drained directly on the soil based upon the volatile analyses. This discharge apparently consisted predominantly of volatiles since the copper and chromium concentrations in MW-4S were not greatly elevated and were lower than groundwater samples taken from areas of known metals discharge (e.g., MW-8, MW-9, MW-25S).

In summary, the shallow aquifer exhibits elevation of certain inorganic analytes (e.g., chromium, nickel, copper and lead) which can be attributed to discharges from site activity to authorized SPDES and unauthorized leaching pools, and the storm drains. The data suggests some off-site transport of these analytes, but the plume has not yet extended to well cluster MW-7, located 280 feet southeast of the Circuitron building.

Review of the inorganic concentrations from the deep aquifer wells showed that all analyte concentrations were below federal or state drinking water or groundwater regulations. Copper concentrations in MW-5D are elevated relative to concentrations in other wells located south of the Circuitron building which suggests that site discharges may be responsible for this elevation.

Zinc was also elevated in MW-4D. This well was located in the vicinity of the old plating bath which may have been the source of contamination. However, the shallow aquifer sample at this location (MW-4S) did not exhibit high zinc levels found in the deep aquifer. Contamination here may not be site related and reflects another unidentified source.

In summary, the deep aquifer appears to be minimally affected by the site except for copper discharged from site activities to the authorized and unauthorized SPDES pools. The data also supports some off-site transport of this contaminant but the plume has not yet extended to MW-7D. Upgradient contamination has been discovered and is likely responsible for some contamination found in on-site and downgradient wells.

6.5.2.5 Filtered versus Unfiltered Samples

All water samples from the 14 monitoring wells were shipped to the CLP laboratories as unfiltered and filtered (0.45 micron) samples to evaluate the effect of coextracted metals from the particulate phase on contaminant concentrations. Table 6-21 summarizes the average change (and range) of six inorganic analytes (arsenic, chromium, copper, iron, lead and zinc) due to filtration of the groundwater samples. When the unfiltered samples yielded non-detects, the one-half SAL concentration was used to calculate the percent difference between the unfiltered and filtered samples.

Review of Table 6-21 shows that four analytes (arsenic, chromium, copper and iron) nearly all showed an average decrease following filtration. The remaining two analytes (lead and zinc) showed an average increase in the shallow wells from Round 1 but an average decrease or slight increase in the Round 2 shallow well samples and deep well samples from both rounds. The later two results may be artifactual since the concentrations of these analytes were lower near the sample quantitation limits.

The comparison of the unfiltered and filtered analytical results shows that there is a significant change in contaminant concentrations by filtration and that for contaminants present above the sample quantitation limits, this change is consistently a decrease in analyte concentrations. The solids content (e.g., TSS) of the groundwater samples were not determined in this investigation. Based upon the soil particle size analyses, the clay fraction may be responsible for this decrease, however, the clay fraction of the soils from this site is extremely small (less than 0.5%). Because of this small relative contribution, it is likely that clays in the groundwater were not responsible for this change following filtration.

6.5.2.6 Municipal and Private Well Results - deep aquifer

Municipal well S-20042 (PW-1) and private well S-22003 (PW-2) are located approximately 1,500 feet downgradient of the site to the south. PW-1 is screened at a depth of 585 feet and PW-2 at 226 feet below the ground surface in the Magothy aquifer.

The only volatile compound detected in PW-1 was trichloroethene at a concentration of 0.6 ug/l. The groundwater from PW-2 was found to have several volatiles (chloroethane, 1,1-dichloroethene, 1,1,1-trichloroethane, trichloroethene, trichlorofluoromethane and tetrachloroethane) at concentrations ranging from 0.3 ug/l (trichloroflouromethane) to 21 ug/l (trichloroethene).

There were no semivolatile organics present in PW-2, while PW-1 had only di-n-butylphthalate at a concentration of 95 ug/l.

TABLE 6-21

CIRCUITRON CORPORATION SITE

PERCENT CHANGE OF SELECTED INORGANIC
CONCENTRATIONS DUE TO FILTRATION

	SHALLOW WELLS				DEEP WELLS			
	ROUND 1		ROUND 2		ROUND 1		ROUND 2	
Analyte	Average	Range	Average	Range	Average	Range	Average	Range
Arsenic	-51.4%	-79.2-(+3.7)	+53.03%	-15.0-(+180.0)	-62.3%	-63.0-(-61.5)	-17.2%	-64.3-(+30.0)
Chromium	-62.6%	-82.5-(-30.0)	-81.1%	-90.7-(-61.5)	-80.2%	-84.6-(-75.7)	-74.3%	-93.0-(-51.6)
Copper	-55.6%	-91.9-(+2.1)	-20.1%	-83.4-(+66.7)	-11.5%	-64.4-(+132.6)	-68.7%	-95.1-(-4.2)
Iron	-82.8%	-99.6-(-7.3)	-71.1%	-99.6-(-6.7)	-45.6%	-84.7-(+17.9)	-73.7%	-90.3-(-55.6)
Lead	+26.7%	-80.8-(+219.1)	-54.1%	-70.6-(-37.6)	-74.3%	-90.2-(-46.2)	-72.7%	-93.2-(-35.4)
Zinc	+28.0%	-73.0-(+200)	-12.3%	-48.3-(+33.0)	+3.2%	-23.6-(+31.2)	+6.8%	-28.9-(+42.4)

NOTE: Values represent the average (and range) percent difference between the unfiltered and filtered analyte concentrations.

Review of the inorganic concentrations in the private and municipal wells showed that all results were below the federal and the state drinking water or groundwater standards.

In general, the contamination found to be present in these two wells, which are screened deep into the Magothy aquifer, appears to be similar or somewhat lower than the contamination at the top of the Magothy aquifer (newly installed monitoring wells) and significantly lower than the contamination of the Upper Glacial aquifer beneath the Circuitron Corporation Site. Therefore, it could be concluded that this portion of the Magothy aquifer has not been affected by the illegal wastes discharges at the Circuitron facility.

6.6 LEACHING POOLS

Two authorized leaching pools are located on site, and additional unauthorized leaching pools have also been discovered. Both authorized leaching pools, designated LP-1 and LP-2, are located beneath the parking lot in the front and at the northeast corner of the building, respectively (see Figure 1-3). The unauthorized leaching pools are all located beneath the plating room floor (Figure 1-3). LP-1 may be accessed via a manhole; LP-2, however, is not accessible. The unauthorized leaching pools are evidenced by circular sunken areas, approximately 2 feet in diameter, and several PVC pipes protruding upward from the plating room floor.

6.6.1 Previous Investigations

The leaching pools at the Circuitron Corporation Site have been the subject of sampling activities by both SCDHS and the USEPA. Liquid samples from authorized leaching pools LP-1 and LP-2 were taken by the SCDHS on several occasions between April 1981 and January 1986. Analytical results of these samplings are contained in Tables 1-2 and 1-4. The SCDHS also took both liquid and soil samples from two of the unauthorized leaching pools. LP-4, beneath the floor in the center of the plating room, was sampled in November 1984, and LP-6, beneath the floor in the southeast corner of the plating room, was sampled in April 1985.

Sediment samples from unauthorized leaching pool LP-4 were also taken by the USEPA in February 1989. In addition, two other leaching pools in the plating room, designated LP-3 and LP-5, were sampled. The remaining pool, LP-6, had already been cleaned and backfilled by the time of the EPA study. The soil obtained during these activities was analyzed for TCL volatiles, semi-volatiles and pesticides/PCBs, and metals.

6.6.1.1 Aqueous Materials

Authorized Leaching Pools

Liquid from LP-1, the SPDES industrial discharge leaching pool, was sampled and analyzed by the SCDHS on ten separate occasions between April 1981 and January 1986. Results of these analyses indicate that solvents and heavy metals were discharged at various times through LP-1. Six of the ten analyses indicated the presence of the volatile organic compounds methylene chloride and 1,1,1-trichloroethane. On one occasion, chloroform was also detected. Detected concentrations ranged from 37 ug/l to 83,000 ug/l for methylene chloride, and 30 ug/l to 580 ug/l for 1,1,1-trichloroethane. Chloroform was detected once at a concentration of 47 ug/l (Table 1-2).

Metals were also detected during the sampling events, and consisted of copper, lead, iron, nickel, and silver. Copper occurred with the greatest frequency and was found in eight of the ten samples, with detected concentrations ranging from 2,100 ug/l to 800,000 ug/l. Lead was found in three samples at concentrations ranging from 400 ug/l to 920,000 ug/l. The remaining metals, nickel and silver, were detected once each at levels of 3,000 ug/l and 430 ug/l, respectively (Table 1-2).

The maximum concentration of all analytes, with the exceptions of 1,1,1-trichloroethane and chloroform, occurred in the sample taken in November 1983. This sample was also the only one in which nickel and silver were detected. After this sampling date, methylene chloride was detected sporadically at concentrations roughly three orders of magnitude less than maximum. Copper and lead were also detected in much lower concentrations after this date. The maximum level of 1,1,1-trichloroethane was found in the sample taken in December 1984; subsequent samples exhibited concentrations ranging from undetected to one order of magnitude less than maximum. Chloroform was detected only once in the sample taken in April 1985.

Liquid from the distribution pool LP-2 in the northeast corner of the building was sampled by the SCDHS three times during 1981, in April, September, and October. Results of the sample analyses again indicate the discharge of both organic solvents and heavy metals through the leaching pool. The sample taken in April 1981 contained elevated levels of methylene chloride (290 ug/l), 1,1,1-trichloroethane (42,000 ug/l), copper (3,200 ug/l) and lead (400 ug/l). High levels of 1,1,1-trichloroethane were found again during the October 1981 sampling (Table 1-4).

Unauthorized Leaching Pools

Liquid samples from two of the unauthorized leaching pools were taken by the SCDHS in 1984 and 1985. The pool located in the center of the plating room, designated LP-4, was sampled in November 1984, and the pool located at the south end of the plating room, designated LP-6, was sampled in April 1985. Results of the sample analyses indicate the discharge of organic solvents and heavy metals to LP-5 and organic solvents to LP-6. However, LP-6 has since been cleaned and backfilled.

Elevated levels of methylene chloride (410 ug/l in LP-4 and 26,000 ug/l in LP-6), 1,1,1-trichloroethane (11,000 ug/l in LP-5 and 6,500 ug/l in LP-6), 1,1,2-trichloroethylene (30 ug/l in LP-4 and 550 ug/l in LP-6), and tetrachloroethylene (160 ug/l in LP-4 and 4,400 ug/l in LP-6) were found in the leaching pools. Samples from LP-4 also contained methylethyl ketone at a concentration of 230 ug/l, and those from LP-6 contained toluene at a concentration of 6,000 ug/l. Copper and zinc were found in the LP-4 sample at levels of 6,600 ug/l and 1,600 ug/l, respectively (Table 1-5).

6.6.1.2 Sediment

Both the SCDHS and USEPA have taken sediment samples of the unauthorized leaching pools; SCDHS activities took place in 1984 and 1985, and EPA sampling took place more recently in February 1989. SCDHS activities included the sampling of LP-4 and LP-6. Because LP-6 had been backfilled by the time of the EPA study, these samples consisted of sediments taken from LP-4 and two additional leaching pools, LP-3 and LP-5, located beneath the plating room floor. A collapsed area of the floor, designated H-1, was also sampled by the USEPA. Analytical results of both studies indicate the presence of organic compounds and some pesticides and metals in various leaching pool soils.

The SCDHS sediment sampling of LP-4 occurred in November 1984, and high levels of the organic compounds methylene chloride (1,200 ug/kg), 1,1,1-trichloroethane (180,000 ug/kg), 1,1,2-trichloroethylene (5,100 ug/kg), and chloroform (40 ug/kg) were detected, indicating organic solvent discharge. The sampling of LP-6 took place in April 1985, but analytical results showed no organic contamination in the soil. However, the metals copper (360,000 ug/kg), iron (550,000 ug/kg), nickel (4,200 ug/kg), zinc (470,000 ug/kg), lead (3,300,000 ug/kg), and silver (2,100 ug/kg) were detected (Table 1-5). Although nickel is within the expected background range (Table 8-3), copper, zinc, lead, and silver were all higher than the maximum expected background concentration. Sediment sampling was performed in conjunction with liquid sampling, and the comparison of results in Table 1-5 shows that organics and metals were present in both leaching pools in either the soil, aqueous, or both matrices. LP-6 has since been cleaned and backfilled as reported by the SCDHS.

In February 1989, the EPA took sediment samples from unauthorized leaching pools LP-3, LP-4, and LP-5, as well as hole H-1. The samples were analyzed for TCL volatile organics, semivolatile organics, pesticides/PCBs, and metals. No volatiles were detected in LP-4, LP-3, or H-1. Three compounds were present in LP-5 sediment: 1,1,1-trichloroethane (5,900 ug/kg), methylene chloride (4,600 ug/kg), and trichloroethene (1,400 ug/kg) (Table 6-7).

In addition, at least one semivolatile was detected at each location. Bis(2-ethylhexyl)phthalate was detected at all locations at levels ranging from 1,050 ug/kg to 43,000 ug/kg. Di-n-butylphthalate was detected in LP-3, LP-5, and H-1 at concentrations of 330 ug/kg, 1,100 ug/kg, and 120 ug/kg, respectively; butylbenzylphthalate was also detected at these locations at concentrations of 4,300 ug/kg, 3,900 ug/kg, and 340 ug/kg, respectively. Di-n-octylphthalate was detected in both LP-3 (340 ug/kg) and LP-5 (850 ug/kg). The pesticide 4-4'-DDE was present in the LP-4 sediment at 18 ug/kg, and 4-4'-DDT was present in the LP-4, LP-5, and H-1 sediments at levels of 50 ug/kg, 1,600 ug/kg, and 58 ug/kg, respectively. No PCBs were detected.

Metals concentrations in sediment samples were consistent with expected background ranges, with the exception of aluminum in LP-4 (4,920 ug/l), LP-5 (1,080 ug/l), and H-1 (2,270 ug/l) (Table 6-6). Aluminum levels at these locations range from 8% to 400% higher than the maximum expected background concentration of 1,000 ppb (Table 8-3).

6.6.2 Ebasco Investigations

Ebasco conducted sampling of LP-1 in May 1989. No liquid was present at the time of sampling. The samples were analyzed for TCL volatile organics, semivolatile organics, pesticides/PCBs, inorganics and hexavalent chromium. Analytical results showed the presence of both volatile and semivolatile organics as well as some metals in LP-1 sediments and are presented in Tables 6-22, 6-23, and 6-24. In addition, Figure 6-7 presents the spatial distribution of the contaminants of concern, as specified in Section 8.0 "Risk Assessment", in the sediments of the leaching pools.

6.6.2.1 Sediment

One volatile organic hit was reported from the LP-1 sediments; the authorized leaching pool LP-1 contained 1,1,1-trichloroethane at a concentration of 9 ug/kg. In addition, ten tentatively identified compounds (TICs) were detected at a total estimated concentration of 412 ug/kg (Table 6-20). A total of 19 TCL semivolatile organics were found to be present in the sediment samples, with the highest concentrations being attributed to bis(2-ethylhexyl)-phthalate (5,500 ug/kg), di-n-octylphthalate (1,300 ug/kg), fluoranthrene (1,200 ug/kg), and pyrene (1,200 ug/kg). Butylbenzylphthalate (940 ug/kg), benzo[b]fluoranthrene (810 ug/kg), and phenanthrene (730 ug/kg), were also detected at high concentrations. Total TIC concentration was 90,870 ug/kg with 21 compounds detected (Table 6-23). No pesticides or PCBs were detected (Table 6-23).

Metals were also detected in the LP-1 soil samples, with high concentrations of aluminum (2,180 mg/kg), cadmium (2.8 mg/kg), copper (23,900 mg/kg), lead (2,650 mg/kg), mercury (5.3 mg/kg), and nickel (109 mg/kg) (Table 6-24).

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TABLE 6-22
CIRCUITRON CORPORATION SITE
VOLATILE ORGANIC COMPOUNDS DETECTED IN THE SEDIMENTS OF THE LEACHING POOLS, SANITARY CESSPOOLS AND STORM DRAINS (IN UG/KG)

SAMPLE ID	CC-CP1-SE01	CC-CP2-SE01	CC-LP1-SE01	CC-LP1-SED1	CC-SD1-SE01	CC-SD2-SE01	CC-SD3-SE01
TCL VOLATILE PARAMETERS:							
1,1-DICHLOROETHANE	65.000	5.000R	---	---	5.000R	6.000J	---
CHLOROFORM	---	5.000R	---	---	5.000R	---	3.000J
1,1,1-TRICHLOROETHANE	1,500.000	5.000R	---	9.000	5.000R	24.000	19,000.000
BENZENE	---	5.000R	---	---	5.000R	---	8.000
TETRACHLOROETHENE	21.000J	5.000R	---	---	5.000R	---	8.000
TOTAL TICS	1	6	NR	10	4	NR	1
TIC CONCENTRATION	62.000J	2,450.000J	---	412.000J	53.000J	---	8.800J

EXPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

DATE: 02/28/90
PAGE 1

TABLE 6-23
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE SEDIMENTS OF THE LEACHING POOLS, SANITARY CESSPOOLS AND STORM DRAINS (IN UG/KG)

MPLE ID	CC-CP1-SE01	CC-CP2-SE01	CC-LP1-SE01	CC-LP1-SED1	CC-SD1-SE01	CC-SD2-SE01	CC-SD3-SE01
BASE/NEUTRAL PARAMETERS:							
ENOL	---	330.000R	---	---	---	110.000J	---
4-DICHLOROBENZENE	62.000J	330.000R	---	---	---	---	---
NZYL ALCOHOL	48.000J	330.000R	---	---	---	---	---
METHYLPHENOL	70.000J	330.000R	---	28.000J	---	---	---
NZOIC ACID	300.000J	1,600.000R	250.000J	290.000J	470.000J	3,100.000	76.000J
PHTHALENE	---	330.000R	20.000J	---	120.000J	45.000J	---
CHLORO-3-METHLYPHENOL	---	330.000R	---	19.000J	---	22.000J	---
METHYLNAPHTHALENE	---	330.000R	---	---	120.000J	31.000J	---
METHYL PHTHALATE	---	330.000R	38.000J	160.000J	100.000J	---	---
ENAPHTHYLENE	---	330.000R	---	---	150.000J	59.000J	---
ENAPHTHENE	21.000J	330.000R	39.000J	29.000J	620.000J	210.000J	160.000J
BENZOFURAN	11.000J	330.000R	22.000J	14.000J	390.000J	140.000J	120.000J
UORENE	---	330.000R	---	---	---	300.000J	160.000J
NTACHLOROPHENOL	---	1,600.000R	---	---	---	---	110.000J
ENANTHRENE	420.000J	330.000R	730.000	540.000	7,600.000	4,500.000	3,500.000
THRACENE	65.000J	330.000R	79.000J	55.000J	1,300.000	630.000	300.000J
-n-BUTYLPHTHALATE	---	330.000R	---	---	630.000B	---	180.000J
UORANTHRENE	590.000	330.000R	1,200.000	910.000	4,400.000	4,400.000	4,800.000
RENE	1,100.000J	330.000R	1,200.000	1,200.000J	27,000.000J	11,000.000J	3,100.000
TYL BENZYL PHTHALATE	2,000.000J	330.000R	660.000	940.000J	5,200.000J	3,000.000J	220.000J
NZO[a]ANTHRACENE	350.000J	330.000R	430.000J	280.000J	6,100.000J	1,800.000J	1,400.000
S[2-ETHYLHEXYL]PHTHALATE	2,700.000J	330.000R	5,500.000	5,700.000JB	39,000.000JB	17,000.000BJ	9,900.000
RYSENE	460.000J	330.000R	310.000J	210.000 J	9,500.000J	2,300.000J	2,200.000
-n-OCTYL PHTHALATE	970.000J	330.000R	790.000J	1,300.000J	5,400.000J	1,100.000J	85.000J
NZO[b]FLUORANTHENE	710.000J	330.000R	810.000J	350.000J	9,100.000J	3,400.000J	1,400.000
NZO[k]FLUORANTHENE	480.000J	330.000R	35.000J	360.000J	6,600.000J	---	1,600.000

PLANATION OF CODES:

DETECTED AT CONCENTRATION INDICATED
ESTIMATED VALUE
COMPOUND FOUND IN BLANK
-- UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
A NOT ANALYZED FOR
, R REJECTED VALUE
R VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-23 (CON'T)
CIRCUITRON CORPORATION SITE
SEMIVOLATILE, PESTICIDE AND PCB COMPOUNDS DETECTED IN THE SEDIMENTS
OF THE LEACHING POOLS, SANITARY CESSPOOLS AND STORM DRAINS (IN UG/KG)

MPLE ID	CC-CP1-SE01	CC-CP2-SE01	CC-LP1-SE01	CC-LP1-SED1	CC-SD1-SE01	CC-SD2-SE01	CC-SD3-SE01
NZO[a]PYRENE	420.000J	330.000R	400.000J	270.000J	6,100.000J	2,200.000J	1,300.000
DENO[1,2,3-CD]PYRENE	---	330.000R	---	---	5,800.000J	1,600.000J	620.000J
BENZO[A,H]ANTHRACENE	---	330.000R	---	---	---	---	280.000J
NZO[G,H,I]PERYLENE	---	330.000R	---	---	8,400.000J	1,300.000J	680.000J
TAL TICS	20	23	22	21	20	24	18
C CONCENTRATION	33,770.000J	1,049,570.000J	52,090.000J	90,870.000J	30,970.000J	41,060.000J	57,460.000J
PESTICIDE/PCB PARAMETERS:							
DOSULFAN I	---	8.000R	---	---	---	11.000	---

XPLANATION OF CODES:

DETECTED AT CONCENTRATION INDICATED
ESTIMATED VALUE
COMPOUND FOUND IN BLANK
-- UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
A NOT ANALYZED FOR
, R REJECTED VALUE
R VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

DATE: 02/28/90
PAGE 1

TABLE 6-24
CIRCUITRON CORPORATION SITE
INORGANIC COMPOUNDS DETECTED IN THE SEDIMENTS OF THE LEACHING POOLS, SANITARY CESSPOOLS AND STORM DRAINS (IN MG/KG)

AMPLE ID	CC-CP1-SE01	CC-CP2-SE01	CC-LP1-SE01	CC-LP1-SED1	CC-SD1-SE01	CC-SD2-SE01	CC-SD3-SE01
NORGANIC PARAMETERS:							
LUMINUM	2,640.000	3,130.000	2,180.000	960.000	10,400.000	200.000R	1,320.000
RSENIC	5.900	1.900B	3.700	6.300	2.800B	4.000	1.500B
ARIUM	28.200B	80.600B	28.400B	40.300B	69.800B	22.000B	7.200B
ADMIUM	---	---	---	2.800J	3.800J	---	---
ALCIUM	1,680.000	6,180.000	13,100.000	15,500.000	20,900.000	6,860.000	5,380.000J
HROMIUM	31.200 J	28.700 J	33.700 J	86.100J	58.300 J	22.200 J	8.600
OPPER	648.000	12,900.000	23,900.000J	5,300.000J	4,230.000	650.000	802.000
RON	11,400.000	4,190.000	12,000.000	16,200.000	9,900.000	8,170.000	7,030.000
EAD	210.000	1,300.000	5.000R	2,650.000	1,130.000	---	21.200
AGNESIUM	931.000B	997.000B	7,250.000	8,340.000	11,900.000	3,660.000	3,090.000
ANGANESE	15.800	32.100	54.000	75.400	75.700	50.600	40.400 J
ERCURY	1.400	6.600	3.500	5.300	2.700	0.330	---
ICKEL	12.500 J	49.200 J	72.400 J	109.000J	55.000 J	17.200 J	9.000
POTASSIUM	5,000.000R	5,000.000R	5,000.000R	5,000.000R	5,000.000R	5,000.000R	---
SILVER	160.000	25.200	3.500B	3.100B	---	8.600J	3.100J
SODIUM	117.000B	254.000B	148.000B	281.000B	302.000B	125.000B	218.000B
VANADIUM	11.600B	---	16.700B	11.100B	71.400	25.200	5.300B
ZINC	20.000R	20.000R	20.000R	20.000R	20.000R	20.000R	66.800
% SOLIDS	69.200	24.700	54.500	63.300	48.100	69.300	90.900
CYANIDE	---	---	---	---	---	---	---

EXPLANATION OF CODES:

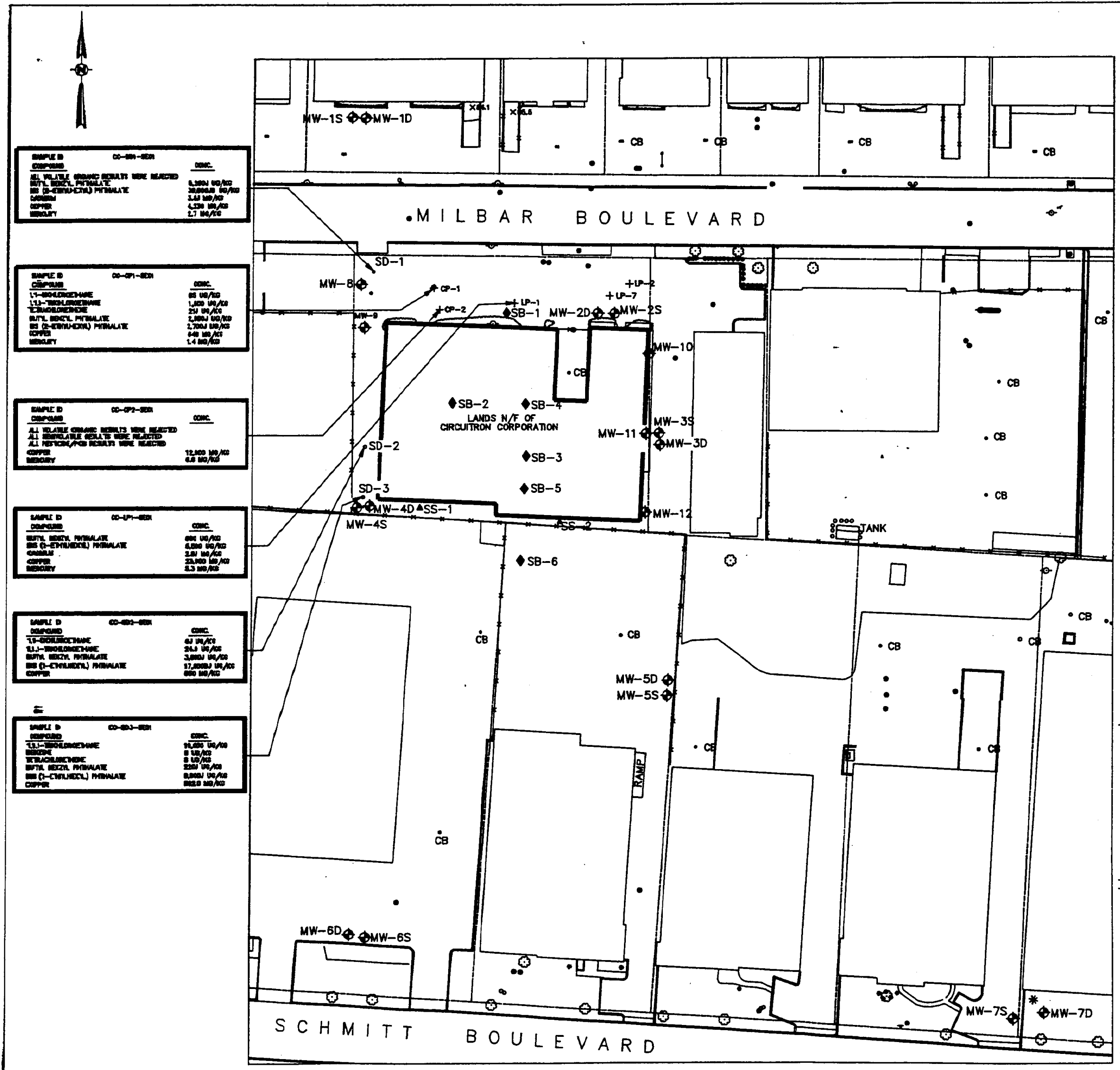
	DETECTED AT CONCENTRATION INDICATED
J	ESTIMATED VALUE
B	COMPOUND FOUND IN BLANK
---	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
NA	NOT ANALYZED FOR
X, R	REJECTED VALUE
NR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED

TABLE 6-25
CIRCUITRON CORPORATION SITE
CHEMICAL COMPOUNDS DETECTED IN THE AQUEOUS CONTENTS OF THE STORM DRAINS (IN UG/L)

MPLE ID	CC-SD1-AQ01	CC-SD2-AQ01
TCL VOLATILE PARAMETERS:		
1,1-TRICHLOROETHANE	---	29.000
TAL TICS	NR	NR
C CONCENTRATION	---	---
BASE/NEUTRAL PARAMETERS:		
ENANTHRENE	---	0.700J
-n-BUTYLPHTHALATE	0.600J	1.000J
UORANTHRENE	---	1.000J
RENE	---	0.800J
RYSENE	---	0.900J
-n-OCTYL PHTHALATE	0.200J	0.600J
TAL TICS	4	3
IC CONCENTRATION	197.000J	40.000JB
*INORGANIC PARAMETERS:		
NTIMONY	70.700J	---
ALCIUM	2,060.000B	1,180.000B
OPPER	25.400	59.100
AGNESIUM	384.000B	---
ODIUM	1,280.000B	---
INC	61.600	85.300
YANIDE	---	---

XPLANATION OF CODES:

	DETECTED AT CONCENTRATION INDICATED
	ESTIMATED VALUE
	COMPOUND FOUND IN BLANK
--	UNDETECTED AT GIVEN INSTRUMENT DETECTION LIMIT (IF REPORTED)
IA	NOT ANALYZED FOR
, R	REJECTED VALUE
IR	VALIDATED RESULTS NOT RECEIVED OR RESULT NOT REPORTED



SAMPLE ID	CC-SD1-SED1
COMPOUND	CONC.
ALL VOLATILE ORGANIC RESULTS WERE REJECTED	
BUTYL BENZYL PHTHALATE	6,200J UG/KG
BIS (2-ETHYLHEXYL) PHTHALATE	30,000JB UG/KG
CADMIUM	3.4J MG/KG
COPPER	4,230 MG/KG
MERCURY	2.7 MG/KG

SAMPLE ID	CC-CP1-SED1
COMPOUND	CONC.
1,1-DICHLOROETHENE	65 UG/KG
1,1,1-TRICHLOROETHANE	1,600 UG/KG
TETRACHLOROETHENE	21J UG/KG
BUTYL BENZYL PHTHALATE	2,800J UG/KG
BIS (2-ETHYLHEXYL) PHTHALATE	2,700J UG/KG
COPPER	640 MG/KG
MERCURY	1.4 MG/KG

SAMPLE ID	CC-CP2-SED1
COMPOUND	CONC.
ALL VOLATILE ORGANIC RESULTS WERE REJECTED	
ALL SEMIVOLATILE RESULTS WERE REJECTED	
ALL PESTICIDE/PCB RESULTS WERE REJECTED	
COPPER	12,900 MG/KG
MERCURY	6.6 MG/KG

SAMPLE ID	CC-LP1-SED1
COMPOUND	CONC.
BUTYL BENZYL PHTHALATE	690 UG/KG
BIS (2-ETHYLHEXYL) PHTHALATE	6,500 UG/KG
CADMIUM	2.8J MG/KG
COPPER	23,900 MG/KG
MERCURY	5.3 MG/KG

SAMPLE ID	CC-SD2-SED1
COMPOUND	CONC.
1,1-DICHLOROETHENE	6J UG/KG
1,1,1-TRICHLOROETHANE	24.0 UG/KG
BUTYL BENZYL PHTHALATE	3,000J UG/KG
BIS (2-ETHYLHEXYL) PHTHALATE	17,000BJ UG/KG
COPPER	890 MG/KG

SAMPLE ID	CC-SD3-SED1
COMPOUND	CONC.
1,1,1-TRICHLOROETHANE	10,000 UG/KG
BENZENE	8 UG/KG
TETRACHLOROETHENE	8 UG/KG
BUTYL BENZYL PHTHALATE	220J UG/KG
BIS (2-ETHYLHEXYL) PHTHALATE	8,900J UG/KG
COPPER	902.0 MG/KG

MAP NOTES:

1.) AERIAL PHOTOGRAPHY AND MAPPING BY LOCKWOOD SUPPORT SERVICES. DATE OF AERIAL PHOTOGRAPHY – NOV. 19, 1989.

LEGEND

◆ SB SOIL BORING
● SD STORM DRAIN
+ LP LEACHINGPOOL
+ CP CESSPOOL
▲ SS SURFACE SOIL SAMPLING LOCATIONS
DIRECTION OF GROUNDWATER FLOW IS TO THE SOUTHEAST
MW NEWLY INSTALLED 1,2,3,4,5,6 & 7 (8,9,10,11 & 12 EXISTING)

NOTES

1. J: ESTIMATED VALUE
B: CHEMICAL FOUND IN THE BLANK

2. VALUES ARE REPORTED HERE FOR THE SEDIMENT CONTAMINANTS OF CONCERN MEETING THE LISTED CONCENTRATION CRITERIA ONLY:

COMPOUND	CONCENTRATION
1,1-DICHLOROETHENE	>DETECTION LIMIT
1,1,1-TRICHLOROETHANE	>DETECTION LIMIT
BENZENE	>DETECTION LIMIT
TETRACHLOROETHENE	>DETECTION LIMIT
BIS (2-ETHYLHEXYHL) PHTHALATE	>DETECTION LIMIT
ENDOSULFAN I	>DETECTION LIMIT
GAMMA CHLORDANE	>DETECTION LIMIT
COPPER	>70 MG/KG
CADMIUM	>1.1 MG/KG
MERCURY	>0.54 MG/JG

SEE TABLES 6-22 THROUGH 6-24 FOR FURTHER DETAILS OF REPORTED VALUES.

80 40 0 80 160
SCALE IN FEET

BASE MAP ADAPTED FROM TOPOGRAPHICAL SURVEY MAP PREPARED BY C.T. MALE ASSOCIATES, P.C. FOR EBASCO SERVICES, INC.

U.S. ENVIRONMENTAL PROTECTION AGENCY

CIRCUITRON CORPORATION SITE

SPATIAL DISTRIBUTION OF CONTAMINANTS OF CONCERN IN THE SEDIMENTS OF THE LEACHING POOLS, SANITARY CESSPOOLS AND STORM DRAINS

EBASCO SERVICES INCORPORATED

FIGURE NO. 6-7
CIRC-Y.DWG

Hexavalent chromium was detected at an estimated concentration of 6.5 ug/kg.

6.7 SANITARY CESSPOOLS

The two sanitary cesspools on-site, CP-1 and CP-2, are located beneath the parking lot near the northwestern corner of the building (Figure 1-3). Both are accessible through manholes. CP-1 is approximately 8 feet in diameter and is 16.6 feet deep from ground surface to sediment; CP-2 has a diameter of approximately 10 feet with a depth from ground surface to sediment of 10.4 feet. The cesspools are interconnected.

6.7.1 Previous Investigations

The SCDHS sampled the cesspool system five times between April 1981 and October 1986. The samples consisted of liquids from the cesspools and were analyzed for organics and metals. Analytical results of these activities are contained in Table 1-3. No other previous investigations have been performed.

6.7.1.1 Aqueous Material

Liquid from the sanitary cesspools was shown to contain the organic compound methylchloride (100 ug/l) during the April 1981 sampling and 1,1,1,-trichloroethane (3,000 ug/l) during the September 1981 sampling. Metals were detected during the November 1983 sampling event. Copper (1,800 ug/l), iron (3,500 ug/l), lead (200 ug/l), and silver (200 ppb) were present, and lead was also detected at a concentration of 200 ug/l in samples taken in December 1984 and October 1988 (Table 1-3).

6.7.2 Ebasco Investigations

Ebasco conducted sampling of both CP-1 and CP-2 in May 1989. No standing water was found in the cesspools at the time of the study; therefore, only sediment samples were taken. Analytes consisted of TCL volatile organics, semivolatile organics, pesticides/PCBs, and metals. The analytical results are presented in Tables 6-22, 6-23, and 6-24. Figure 6-7 presents the hits detected in the sediments of these two sanitary cesspools.

6.7.2.1 Sediment

Volatile organics were detected in the CP-1 sample and consisted of 1,1-dichloroethane (65 ug/kg), 1,1,1-trichloroethane (1,500 ug/kg), and tetrachloroethane (21 ug/kg). One TIC was present at a concentration of 62 ug/kg. Results for the CP-2 sediment volatile analysis were rejected by Ebasco QC, with the exception of TIC data. Six TICs were detected at a total concentration of 2,450 ug/kg in the CP-2 sediments (Table 6-22).

Several semivolatile organic hits were reported for the CP-1 sample. A total of 18 compounds were detected, with the highest concentrations being exhibited by bis[2-ethylhexyl]phthalate (2,700 ug/kg), butylbenzylphthalate (2,000 ug/kg), pyrene (1,100 ug/kg), di-n-octylphthalate (970 ug/kg), benzo[b]fluoranthrene (710 ug/kg), and fluoranthrene (590 ug/kg). Benzo[k]fluoranthrene (480 ug/kg), chrysene (460 ug/kg), phenanthrene (420 ug/kg), and benzo[a]pyrene (420 ug/kg) were also present at high levels. Twenty TICs were reported at a total concentration of 33,770 ug/kg. Semivolatile organic analysis results for the CP-2 sample were rejected by Ebasco QC, except for the TIC data, which indicated the presence of 23 TICs at a total concentration of 1,049,570 ug/kg (Table 6-23). No pesticides or PCBs were detected in CP-1 sediment, and analytical results for CP-2 sediment failed Ebasco QC (Table 6-23).

Results of metal analyses for both CP-1 and CP-2 sediments indicated the presence of metals at levels above the maximum expected background concentrations (Table 8-3). Aluminum, copper, lead, and mercury were detected in CP-1 at levels of 2,640 mg/kg, 648 mg/kg, 210 mg/kg, and 2.7 mg/kg, respectively, and in CP-2 at levels of 3,130 mg/kg, 12,900 mg/kg, 1,300 mg/kg, and 6.6 mg/kg, respectively. In addition, silver was present in CP-1 sediments at a concentration of 160 mg/kg (Table 6-24).

6.8 STORM DRAINS

There are several storm drains on the Circuitron Corporation Site. Those of concern to this study are located along the western edge of the building and are interconnected. Some of these drains are accessible via slotted manhole covers; three have been sampled by Ebasco and are designated SD-1, SD-2, and SD-3 (Figure 1-3). The depth of the drains from ground surface to sediment is 10.7 feet at SD-1, 10.9 feet at SD-2, and 12.6 feet at SD-3.

6.8.1 Previous Investigations

The storm drain located at the southwest corner of the buildings, now designated SD-3, was sampled by the SCDHS three times between December 1984 and January 1986. The liquid obtained during these activities was analyzed for organics and metals. No other investigations have been performed.

The volatile organic compound 1,1,1-trichloroethane was detected in two of the three samples. In April 1985 a concentration of 260 ug/l was detected, and in January 1986 a concentration of 22 ug/l was present. The sample of December 1984 indicated the presence of copper at a level of 1,400 ug/l (Table 1-6).

6.8.2 Ebasco Investigations

Sampling activities were conducted by Ebasco for three of the site's storm drains in May 1989. Both sediment and aqueous samples were obtained for SD-1 and SD-2, while only sediment samples were taken from SD-3, due to the absence of standing water. All samples were analyzed for TCL volatile organics, semivolatile organics, pesticides/PCBs, and metals. The sediment analytical results for the storm drains are presented in Tables 6-22, 6-23 and 6-24, while the aqueous results are summarized in Table 6-25. Figure 6-7 presents the contaminants of concern found in the sediments of these three storm drains.

6.8.2.1 Sediment

The volatile organic analytical results for the SD-1 soil was rejected, with the exception of the TIC results. SD-1 soil contained 4 TICs at a total concentration of 53 ug/kg. In the SD-2 sediment, two volatile hits were reported, consisting of 1,1-dichloroethane (6 ug/kg) and 1,1,1-trichloroethane (24 ug/kg). The SD-3 sample contained chloroform (3 ug/kg), 1,1,1-trichloroethane (19,000 ug/kg), benzene (8 ug/kg), tetrachloroethene (8 ug/kg), and one TIC (8.8 ug/kg) (Table 6-22).

Several semivolatile hits were reported for each of the three storm drain sediments. Nineteen semivolatiles were detected in the SD-1 soil, with the highest concentrations being exhibited by bis[2-ethylhexyl]phthalate (39,000 ug/kg), pyrene (27,000 ug/kg), chrysene (9,500 ppb), benzo[b]fluoranthrene (9,100 ug/kg),and benzo[g,h,i]perylene (8,400 ug/kg). Phenanthrene (7,600 ug/kg), benzo[k]fluoranthrene (6,600 ug/kg), benzo[a]-anthracene (6,100 ug/kg), and benzo[a]pyrene (6,100 ug/kg) were also present at high levels. Twenty TICs were detected in SD-1 soil with a total concentration of 30,970 ug/kg (Table 6-23).

The SD-2 soil contained a total of 22 semivolatiles. Compounds present at the highest concentrations include bis[2-ethylhexyl]phthalate (17,000 ug/kg), pyrene (11,000 ug/kg), phenanthrene (4,500 ug/kg), fluoranthrene (4,400 ug/kg), and benzo[b]fluoranthrene (3,400 ug/kg). Twenty-four TICs were detected at a total concentration of 41,060 ug/kg. The SD-3 sediment contained 21 semivolatiles, with bis[2-ethylhexyl]phthalate (9,900 ug/kg), fluoranthrene (4,800 ug/kg), phenanthrene (3,500 ug/kg), pyrene (3,100 ug/kg), and chrysene (2,200 ppb) exhibiting the highest concentrations. Eighteen TICs at a total level of 57,460 ug/kg were present in the sample (Table 6-23).

Three pesticide hits occurred in the storm drain sediments. Both SD-1 and SD-2 soils contained gamma-chlordane at concentrations of 340 ug/kg and 120 ug/kg, respectively. The SD-2 sediments also contained endosulfan I at a concentration of 11 ug/kg. SD-3 soil did not contain any pesticides, and no PCBs were detected in any of the drains (Table 6-23).

Copper was present in SD-1, SD-2, and SD-3 sediments at concentrations of 4,230 mg/kg, 650 mg/kg, and 802 mg/kg, respectively. Aluminum was found in SD-1 and SD-3 samples at concentrations of 10,400 mg/kg and 1,320 mg/kg, respectively, and silver was present in SD-2 and SD-3 samples at concentrations of 8.6 mg/kg and 3.1 mg/kg, respectively. SD-1 also contained elevated levels of cadmium (3.8 mg/kg), lead (1,130 mg/kg), and mercury (2.7 mg/kg) (Table 6-24).

6.8.2.2 Aqueous Material

Only one volatile organic was detected in the storm drain aqueous samples. A 1,1,1-trichloroethane concentration of 29 ug/l was present in SD-2 (Table 6-25). Semivolatiles were detected in both SD-1 and SD-2 at very low levels. The SD-1 sample contained di-n-butylphthalate and di-n-octylphthalate at concentrations of 0.6 ug/l and 0.2 ug/l, respectively. Four TICs were detected in the SD-1 sample at a total concentration of 197 ug/l. SD-2 also contained di-n-butylphthalate (1.0 ug/l) and di-n-octylphthalate (0.6 ug/l). In addition, phenanthrene (0.7 ug/l), fluoranthrene (1.0 ug/l), pyrene (0.8 ug/l), and chrysene (0.9 ug/l) were detected. Three TICs were also detected in the SD-2 sample at a level of 40 ug/l (Table 6-25). No pesticides or PCBs were detected (Table 6-25).

Metals were found in both storm drain samples. The SD-1 liquid contained antimony (70.7 mg/l), copper (25.4 mg/l), and zinc (61.6 mg/l), and the SD-2 liquid contained copper (59.1 mg/l), lead (1,410 mg/l), and zinc (85.3 mg/l) (Table 6-25).

Summary

The contamination detected in the contents (sediments and/or aqueous material) of the leaching pools, sanitary cesspools and storm drains existing beneath the Circuitron Corporation Site consisted of significant levels of volatile, semivolatile and inorganic compounds higher than the expected background soil concentrations expected to be found in U.S. sandy soils. Therefore, these underground structures currently serve as potential contaminant sources to the soil and/or groundwater below the site. The presence of all the contaminants found in the contents of the pools could be primarily attributed to the illegal discharges of untreated wastes during the operation of the Circuitron plating facility.

6.9 DRILL BLANKS

Three samples of the inorganic bentonite slurry, one sample of the potable water and one sample of the sand used for the mud rotary drilling of the deep monitoring wells were collected and sent to the assigned CLP laboratories to be analyzed for the same parameters as the soil and the groundwater samples (volatile organics, extractables and inorganics). The bentonite slurry (mud) samples were sent to the laboratory moist in order to avoid the loss of volatile compounds. The analyses of these samples were rejected in the QA validation and review process, which was performed from October, 1989, to February 1990, due to their high moisture content (over 50%). This was the USEPA validation protocol which had been in effect since March 1989. However, this validation protocol has been changed and the new one came in effect in March 1990. According to this new USEPA validation protocol, analytical results that had been rejected in the past due to their high moisture content (over 50%) should now be flagged with a "J" (estimated value) and could be included in the RI report document. Copies of the original form 1 of the drill blanks that had been previously rejected, are now included in Appendix E of Volume II of this report with all the "R"s changed to "J"s. The analytical results of the mud samples (CC-DB-01, CC-DB-03 and CC-DB-04), the potable water sample (CC-DB-02) and the sand sample (CC-DB-05) are summarized and presented in Table 6-26.

A comparison was made between the analytical results of the drill blanks and those of the groundwater and soils samples collected from the corresponding monitoring wells and monitoring well borings (at the 95-97 foot depth interval).

The volatile organic compounds detected in the drill blanks were not detected in the soil and/or groundwater samples from wells MW-1D, MW-3D, MW-5D and MW-7D. Semivolatiles and pesticides/PCBs were not found in the drill blanks with the exception of 1,2,4-trichlorobenzene in CC-DB-01 which was not present in MW-1D. The metals present in the drill blanks are in estimated concentrations lower than the background soil concentrations (see Table 8-3). The only exceptions were aluminum and zinc which have not been identified as contaminants of concern neither in the soil nor in the groundwater. Therefore, it does not appear that cross contamination has occurred between the mud and the soil/groundwater samples.

TABLE 6-26

CIRCUITRON CORPORATION SITE

CONTAMINANTS DETECTED IN THE DRILL BLANKS

Sample ID From Compound	CC-DB-01(1) MW-1D	CC-DB-02(2) MW-3D	CC-DB-03(1) MW-7D	CC-DB-04(1) MW-5D	CC-DB-05(3) MW-7D
A. Volatiles (ug/kg)		NOT ANALYZED			
Methyl Chloride	160.0 BJ		220.0 BJ	380.0 BJ	37.0
Acetone	94.0 BJ		290.0 J	600.0 BJ	5.0 J
Chloroform	22.0 BJ				
2-Butanone	380.0 J				
Benzene	18.0 BJ				
Toluene	20.0 J				
Chlorobenzene	160.0 J			44.0 J	
B. Semivolatiles (ug/kg)					
1,2,4-Trichlorobenzene	540.0 J				
C. Inorganics (mg/kg)					
Aluminum	644.0	128.0 B	10,100.0	10,600.0 J	64.4 J
Antimony					9.3 B
Arsenic	0.73		10.6 BJ	36.2 J	
Barium	8.6 B		69.4 BJ		5.6 B
Calcium	708.4 B	5,400.0	6,920.0 BJ	6,210.0 BJ	13.0 B
Chromium		28.6 J			1.5 B
Copper	6.6	87.5	63.2 BJ		1.5B
Iron	347.5	2,900.0	5,100.0 J	4,560.0 J	39.1
Lead	3.2	1.2 BJ	44.6 J	40.0 J	0.86 B
Magnesium	318.0 B				
Manganese	4.2	61.8	51.7 J	52.1 J	0.65 B
Nickel	3.0 B				
Potassium	103.6 B				
Sodium	1,123.2	6,110.0	15,200.0 J	15,900.0 J	20.5 B
Zinc	11.0	125.0	132.0 J	86.0 J	40.0 J

Notes:
(1) Mud blank
(2) Potable water blank
(3) Sand Blank

7.0 CONTAMINANT FATE AND TRANSPORT

An understanding of the environmental fate and transport of the contaminants present at the Circuitron Corporation Site is necessary to determine the potential for continued on-site and/ or off-site migration of the contaminants of concern and to assess the potential for exposure to these contaminants. Two major factors affecting the fate and transport of a chemical are chemical mobility and persistence in environmental media. Mobility is a measure of the tendency for a chemical to migrate through the environment and is affected by the site characteristics, and by the physical/chemical characteristics of the compound. The chemical specific characteristics are: chemical aqueous solubility, volatilization, sorption, hydrolysis, photolysis, and oxidation rates. Persistence, a measure of the time a chemical remains in the environment, is influenced by many of the factors affecting chemical mobility (including photolysis, hydrolysis, and oxidation), but is also a function of chemical-biological interactions in the environment such as biodegradation and/or bioaccumulation.

This chapter summarizes the Circuitron Corporation Site environmental and waste characteristics and disposal practices (7.1), environmental fate and transport processes including fate and transport data (physical/chemical characteristics of contaminants) (7.2), as well as transport and migration mechanisms of contaminants (7.3).

7.1 SITE CHARACTERISTICS

7.1.1 Site Environmental Characteristics

The fate and transport of contaminants are affected by site environmental characteristics namely the geology and soil type, geochemistry, hydrology and climate. These characteristics, except the geochemistry, are discussed in Sections 4.0 and 5.0 of this RI report. A summary of these characteristics is presented in the following subsections.

Geology

The Circuitron Corporation Site is located on outwash plain deposits south of the Ronkonkoma recessional moraine. These deposits, which are a mixture of coarse sand and gravel, constitute the soils of the Upper Glacial Aquifer. These soils overlay a southward sloping wedge of unconsolidated deposits consisting of the Magothy aquifer, an aquiclude of Raritan clay, the Lloyd sand aquifer and finally bedrock (Franke and McClymonds, 1972).

Recharge to the Upper Glacial Aquifer occurs by percolation of precipitation; the underlying aquifers are hydraulically connected to the Upper Glacial aquifer (EA, 1987). The geology of the site is detailed in Section 5.0 of this RI report.

Soil

The site soil column is deep. Grain size analysis and total organic carbon analyses were performed on soils sampled from 5 to 32 feet in four different monitoring well borings. The grain size averaged 22.6% gravel, 75.8% sand and 1.6% silt-clay. Soil texture is an important factor and can control a contaminants' mobility (e.g., Hirata and Muraoka, 1988). The organic carbon content of soils averaged 0.058% (range: 0.010% to 0.270%); the cation exchange capacity of the soil was not determined but is likely to be minor because of the small amount of the silt/clay fraction.

Geochemistry

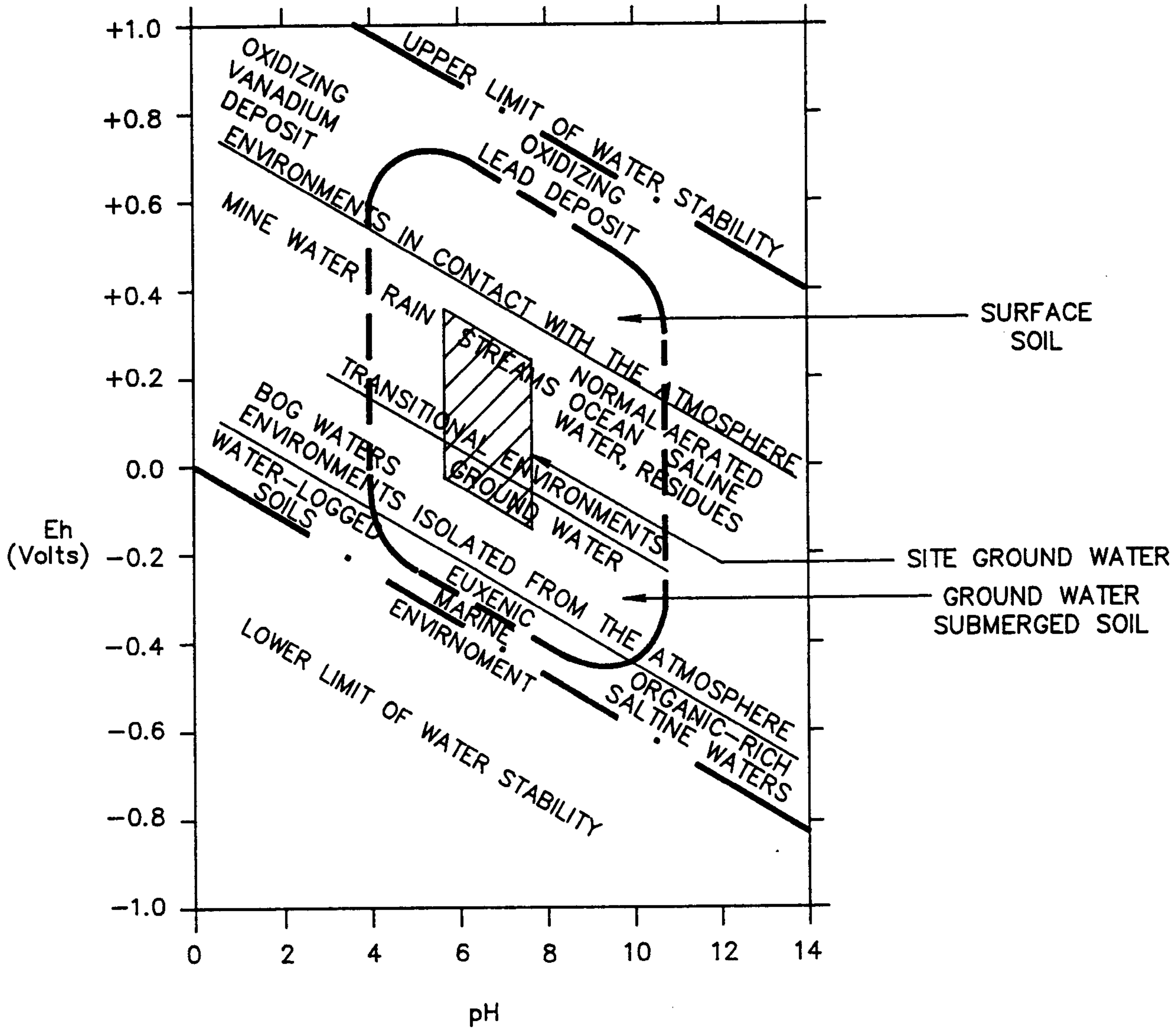
The geochemical environment of the Circuitron Corporation Site, (i.e., whether it is an aerobic or anaerobic environment) can affect the fate of contaminants on the site. For example, reductive dechlorination of chlorinated volatile organics may be a significant fate process for compounds under anaerobic conditions (Kleopfer et al, 1985). However, under aerobic conditions, volatilization may be a more important fate process for these contaminants.

The fate of inorganic metals is also affected by the geochemical environment. The potential fixation and/or mobility of elements in soils, for example, is greatly influenced by the pH and Eh of the aqueous phase. In addition, the toxicity of some elements is dependent upon their oxidation states (e.g., arsenic, chromium).

The limits superimposed on the Eh-pH diagram of natural environments (Figure 7-1) suggests that the site groundwater is a transitional environment with good potential for contaminant exchange with the environment (Eh = +0.360 volts) to an environment isolated from the atmosphere (Eh = -0.020 volts) in which no exchange with the atmosphere can occur. Comparison of Figure 7-1 and Table 4-6 shows that in fact most of the measured redox potentials were positive with dissolved oxygen concentrations supporting the contention that there is exchange with the atmosphere.

7.1.2 Waste Characteristics and Disposal Practices

The history of the disposal practices and the nature of the waste was discussed in Section 1.2.2. Briefly, chlorinated solvents and spent metal plating solutions were discharged to unauthorized leaching pools below the Circuitron building and to storm sewers adjacent to the building. Both the leaching pool and storm sewers were not contained, so the discharge was able



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SCALE NONE

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CIRCUITRON CORPORATION SITE

GROUNDWATER Eh–pH SITE LIMITS SUPERIMPOSED ON A DIAGRAM SHOWING APPROXIMATE POSITION OF SOME NATURAL ENVIRONMENTS AS CHARACTERIZED BY Eh AND pH. (MODIFIED, AFTER GARRELS AND CHRIST, 1969)

EPA

8310.065

FIG. NO.7–1 00

CIRC–15.DWG

to percolate into soils. Monitoring wells installed by Circuitron Corporation showed contamination by chlorinated solvents and metals.

7.2 ENVIRONMENTAL FATE AND TRANSPORT PROCESS

This section defines the factors affecting environmental fate and transport processes and summarizes pertinent environmental fate and transport data for the chemical classes detected at the Circuitron Corporation Site. Data for specific compounds have been elaborated upon where available and particularly relevant.

7.2.1 Factors Affecting Environmental Fate and Transport Processes

- Solubility is the measure of a chemical's ability to dissolve in water and is expressed in units of chemical mass/unit volume of water (e.g., ug/l or mg/l). Aqueous solubility is an important determinant of chemical concentration and residence time in water. Highly soluble chemicals readily dissolve in water and remain in solution whereas chemicals exhibiting low solubility tend to adsorb to solids or form non-polar phases. Solubility is also related to the ease of leachability of the chemical from wastes and soils.

- Volatilization describes the movement of a chemical from the surface of a liquid or solid matrix to a gas or vapor phase. Only the neutral (uncharged) form of compounds can volatilize. Therefore, the fraction of the compound in the uncharged form should be calculated using pKa (acids) or pKb (bases) under the site pH conditions. Volatilization is calculated from the equilibrium vapor pressure which measures chemical solubility in air (when the initial chemical concentration is in the liquid phase). Volatilizazation losses to air are related to the chemical concentration, molecular weight, solubility and ambient temperature. Volatilization is a particularly important environmental fate process for chemicals exhibiting low aqueous solubility and polarity. Lyman et al. (1982) described compounds as readily, significantly or limitedly volatilized based on the values of their Henry's Law constants. These values in atm-m^3/mol are $\geq 10^{-3}$, 10^{-3} to 10^{-5} and 10^{-5}, respectively.

- Adsorption and desorption are the binding to and release from (respectively) a chemical to a solid matrix. Although adsorption is generally modelled as a fully reversible process, there is evidence in the published literature that there is a partially irreversible component related to the length of time that the material has been adsorbed (Di Toro and Horzempa, 1983; Voice and Weber, 1983). Generally, the less polar the chemical of interest, the greater the adsorption to the solid phase (e.g., soils, sediments and suspended solids). Adsorption to a solid phase limits the fraction available for other fate process such as volatilization and/or hydrolysis. Partition coefficients, which are important measures of sorptive characteristics, define the relative concentration of a given chemical in two phases or matrices.

- Partition coefficients are expressed as concentration ratios between two phases. Partition coefficients useful in describing the environmental behavior of a chemical include Kow, Kd and Koc. These are defined as:

Kow: The octanol-water partition coefficient is the ratio of the chemical concentration in octanol to that in water at equilibrium conditions. The octanol serves as a surrogate for lipid or other organic phases.

Kd: The soil-water partition coefficient is the ratio of the chemical concentration in the solid and aqueous phases. The Kd values are constant for inorganic analytes but are dependent upon the organic carbon content of the solid phase for organic compounds.

Koc: The organic carbon-water partition coefficient is the Kd normalized to the fraction of organic carbon in the solid phase. High Koc values usually indicate a high tendency of an organic compound to adsorb to the soil organic matter. Koc's are calculated for organic compounds only since adsorption of inorganics to solids is less dependent upon the organic carbon fraction of the solid phase.

- Bioconcentration is the accumulation of a chemical by plants or animals due to an aqueous exposure alone. The potential for bioconcentration is quantified by bioconcentration factors (BCFs) which is the concentration ratio of the contaminant in the animal or plant tissue and the aqueous concentration. Organic chemicals with large BCFs (e.g., pesticides) generally are lipophilic and tend to accumulate in animal fat tissues. Some heavy metals (e.g., mercury) can also be bioconcentrated. Literature BCF values most commonly pertain to fish species. Bioaccumulation is the accumulation of a contaminant both via the water and through the food chain. Utilizing BCFs alone would tend to underestimate the potential contaminant concentration in the organism if the food chain transfer contributes significantly to the exposure.

- Biotransformation/Biodegration: Many microorganisms and biota are resistant to or develop resistance to chemicals (particularly organic chemicals) and can metabolically transform the compounds to products which may or may not be as toxic as the original compounds. Biotransformation includes a variety of enzyme-catalyzed reactions such as oxidation and reduction.

- Hydrolysis is the reaction of a chemical with hydrogen ions (H+) and hydroxyl radicals (OH^-) resulting in the breakdown or structural modification of the chemical in the environment. The extent of a chemical's hydrolytic reactivity depends on both pH (acidity/alkalinity) of the environment and the molecular structure of the specific chemical.

- Photolysis is a chemical decomposition process induced by radiant energy (sunlight). The rate of loss of a chemical from photochemical reactions depends on both its molecular structure, the proximity and character of the light source and the presence of other reactant compounds.

- Oxidation is a chemical reaction which involves the removal of electrons from a metal or other chemical. Conversely, electrons are added to chemical substrates in reduction reactions. Both oxidation and reduction reactions are significant in that they influence the mobility and fate of chemicals in environmental matrices. Oxidized and reduced forms of the same chemical may also exhibit unique chemical, ecological and/or toxicological properties (e.g., arsenic).

7.2.2 Fate and Transport Data

This section summarizes the chemical characteristics and the available environmental fate and transport data for organic and inorganic chemicals detected at the Circuitron Corporation Site. The chemicals detected were grouped into two groups: organic (7.2.2.1) and inorganic (7.2.2.2). The organic constituents were grouped into four generalized classes sharing similar characteristics. These classes are: (1) volatile organics (chlorinated and non-chlorinated), (2) semivolatiles (base neutral and acids), (3) pesticides and (4) PCBs. The subsections to follow provide a discussion of the characteristics of chemicals of each class with specific highlight of the indicator chemicals identified in the risk assessment (Chapter 8.0). A summary of the fate and transport data is given in Table 7-1 (organic) and Table 7-2 (inorganic).

7.2.2.1 Organic Chemicals

Volatile organics and semivolatile organics were detected in groundwater and soils at the Circuitron Corporation Site.

TABLE 7-1

CIRCUITRON CORPORATION SITE
ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS: ORGANICS

	WATER(a) SOLUBILITY (mg/l)	VAPOR(a) PRESSURE (mm Hg)	HENRY'S LAW(a) CONSTANT (atm-m^3/mol)	K_{oc}(a) (l/kg)	Log(a) K_{ow}	Susceptible to(b) Photolysis	Susceptible to(b) Hydrolysis
1. VOLATILES							
<u>CHLORINATED VOLATILE ORGANICS</u>							
Chlorobenzene	4.66×10^2	1.17×10^1	3.72×10^{-3}	330	2.84	Negligible	No
Chloroform	8.20×10^3	1.51×10^2	2.87×10^{-3}	31	1.97	Negligible	Negligible
Dichlorodifluoromethane	2.80×10^2	4.87×10^3	-	58	2.16	-	-
1,1-Dichloroethane	5.50×10^3	1.82×10^2	4.31×10^{-3}	30	1.79	Negligible	Negligible
1,2-Dichloroethane	8.52×10^3	6.40×10^1	9.78×10^{-4}	14	1.48	Negligible	Negligible
1,1-Dichloroethene	2.25×10^3	6.00×10^2	3.40×10^{-2}	65	1.85	Negligible	No
Trichloroethene	1.10×10^3	5.79×10^1	9.10×10^{-3}	126	2.38	Negligible	No
Tetrachloroethene	1.50×10^2	1.78×10^1	2.59×10^{-2}	364	2.66	Negligible	Negligible
1,1,1-Trichloroethane	1.50×10^3	1.23×10^2	1.44×10^{-2}	152	2.5	Negligible	Negligible
1,1,2-Trichloromethane	4.50×10^3	3.00×10^1	1.17×10^{-3}	56	2.47	Negligible	Slight
<u>NON-CHLORINATED VOLATILE ORGANICS</u>							
Benzene	1.75×10^3	9.52×10^1	5.59×10^{-3}	83	2.12	Negligible	No
Toluene	5.35×10^2	2.81×10^1	6.37×10^{-3}	300	2.73	Negligible	No
Ethylbenzene	1.52×10^2	7.00	6.43×10^{-3}	1.10×10^3	3.15	Negligible	No
Total Xylene	1.98×10^2	1.00×10^1	7.04×10^{-3}	240	3.26	—	—

TABLE 7-1 (Cont'd)

CIRCUITRON CORPORATION SITE
ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS: ORGANICS

	WATER(a) SOLUBILITY (mg/l)	VAPOR(a) PRESSURE (mm Hg)	HENRY'S LAW(a) CONSTANT (atm-m^3/mol)	K_{oc}(a) (l/kg)	Log(a) K_{ow}	Susceptible to(b) Photolysis	Susceptible to(b) Hydrolysis
2. SEMIVOLATILES							
BASE/NEUTRAL EXTRACTABLES							
Acenaphthene	3.42	1.55×10^{-3}	9.20×10^{-5}	4.6×10^{3}	4.00	Negligible	-
Acenaphthylene	3.93	2.9×10^{-2}	1.48×10^{-3}	2.5×10^{3}	3.70	-	No
Anthracene	4.50×10^{-2}	1.95×10^{-3}	1.02×10^{-3}	1.4×10^{4}	4.45	Negligible	No
Benzo(a)anthracene	5.70×10^{-3}	2.20×10^{-8}	1.16×10^{-6}	1.38×10^{6}	5.60	Negligible	No
Benzo(a)pyrene	1.20×10^{-3}	5.60×10^{-9}	1.55×10^{-6}	5.50×10^{6}	6.06	Negligible	No
Benzo(b)fluoranthene	1.40×10^{-2}	5.00×10^{-7}	1.19×10^{-5}	5.50×10^{5}	6.06	-	No
Benzo(g,h,i)perylene	7.00×10^{-4}	1.03×10^{-10}	5.34×10^{-8}	1.60×10^{6}	6.51	-	No
Benzo(k)fluoranthene	4.30×10^{-3}	5.10×10^{-7}	3.94×10^{-5}	5.50×10^{5}	6.06	-	No
Bis(2-ethylhexyl) phthalate	0.4	2.0×10^{-7} (20°C)	3.00×10^{-7}	2.00×10^{9}	9.61	Negligible	Negligible
Butylbenzyl phthalate	2.9(2)	6.0×10^{-5}(B)	8.30×10^{-6}(B)	1.70×10^{5}(B)	5.56(B)	Negligible	Slight
Chrysene	1.80×10^{-3}	6.30×10^{-9}	1.05×10^{-6}	2.00×10^{5}	5.61	-	No
Dibenzo(a,h)anthracene	5.00×10^{-4}	1.00×10^{-10}	7.33×10^{-8}	3.3×10^{6}	6.80	-	No
1,4-Dichlorobenzene	7.90×10^{1}	1.18	2.89×10^{-3}	1700	3.60		
Diethyl phthalate	8.96×10^{2}	3.50×10^{-3}	1.14×10^{-6}	142	2.50	Negligible	Slight
Dimethyl phthalate	5.00×10^{3}(B)	4.19×10^{-3} (20°C)	2.15×10^{-6}	17.4(B)	1.56(B)	Negligible	Slight
Di-n-butyl phthalate	1.30×10^{1}	1.00×10^{-5}	2.82×10^{-7}	1.70×10^{5}	5.60	Negligible	Slight
Di-n-octyl phthalate	3.0(B)	1.40×10^{-4}(B)	1.70×10^{-5}(B)	3.6×10^{9}(B)	9.87	Negligible	Slight

TABLE 7-1 (Cont'd)

CIRCUITRON CORPORATION SITE
ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS: ORGANICS

	WATER(a) SOLUBILITY (mg/l)	VAPOR(a) PRESSURE (mm Hg)	HENRY'S LAW(a) CONSTANT (atm-m^3/mol)	K_{oc} (a) (l/kg)	Log(a) K_{ow}	Susceptible to(b) Photolysis	Susceptible to(b) Hydrolysis
2. SEMIVOLATILES (Cont'd)							
BASE/NEUTRAL EXTRACTABLES (Cont'd)							
Fluoranthene	2.06×10^{-1}	5.00×10^{-6}	6.46×10^{-6}	3.80×10^{4}	4.90	-	No
Fluorene	1.69	7.19×10^{-4}	6.42×10^{-5}	7.30×10^{3}	4.20	-	No
Hexachloroethane	5.00×10^{1}	4.00×10^{-1}	2.49×10^{-3}	2.00×10^{4}	4.00	-	-
Indeno(1,2,3-c,d)pyrene	5.30×10^{-4}	1.00×10^{-10}	6.86×10^{-8}	1.60×10^{6}	6.50	-	No
Napthalene	31.7(b)	8.70×10^{-2}(b)	4.60×10^{-4}(b)	940(b)	3.29(b)	-	No
Phenanthrene	1.00	6.80×10^{-4}	1.59×10^{-4}	1.40×10^{4}	4.46	-	No
Pyrene	1.32×10^{-1}	2.50×10^{-6}	5.04×10^{-6}	3.80×10^{4}	4.88	-	No
ACID EXTRACTABLES							
Benzoic Acid	2.90×10^{3}(B) (18°C)	-	-	46(D)	1.87(C)	-	-
4-Chloro-3-methylphenol	3.85×10^{3}(B)	5×10^{-2}	2.5×10^{-6}	550(D)	2.95(B)	-	-
4-Methylphenol	2.40×10^{4}(C) (40°C)	1.10×10^{-1}(3)	-	54(D)	1.94[C]	-	-
Pentachlorophenol	1.40×10^{1}	1.10×10^{-4}	2.75×10^{-6}	5.3×10^{4}	5.0	Slight	No
Phenol	9.30×10^{4}	3.41×10^{-1}	4.54×10^{-7}	14.2	1.46	Negligable	No

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(a) - USEPA, 1986.
(b) - Clement Associates, (1985).
(c) - SRI (1982)
(d) - Calculated from log K_{oc} - log K_{0w} regression (Karickhoff et al, 1979).

TABLE 7-1 (Cont'd)

CIRCUITRON CORPORATION SITE
ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS: ORGANICS

	WATER$^{(A)}$ SOLUBILITY (mg/l)	VAPOR$^{(A)}$ PRESSURE (mm Hg)	HENRY'S LAW$^{(A)}$ CONSTANT (atm-m^3/mol)	K_{oc} $^{(A)}$ (l/kg)	Log$^{(a)}$ K_{ow}	Susceptible to$^{(b)}$ Photolysis	Susceptible to$^{(b)}$ Hydrolysis
3) PESTICIDES/PCBs							
Aldrin	1.80×10^{-1}	6.00×10^{-6}	1.60×10^{-5}	9.60×10^{4}	5.30	Negligable	No
BHC-Delta	31.4×10^{1}	1.70×10^{-5}	2.07×10^{-7}	6.60×10^{3}	4.10	Negligable	No
Chlordane	5.60×10^{-1}	1.00×10^{-5}	9.63×10^{-6}	1.40×10^{5}	3.32	Negligable	No
DDE	4.00×10^{-2}	6.50×10^{-6}	6.80×10^{-5}	4.40×10^{6}	7.00	Negligable	Negligable
DDT	5.00×10^{-3}	5.50×10^{-6}	5.13×10^{-4}	2.43×10^{5}	6.19	Negligable	Negligable
Endosulfan I	$5.30 \times 10^{-1(C)}$	$1.0 \times 10^{-5(C)}$	$1.0 \times 10^{-5(C)}$	$9.6 \times 10^{-3(C)}$	$-1.70^{(C)}$	-	Yes
Endosulfan Sulfate	$2.20 \times 10^{-1(C)}$	$1 \times 10^{-5(C)}$	$2.6 \times 10^{-5(C)}$	$2.4 \times 10^{-1(C)}$	$-1.30^{(C)}$	-	
Heptachlor	1.80×10^{-1}	3.00×10^{-4}	8.19×10^{-4}	1.20×10^{4}	4.40	-	Negligable
Heptachlor epoxide	3.50×10^{-1}	3.00×10^{-4}	4.39×10^{-4}	2.20×10^{2}	2.70	-	No
Aroclor 1248	$5.40 \times 10^{-1(C)}$	$4.94 \times 10^{-4(C)}$	3.60×10^{-3}	2.77×10^{5}	5.76	-	No
Aroclor 1254	$3.10 \times 10^{-1(C)}$	$7.71 \times 10^{-5(C)}$	2.60×10^{-3}	5.30×10^{5}	6.04	-	No
Aroclor 1260	$2.7 \times 10^{-3(C)}$	$4.05 \times 10^{-5(C)}$	7.40×10^{-1}	6.70×10^{6}	7.15	-	No

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(A) - USEPA, 1986.
(B) - Clement Associates (1985).
(C) - SRI (1982)

TABLE 7-2

CIRCUITRON CORPORATION SITE

ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS: INORGANICS

Inorganic Compound	K_d (a)	Susceptibility to Photolysis
Arsenic (As)	200	No
Beryllium (Be)	650	No
Cadmium (Cd)	6.5	No
Chromium (Cr)	850	No
Copper (Cu)	35	Yes (b)
Lead (Pb)	900	Yes (b)
Mercury (Hg)	10	Yes
Nickel (Ni)	150	No
Silver (Ag)	45	No

Notes:

(a) The K_d is the water-solid phase partition coefficient (l/kg); data from Baes et al, 1984

(b) Principally organo-metallic complexes are capable of undergoing photolysis

Volatile Organics

Volatile organic compounds were detected in groundwater, surface soils and subsurface soils sampled during the site investigation. Of these, 10 compounds are chlorinated; the remaining 4 compounds are nonchlorinated. Because of the behavior and ultimate environmental fate and transport differences in these two groups of compounds, the discussion of the volatile contaminants of concern have been broken into two subclasses: chlorinated volatiles and nonchlorinated volatiles. Summary data for environmental fate and transport parameters are given in Table 7-1.

- Chlorinated Volatiles

Sources and Background

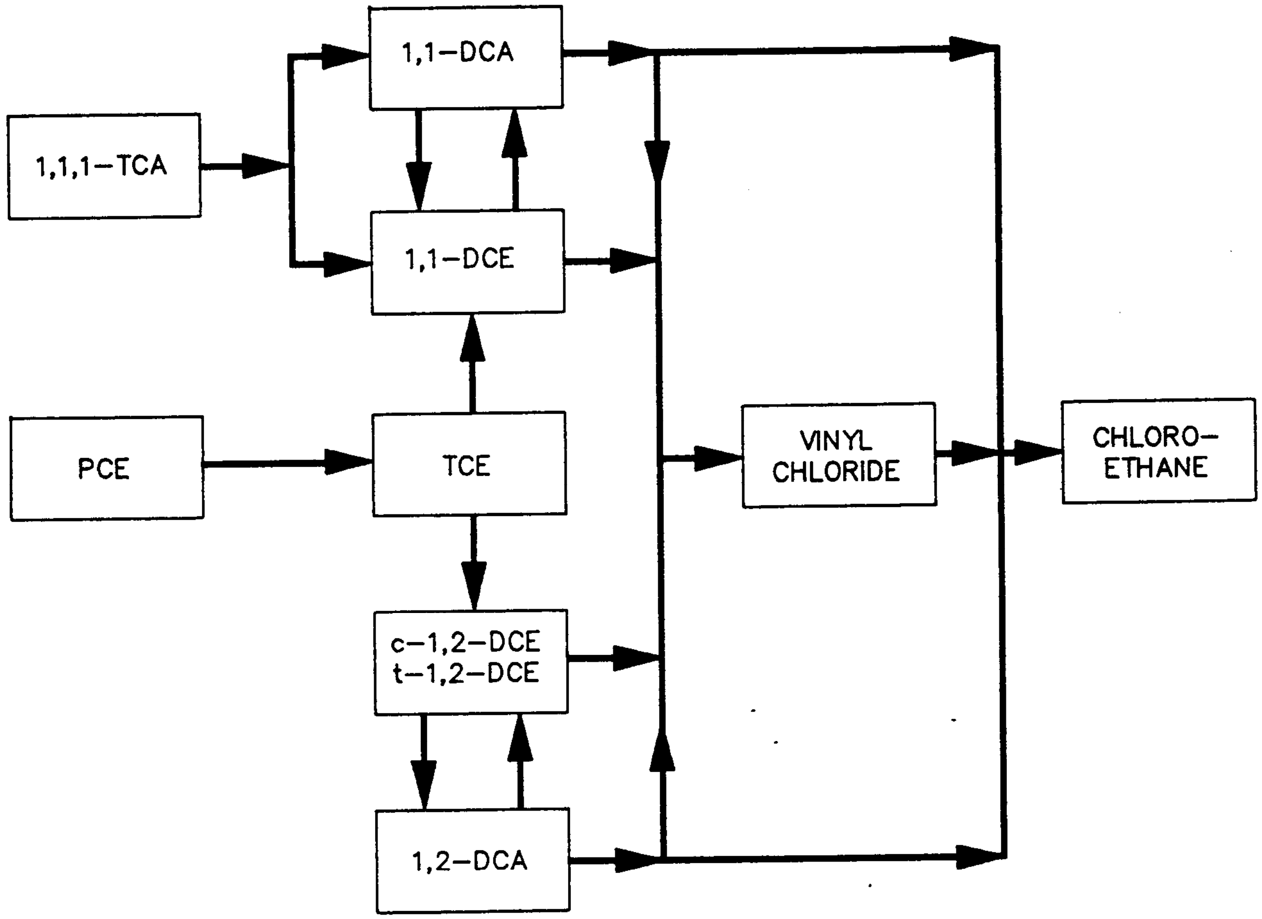
Among the chlorinated volatile organics detected at the Circuitron Corporation Site are trichloroethene, tetrachloroethene and 1,1,1-trichloroethane. These three principal solvents and degreasers were actively discharged to the leaching pools, "bottomless" storm drains and sanitary cesspools and the surface soil beneath and in the vicinity of the Circuitron building. The less chlorinated degradation products of the principal solvents in soils (Figure 7-2) detected are 1,1-dichloroethane, 1,2-dichloroethane and 1,1-dichloroethene. However, since vinyl chloride and chloroethane were not detected in site soils or groundwater, it appears that the extent of this degradation may not be great.

Solubility

The chlorinated volatile organic compounds associated with the site are highly water soluble, ranging from $1.50\text{x}10^2$ mg/l (tetrachloroethene) to $8.52\text{x}10^3$ mg/l (1,2-dichloroethane). The high solubilities for these compounds are due to their small molecular size, low molecular weights and high polarity. Given the highly soluble nature of these compounds in water, surface runoff and groundwater transport of chlorinated volatile organic compounds is a principal environmental fate process. These compounds were detected in groundwater from wells installed at the site.

Volatilization

As the vapor pressure and Henry's Law constants data (Table 7-1) illustrate, volatile chlorinated organics would be readily transported into the atmosphere from surficial soils and water matrices when in contact with the atmosphere. Vapor pressures (in mm mercury) range from 1.17×10^1 (chlorobenzene) to 4.87×10^3 (dichlorodifluoromethane) and Henry's Law constants



KEY

1,1,1-TCA: 1,1,1-TRICHLOROETHANE
PCE: TETRACHLORETHENE
1,1-DCA: 1,1-DICHLOROETHANE
1,1-DCE: 1,1-DICHLOROETHENE
TCE: TRICHLOROETHENE
1,2-DCE: 1,2-DICHLOROETHENE (CIS, TRANS ISOMER)
1,2-DCA: 1,2-DICHLORETHANE

EBASCO SERVICES INCORPORATED
DEPT ______ DR DSW
DATE ______ CH ___
SCALE NONE
APPROVED

U.S. ENVIRONMENTAL PROTECTION AGENCY
CIRCUITRON CORPORATION SITE
TRANSFORMATION PATHWAYS FOR VARIOUS CHLORINATED VOLATILE HYDROCARBONS IN SOIL SYSTEMS (DRAGUN,1988)

EPA
8310.065
FIG. NO.7-2 00

CIRC-16.DWG

range from 9.78 x 10^{-4} (1,2-dichloroethane) to 3.40 x 10^{-2} (1,1-dichloroethene) atm-m^3/mole for the volatile chlorinated organics associated with the Circuitron Corporation Site (EPA, 1986; Clement Associates, 1985). Thus, volatilization from the surface soils and shallow subsurface soils would be a major environmental fate process for chlorinated volatile organics at the site. The surface soil (0 to 5 feet) results support this conclusion since only two volatile analytes (chloroform and toluene) were present at low concentrations relative to those in deeper soils.

Adsorption /Desorption

The values for log Koc are comparatively low for the volatile organics (range: 14 to 364 l/kg) and thus adsorption to soils or organic matter would not be a significant environmental fate process for the chlorinated solvents associated with the site. This does not imply that there would be no soil associated volatile organics, but rather that the volatile organics associated with the soils would be labile and have the potential to be a source for groundwater or air contamination.

Bioaccumulation

Volatile organics associated with site soils do not pose a bioconcentration or bioaccumulation hazard since there are no waterbodies in the vicinity of the site.

Biodegradation/Biotransformation

Data pertaining to the biodegradation/biotransformation of the chlorinated volatile organic compounds associated with the site are not extensive. The biodegradation of chlorinated volatile compounds is a slow process (EPA, 1979). However, biodegradation rates are generally faster than abiotic degradation rates (e.g., hydrolysis; Vogel et al, 1987). Halogenated methanes, ethanes and ethenes can all undergo oxidation transformation by bacteria and higher organisms (Vogel et al, 1987).

Reductive dechlorination of chlorinated volatile compounds under anaerobic conditions is another significant transformation pathway. For example, 1,1,1-dichloroethane, which was the dominant chlorinated solvent at Circuitron, can be reductively dechlorinated to 1,1-dichloroethane which can be further degraded to ethanol via abiotic hydrolysis (Vogel et al, 1987).

Hydrolysis/Photolysis

Hydrolysis of chlorinated volatile compounds occurs very slowly with half-lives ranging from approximately 1.1 to 2.1 x 10^{10}

years (Table 7-3). Review of this table shows that the chlorinated ethenes are hydrolyzed much more slowly than the chlorinated ethanes.

The degradation of 1,1,1-trichloroethane is of interest since it was the dominant volatile contaminant at this site and has been discussed by Vogel et al (1987). Hydrolysis of 1,1,1-trichloroethane can occur by two alternative hydrolytic pathways under methanogenic (i.e., reduced) conditions with one product being 1,1-dichloroethene and the other product being acetic acid. The biotic pathway results in three products - 1,1-dichloroethane, chloroethane and ethanol. The product of one of the hydrolytic pathways (1,1-dichloroethene) can be further degraded to vinyl chloride. All products can be mineralized to carbon dioxide via biotic-mediation.

Direct photolytic degradation of chlorinated volatile organics via photodissociation is usually restricted to the stratosphere (EPA, 1979; Clement Associates, 1985). In aqueous environments, direct photodissociation is generally negligible or non-existent. For most of the chlorinated volatile organic compounds associated with the site, photooxidation mediated by hydroxyl radicals would be the predominant process of degradation in the atmosphere (EPA, 1979; Clement Associates, 1985). Therefore, photolytic degradation of chlorinated volatile organics is not a significant removal mechanism for these compounds.

Oxidation

Direct oxidation of chlorinated volatile organics is generally an insignificant process in natural environments (EPA, 1979; Clement Associates, 1985). As mentioned previously, photo-oxidation within the troposphere is the predominant, though relatively minor, degradation removal process.

Summary

Chlorinated volatile organic compounds are in general very labile and not very persistent in the environment, principally due to their high volatility, low adsorption to soils and high water solubility.

Due to the high mobility of chlorinated volatile organic compounds, a decrease in their concentrations in the various matrices is anticipated with time, as long as there is no additional input of these compounds.

- Non-Chlorinated Volatiles

Chemical data important in assessing the fate and transport of non-chlorinated volatile organics are summarized in Table 7-1.

TABLE 7-3

CIRCUITRON CORPORATION SITE

HALF-LIVES OF ABIOTIC HYDROLYSIS OF SELECTED CHLORINATED SOLVENTS IN THE SOILS AND GROUNDWATER

Compound	Half-Life (Years)	Ref
Chloroform	1.8×10^2	1
1,1-dichloroethane	61.3	1
1,1,1-dichloroethane	1.1	1
1,1-dichloroethene	1.2×10^8	1
Trichloroethene	1.3×10^6	1
Tetrachloroethene	9.9×10^8	1

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[1] Data from Jeffers et al (1989)

A brief synopsis of the important characteristics affecting the environmental fate of this entire class of compounds is presented in subsequent sections.

Sources and Background

Four non-chlorinated volatile organic compound were detected at the Circuitron Corporation Site. These are benzene, toluene, ethylbenzene, and total xylene. The concentrations of these contaminants are comparatively low (relative to the chlorinated volatile organics) suggesting that they may not have routinely used or disposed of at the site but were due to other sources of contamination (e.g., gasoline spills).

Solubility

The non-chlorinated volatile organic compounds present on site exhibit high water solubilities (1.52×10^2 to 1.75×10^3 mg/l; EPA, 1986; Verschueran, 1983). Considering their highly soluble nature in water, runoff and groundwater transport of these compounds will be a principal environmental fate process at the site. These compounds were detected in groundwater samples at the site.

Volatilization

As the vapor pressure and Henry's Law constant data in Table 7-1 illustrate, these compounds would be readily transported into the atmosphere from surficial soils. Vapor pressure (in mm mercury) ranges between 7.00×10^0 and 9.52×10^1; Henry's Law constant ranges between 5.59×10^{-3} and 7.04×10^{-3} atm-m^3/mole (EPA, 1986; Verschueran, 1983). Because of these high values, these compounds will tend to volatilize from matrices in contact with the atmosphere (e.g., surface soils).

Adsorption/Desorption

Adsorption to soils/sediments or organic matter is generally not a significant environmental fate process for non-chlorinated volatile compounds. They exhibit low K_{OC} (ranging between 83 to 300 l/kg), except for ethylbenzene ($K_{OC}=1.10 \times 10^3$ l/kg), and log K_{OW} (ranging between 2.12 to 3.26) coefficients (see Table 7-1) indicating a low affinity for adsorption to organic matter. Low K_{OC} values coupled with the high water solubility and volatility of most compounds make adsorption an insignificant environmental fate process, except for ethylbenzene, in relation to water and airborne transport mechanisms.

Bioaccumulation

The non-chlorinated volatile organics associated with site soils do not pose a bioconcentration or bioaccumulation hazard since there are no waterbodies in the vicinity of the site.

Biodegradation/Biotransformation

Biodegradation of these compounds occurs via microbial processes or metabolic pathways of higher organisms. Wilson et al (1986) quantified the decay of four alkylbenzenes (benzene, toluene, ethylbenzene and xylene) under methanogenic (i.e., reduced) conditions by aquifer soils. Although the authors did not calculate the decay rate constants, these values along with the contaminant half-lives can be calculated from their report. The results are shown in Table 7-4. Note that under reduced conditions the degradation of these compounds are fairly comparable. The exception to this is toluene which degrades more quickly relative to the other alkylbenzenes. The cause of this is unclear. The results do show that under anaerobic conditions these compounds can degrade.

Hydrolysis/Photolysis

Hydrolysis of these compounds generally does not occur (Clement Associates, 1985; EPA, 1979). Direct photodissociation within aqueous and/or atmospheric matrices is typically insignificant or negligible (EPA, 1979; Clement Associates, 1985).

Oxidation

Direct oxidation of these compounds associated with the site is generally an insignificant process in natural environments (EPA, 1979). Photooxidation within the troposphere is the predominant (though relatively insignificant) degradation removal process.

Summary

Compounds of this subclass generally are mobile and not very persistent in the environment due to their high volatility, low adsorption to soils and high water solubility.

Semivolatile Organics and Pesticide/PCBs

Thirty-one semi-volatile organic compounds were detected from the environmental matrices analyzed from the site. These include four phthalate ester compounds and eighteen polycyclic aromatic hydrocarbons (PAHs). The phthalate

TABLE 7-4

CIRCUITRON CORPPORATION SITE

DECAY RATE CONSTANTS AND CALCULATED HALF-LIVES OF SELECTED ALKYLBENZENES IN METHANOGENIC AQUIFER MATERIAL

Compound	Decay Rate Constant (weeks^{-1})	Half-Life (years)
Benzene	2.88×10^{-2}	0.46
Toluene	1.15×10^{-1}	0.12
Ethylbenzene	3.22×10^{-2}	0.41
Xylene	3.68×10^{-2}	0.36

Data calculated from Wilson et al (1986) compounds may represent compounds not directly associated with site activity, but are attributale to leaching of PVC piping and plastic drums. Similarly, the PAHs can be classified in the same manner since they could be attributed to road runoff from the parking lots. Two Aroclor PCBs were found in surface soils sampled in the vicinity of the aboveground "heating oil" tank. The processes controlling the fate and transport of these contaminants in the environment are discussed in the following sections.

- Phthalate esters

The relevant data describing the fate and transport of the phthalate esters is shown in Table 7-1.

Sources and Background

Phthalate esters are base/neutral extractables which are ubiquitous environmental contaminants. Their presence on the site is likely due to the leaching of plastic piping and drums and not due directly to site disposal activity.

Solubility

Phthalate esters are typically some of the more soluble base/neutral extractable organic compounds, primarily due to their low aromaticity (i.e., only one benzene ring) and the high polarity imparted to the molecule by the diester linkage. Variability in aqueous solubility among the different phthalate esters depends upon the hydrophobic character of the functional groups attached to the diester linkage. Additionally, phthalate esters readily form complexes with fulvic acid that result in fulvic acid-phthalate complexes which are very soluble in water, thus mobilizing and increasing the aqueous solubility of some of the less soluble phthalate esters (USEPA, 1979).

Water solubilities for the phthalate esters associated with the site ranges between 0.40 mg/l (bis(2-ethylhexyl) phthalate) and $5.00\text{x}10^3$ mg/L (dimethyl phthalate) (USEPA, 1979). Very low levels of these compounds were detected in some of the water samples of the site. Because of their low solubilities, except dimethyl phthalate, runoff and groundwater transport of the phthalate esters will not be an important environmental fate process at the site. Dimethyl phthalate was detected only in the dry leaching pool sediment samples. This compound may have been disposed of in the pool.

Volatilization

In general, phthalate esters are not very volatile. Vapor pressures (mm Hg) for the phthalate esters detected on-site range from $2.00\text{x}10^{-7}$ (bis(2-ethylhexyl)phthalate) to $4.19\text{x}10^{-3}$ (dimethyl phthalate), whereas Henry's Law constants range from 2.82×10^{-7} (di-n-butyl phthalate) to 1.7×10^{-5} (di-n-octyl phthalate) atm-m^3/mole (USEPA, 1979). Due to their low volatilization rates, volatilization of phthalate esters at the site will be an insignificant environmental fate process.

Photolysis

Direct photolysis of phthalate esters is unlikely to occur, and indirect photolysis via hydroxyl radical interaction with the aromatic ring is a negligible, slow process in the natural environment (USEPA, 1979). Thus, photolysis would be an environmentally insignificant degradation process for these compounds at the site.

Oxidation

No information was found in the literature to suggest that oxidation is a significant environmental fate process for phthalate esters in the natural environment.

Hydrolysis

Phthalate esters are susceptible to hydrolytic reactions, but these reactions typically proceed at such a slow rate (i.e., half-lives on the order of years) that hydrolysis of these compounds is not significant in the natural environment (USEPA, 1979). In general, the hydrolysis rate is slower for longer chain esters and may be catalyzed by both acids and bases (USEPA, 1979). Low hydrolysis rates, in combination with the very low concentrations of these compounds detected in water samples at the site may relegate this environmental fate mechanism to one of little importance.

Adsorption/Desorption

Some of the phthalate esters detected on site adsorb readily to organic matter and soil particles. The tendency to readily adsorb to organic matter is reflected in the high K_{OC} (1.70×10^5 (butylbenzylphthalate and di-n-butyl phthalate), 2.00×10^9 (bis(2-ethylhexyl)phthalate), and 3.6×10^9 (di-n-octyl phthalate)) and log K_{OW} (5.6 (butyl benzyl phthalate and di-n-butyl phthalate), 9.61 (bis(2-ethylhexyl)phthalate) and 9.87 (di-n-octyl phthalate)) partition coefficients for these compounds (USEPA, 1979; USEPA, 1986). The high binding affinity of phthalate esters to soil is substantiated by the data which showed phthalates in the on-site soils (Section 6.0). Therefore, the adsorption of phthalate esters to organic matter and/or soil particles will be an important environmental fate process at the site.

Bioaccumulation

An evaluation of the potential bioconcentration and bioaccumulation of phthalate esters is not required for this site.

Biodegradation/Biotransformation

Biodegradation is a significant environmental fate process for the phthalate esters associated with the site. Phthalate esters are degraded under most conditions by microbial populations and/or metabolized by multicellular organisms (USEPA, 1979). Microbial degradation occurs readily under aerobic conditions, and more slowly under anaerobic conditions, with rates greatly increasing if the compounds are utilized as a sole carbon source (USEPA, 1979; Gibbons and Alexander, 1989).

Summary

In general, phthalate esters associated with the site are relatively persistent in soil matrices. This is primarily due to their high affinity for organic matter and soil particles, low water solubility, resistance to photolytic, oxidative and hydrolytic degradation, and low volatilization rate. However, once desorbed from soil, phthalate esters would not persist appreciably due to their water solubilities and susceptibility to microbial degradation. Microbial degradation may occur under certain environmental conditions leading to a decrease in phthalate ester concentrations. Accordingly, a decrease in these compounds concentrations is expected at the site, however, at a slower rate relative to volatile organics.

o Polycyclic Aromatic Hydrocarbons (PAHs)

Relevant data describing the physico-chemical characteristics which affect the fate and transport of the PAHs are shown in Table 7-1.

Sources and Background

The PAHs at the Circuitron site were detected in the sediments of the storm drains and authorized SPDES leaching pool. Both the storm drains and leaching pool received road surface runoff since they are located in parking lots. As discussed in Chapter 6.0, the contamination of PAHs in these sediments was due to the PAHs associated with oils, grease, gasoline and gasoline combustion products from motor vehicles. Substantiation for this conclusion was the lack of PAHs in the unauthorized leaching pools below the Circuitron building.

Solubility

The solubility of PAH compounds is highly variable and a function of molecular structure, degree of aromaticity and presence and type of functional groups attached to the parent molecule. Generally, solubility is positively correlated with molecular polarity and negatively correlated with degree of armoaticity. With some exceptions, base/neutral extractable semivolatile organics are generally less soluble than acid extractable compounds.

Water solubilities for the polyaromatic hydrocarbon compounds (PAHs) range from 5.00 x 10^{-4} mg/l (dibenz(a,h)anthracene) to 31.7 mg/l (naphthalene). As the data in Table 7-1 illustrate, base/neutral compounds exhibiting the highest water solubilities are those containing highly polar functional groups (i.e., amino, carboxyl) whereas the compounds showing the lowest water solubility have a high degree of aromaticity (i.e., polynuclear aromatics). Therefore, runoff and groundwater transport of PAHs is not a significant process.

Volatilization

The PAH compounds have low vapor pressures (i.e., ranging from 10^{-2} to 10^{-10} mm Hg) and thus would not tend to volatilize under normal environmental conditions. At Circuitron, it is likely that these compounds would remain with the adsorbing solids.

Adsorption

As discussed in the preceding subsection, the PAHs have high log Koc values (range: 10^2 to 10^6 l/kg) and thus readily adsorb to soils and sediments. Migration of particle-associated PAHs would be controled by the slow-leaching of PAHs to percolating water and any gross particle movements such as surface soil runoff.

Bioaccumulation

An evaluation of the potential bioaccumulation of PAHs is not required for this site.

Biodegradation/Biotransformation

Biodegradation of PAHs represent a significant environmental fate process. PAHs can be biotransformed by higher organisms and microbial populations to more water soluble derivatives and/or compounds of lower molecular weight (SRI, 1979)

Hydrolysis/Photolysis

Hydrolytic reactions occur slowly for PAH compounds and this would not be considered a valid environmental fate process for compunds for this site.

In general, many of the PAH compounds in aqueous and/or atmospheric matrices are vulnerable to direct photolysis and/or photooxidation (Clement Associates, 1985; USEPA, 1979). The PAHs, in the dissolved phase may undergo rapid photolysis in aqueous matrices if the water is clear. (USEPA, 1979). The low solubility of these compounds in water generally relegates this environmental fate mechanism to one of little importance.

Oxidation

Oxidation of some PAHs (via hydroxyl radicals) found in aqueous matrices and/or soils at the site is possible; however, it is generally a slow, insignificant transformation mechanism. As a result,the oxidation of base/neutral compunds is not considered to be significant environmental fate process.

o Acid Extractables

Relevant data for the acid extractable compounds associated with the Circuitron site that impact environmental fate and transport are presented in Table 7-1.

Sources and Background

Acid extractables consist primarily of phenolic compounds. Phenols are a diverse group of chemicals consisting of a basic benzene ring and one or more hydroxyl (OH) groups. Phenol (hydroxyl-benzene) was isolated in 1834 from coal tar, the only known source until World War I. Synthetic production subsequently grew in importance and by 1930 exceeded natural production. Currently, most phenol is manufactured by sulfonation of benzene. The more complex phenols are obtained by replacing one or more of the hydrogen atoms attached to the benzene ring with various atoms (e.g., chlorine) or more complex substituents (methyl or nitro molecules). Phenols are high-volume industrial chemicals with multiple uses. Their presence at the Circuitron Corporation Site may not be attributable to site discharges but rather as incomplete combustion products of aromatics in fuel.

Solubility

Acid extractable semivolatile organic compounds exhibit relatively high solubility in aqueous matrices due primarily to the polarity of molecular functional groups. Five acid extractable analytes were found at the Circuitron Corporation

Site. The water solubilities of these analytes range from 1.40 x 10^1 mg/l to 9.30 x 10^4 mg/l (USEPA, 1983; Clement Associates, 1985; Verschuran, 1983). Consequently runoff and groundwater transport of the acid extractable semivolatile organics detected at the site are major environmental fate processes.

Volatilization

Semivolatile and extractable organic compounds (by definition) are capable of volatilizing (although, at much lower rates than lighter volatile organic compounds). Vapor pressures (in mm mercury) range from 1.10 x 10^{-4} to 3.41 x 10^{-1} mm Hg and Henry's Law constants range from 4.54 x 10^{-7} to 2.75 x 10^{-6} atm-m^3/mole for the acid extractable organic compounds detected in the site samples (USEPA, 1986; Clement Associates, 1985; Verschuran, 1983).

Adsorption/Desorption

The acid extractable phenolic compounds associated with Circuitron exhibit a varying degree of binding to organic matter in soils. K_{OC} values range from 14.2 to 5.3 x 10^4 l/kg and log K_{OW} values range, from 1.46 to 5.0. As a chemical class, phenolic compounds adsorption to clay is highly variable for the phenolic compounds associated with the Circuitron Corporation Site. Some compounds (e.g., 2-methylphenol, 2,4-dichlorophenol), do not adsorb readily to clay whereas others (e.g., nitrophenols), are capable of binding strongly (USEPA, 1979).

Biodegradation/Biotransformation

In general, biodegradation by microbial populations is a significant environmental fate process for the acid extractable compounds associated with the site. All of these compounds can be biodegraded relatively rapidly under most conditions (USEPA, 1979).

Hydrolysis/Photolysis

Available data summarized by Clement Associates (1985), indicate that hydrolysis is an insignificant environmental fate process for the acid extractable organics associated with the Site. Hydrolysis may occur during sorption to clays for some compounds (i.e., nitrophenols), but there is a general paucity of data on this topic (USEPA, 1979).

In general, direct photolysis and/or photooxidation (via hydroxyl radicals) can occur for the phenolic acid extractable compounds in aqueous and/or atmospheric matrices (Clement Associates, 1985; USEPA, 1979). However, these photolytic processes usually proceed at a slow rate and more typically occur in aerobic environments. While these processes will be important in contaminant reduction mechanisms in the environment, they can be considered to be a minor environmental fate process for this class of compounds at Circuitron.

Oxidation

Oxidation of the acid extractable compounds associated with the Site may occur via hydroxyl radicals (i.e., chlorophenols) in aqueous and/or atmospheric matrices, and/or metal-catalyzed oxidation (i.e., 2,4-dimethyl-phenyl phenol) in aerobic matrices (USEPA, 1979). Considering this, oxidation may be an important environmental fate process for the acid extractable compound associated with the site.

Summary

With few exceptions, the semivolatile acid extractable organic compounds associated with the Circuitron Corporation Site are not very persistent in environmental matrices. This is primarily due to high water solubility, susceptibility to microbial degradation, and low affinity for organic matter and clay. The few anomalous compounds within this chemical class that are the exceptions differ from this generalized trend by exhibiting inhibition of microbial populations, and/or exhibiting a high affinity for organic matter and/or clay in aquatic organisms.

o Pesticides

Nine pesticides were detected on-site. These are: aldrin, BHC-delta, heptachlor, heptachlorepoxide, DDE, DDT, chlordane, endosulfans, and endosulfan sulfate. Table 7-1 summarizes available data on environmental fate parameters of chlorinated pesticides which are quantified in the TCL pesticide analysis.

Sources and Background

Chlorinated pesticides are man-made chemicals characterized by a cyclic structure and a variable number of chlorine atoms. Pesticides were first produced in the early 1940s after discovery of their insecticidal properties. While pesticides are present at Circuitron, they are not major contaminants. They are present in few surface soil and sediment samples.

Solubility

Water solubilities for the pesticides associated with the site range from a minimum of 5.0×10^{-3} mg/l (DDT) to a maximum of $31.4\text{x}10^{1}$ mg/l (delta-BHC). Variations in these solubilities are due principally to differences in molecular structure, polarity (resulting from the degree of chlorination) and/or the presence of other functional radicals on the molecule. This low range of solubilities in addition of the infrequent occurrences suggest that surface runoff and groundwater transport of pesticides is an insignificant transport mechanism at the Site.

Adsorption/Desorption

Adsorption to soils/sediments or organic matter is the major environmental fate/transport process for a majority of chlorinated pesticides detected at Circuitron. The pronounced tendency of chlorinated pesticides to be adsorbed is reflected in the partition coefficients (high K_{OC} and log K_{OW} values) (Table 7-1) exhibited by most of these chlorinated pesticides (EPA, 1986). Endosulfan I and endosulfan sulfate, however, exhibit low partition coefficient (Table 7-1).

Bioaccumulation

An evaluation of the potential bioaccumulation of pesticides in not required for this site.

Biodegradation/Biotransformation

The chlorinated pesticides detected in Circuitron samples show varying degrees of susceptibility to biodegradation and biotransformation. For example, DDE and heptachlor are highly resistant to biodegradation. However, DDT degrades to DDE under aerobic microbial degradation; DDD is the degradation product under anaerobic conditions (Clement Associates, 1985). The resistance of chlorinated pesticides to microbial degradation indicates that biodegradation/biotransformation is not a significant environmental fate process for the chlorinated pesticides detected at the site.

Volatilization

Vapor pressures (mm Hg) of the chlorinated pesticides range from 1.0×10^{-5} (endosulfan) to 3.0×10^{-4} (heptachlor). Henry's Law constants (atm-m^3/mole) range from 2.07×10^{-7} (delta-BHC) to 8.19×10^{-4} (Heptachlor) for the chlorinated pesticides detected (EPA, 1986; Clement Associates, 1985). These levels indicate that volatilization, particularly of DDT, could be an important environmental fate process. Once volatilized, these compounds would exist primarily in the vapor phase, subject to rapid dilution by ambient air. However, because open areas in the site are paved, this exposure pathway is not considered significant.

Hydrolysis/Photolysis

Most chlorinated pesticides either do not hydrolyze or exhibit only negligible hydrolysis under extreme conditions (Clement Associates, 1985). Pesticides exhibiting some degree of hydrolysis include heptachlor, DDE, and DDT and its metabolites. The rate of pesticide hydrolysis is strongly dependent upon pH. Hydrolysis is expected to be an environmental fate process for these pesticides and not for the others.

Direct photolysis of chlorinated pesticides under natural light is negligible (Clement Associates, 1985). Indirect photolysis of pesticides detected can occur (Clement Associates, 1985), but current data concerning photolysis are insufficient. Consequently, the extent to which photolysis affects environmental fate of chlorinated pesticides at the site is inconclusive.

Oxidation

The chlorinated pesticides associated with Circuitron are relatively resistant to oxidation (Clement Associates, 1985). Consequently, oxidation is not considered a process which will affect fate and transport of chlorinated pesticides.

Summary

Chlorinated pesticides detected at the Circuitron site are highly persistent chemicals which strongly adsorb to soils and organic matter. Sorption appears to be the dominant environmental process affecting the fate of pesticides. Water solubility of the chlorinated pesticides indicates that surface runoff and groundwater transport are likely mechanisms affecting the fate of pesticides such as delta-BHC, but not compounds such as DDT (except by transport of particles to which strongly sorbed pesticides adhere). Volatilization is expected. The processes of photolysis, hydrolysis, oxidation, biomagnification and biodegradation are not likely to be major factors in determining the fate of these compounds. However, this group os compounds are not major contaminants at the site.

- Aroclor PCBs

Relevant data describing the physico-chemical characteristics which affect the fate and transport of PCBs are shown in Table 7-1.

Sources and Background

The PCBs at the Circuitron Corporation Site were detected in the surface soils sampled in the vicinity of the oil-storage tank UT-5 and also sporadically in the monitoring well soil borings. PCBs were not detected in the groundwater from the site or in the principal discharge areas (e.g., leaching pools, storm drains). Therefore, their presence is probably not due to site discharge activity.

Solubility

The Aroclor PCBs represent some of the least water soluble contaminants identified at the Circuitron site. The solubilities range from 2.7 x 10^{-3} to 5.4 x 10^{-1} mg/l (SRI, 1986). Thus, runoff and groundwater transport of dissolved PCBs will not be a principal environmental fate process for the PCB observed in Circuitron soils/sediments.

Adsorption/Desorption

Adsorption to soils/sediments or organic matter is a major process defining the environmental fate of PCBs. Like chlorinated pesticides, the high affinity for adsorption to organic matter is evident in the high K_{OC} values (range: 2.77 x 10^5 to 6.70 x 10^6 l/kg) and log K_{OW} values (range: 5.76 to 7.15). Water solubility and K_{OC} values among different PCBs are correlated with the number of chlorine atoms on the molecule. Consequently, PCB congeners with lower numbers of chlorine atoms tend to sorb less strongly than the more heavily chlorinated molecules, such 1248, 1254 and 1260 (USEPA, 1987). Although adsorption can immobilize PCBs in soils and sediments, remobilization via leaching has been observed (Swackhamer and Armstrong, 1986). The strong adsorptive tendencies of PCBs suggest that most PCBs observed from the field investigation will be tied up in the soil samples.

Bioaccumulation

An evaluation of the potential bioaccumulation of PCBs is not required for this site.

Biodegradation/Biotransformation

Biodegradability of PCBs depends heavily upon both the degree of chlorination and the specific position of the chlorine on the biphenyl molecule (Brown et al., 1987; Leifer et al, 1983). In general, mono-, di- and tri-chlorinated biphenyls (Aroclors 1221 and 1232) degrade rather rapidly. Tetrachlorinated biphenyls (Aroclors 1016 and 1242) degrade slowly while higher chlorinated biphenyls (Aroclors 1248, 1254 and 1260) are resistant to biodegradation.

Volatilization

Limited volatilization of PCBs occurs (vapor pressure range: $4.05\text{x}10^{-5}$ to $4.94\text{x}10^{-4}$ mm Hg), with PCBs existing primarily in the vapor phase (Eisenreich et al., 1981).

Atmospheric removal mechanisms include physically mediated wet and dry deposition, with dry deposition occurring only for PCBs attached to the particulate phase. Volatilization of PCBs from water may be a major removal mechanism of dissolved PCBs from natural waters (Swackhamar and Armstrong, 1986). Consequently, volatilization with concomitant atmospheric recycling via wet and/or dry deposition is a reasonably expected environmental fate process for PCBs.

Hydrolysis/Photolysis

PCBs are strongly bonded compounds which are not readily hydrolyzed (USEPA, 1979). PCBs may undergo photolysis in the atmosphere where they react with photochemically-produced hydroxyl radicals (USEPA, 1979). However, this is apparently a slow process, particularly for the highly chlorinated PCBs (e.g., Aroclor 1260). Insufficient data are available to assess the importance of photolysis within aqueous systems. Hence, the extent to which photolytic factors into the ultimate environmental fate of PCBs has yet to be determined.

Oxidation

Oxidation is not considered to be a significant degradation process for PCBs (USEPA, 1979).

Summary

PCBs exhibit high persistence in the environment. This high persistence results from: (1) low solubility in water and air, (2) strong adsorption to soils, sediments and organic matter, (3) the recycling of volatilized PCBs between the atmosphere, surface soils and water, and (4) relative resistance to biodegradation. Occurrence of PCBs was rare among Circuitron samples, and of arguable origin from Circuitron disposal activities. Given the above fate and transport characteristics of PCBs, adsorption is the predominant fate process, with soils as the predominant reservoir of PCBs.

7.2.2.2 Inorganics

Numerous metals were detected in the aqueous and soil/sediment matrices of the Circuitron Corporation Site. Many of these metals are normal constituents of soil/sediment parental material or common constituents in aqueous matrices due to leaching from soil/ sediment. However, a number of metals detected at the site were present at concentrations in excess of those levels generally considered background (For example, As, Be, Cd, Cr, Cu, Pb, Hg, Ni and Ag). This section will focus on summarized environmental fate data for these metals.

Sources and Background

The inorganic forms of metals detected at the site are characterized by their combination with oxygen, chlorine, carbonate, and/or other anions. Although these metals are naturally occurring, their occurrence at the site may also be attributable to disposal practices.

Relevant data for the selected metals at the site that impact environmental fate and transport are presented in Table 7-2. These metals were present at concentrations in excess of those levels generally considered background. A synopsis of the important characteristics affecting the environmental fate of these metals was compiled from USEPA (1979) and Clement Associates (1985) data sources, and are presented in subsequent sections.

Solubility/Aqueous Chemical Speciation

In general, the aqueous speciation of metals depends primarily upon: the relative stability of individual valence states (which are element-specific), oxygen content, pH and Eh conditions, and the presence of available complexing agents. The predominant dissolved species or minerals of the elements in aqueous systems usually are deduced from geochemical equilibrium models. The distribution of these species is commonly expressed as Eh-pH diagrams. In order to determine the potential for a metal to exist on-site in the aqueous form or immobile form and the oxidation state of the element, a set of equilibrium equations need to be developed for that element. However, for a rapid assessment, the site specifics, Eh and pH, may be imposed on an already made Eh-pH diagram given that the conditions assumed to construct the diagram (concentration of the element and other coexisting ions) are not very different from the conditions at the site.

An example of the use of these diagrams was to assess the valance state of chromium under site groundwater conditions. For estimated pH and Eh conditions at the site (pH range 5.5 to 7.5 and Eh -0.02 to +0.36 volts), Cr is primarily in the trivalent form. Chromium (+3) volts salts are easily hydrolyzed and generally precipitate as the hydroxide or oxide at pH above 5. Cr(+3) could be oxidized to Cr(+6) under higher Eh-pH conditions or in the presence of an oxidizing agent. Cr(+6) remains soluble over varying pH ranges as stable oxy species (i.e., CrO_3, $CrO4^{-2}$ etc.) which strongly oxidize organic matter on contact. Chromium most probably is present as particulate matter in the groundwater.

The wide variation of aqueous speciation for the metals associated with the site dictates metal-specific discussions. The site specifics, Eh and pH, were imposed on Eh-pH diagrams showing the distribution of the metal species which are presented in Dragun (1988). There are uncertainties in using these diagrams to estimate the on-site metal speciation. However, with caution, information otherwise not available could be obtained.

- Arsenic

Arsenic (+3) and As(+5) valence states are the most common valence states of arsenic as dissolved salts, depending upon Eh and pH conditions in the natural environment. Additionally, arsenious acid (H_3AsO_3) and arsenic acid (H_3AsO_4) can be prevalent forms under certain conditions in aerobic environments. Arsine gas (AsH_3) may also be formed under limited environmental conditions (i.e., extremely low Eh). Finally, arsenic may exist in soluble organic complexes within on-site aqueous matrices. Under pH-Eh conditions of the groundwater from the site, arsenic can be in the As(+3) or As(+5) valence states. Under the average pH and Eh conditions, arsenic will be present in the As(+5) valence state. Arsenic may be associated with a particulate phase rather than being in a dissolved form. Arsenic may also be complexed with dissolved organic compounds within the on-site aqueous matrices.

- Lead

Lead(+2), is the most common stable ionic aqueous species with hydroxyl, carbonate, sulfide and sulfate anions acting as solubility controls. Under aerobic conditions, $PbSO_4$ and to a lesser extent $PbCO_3$, control lead stability; whereas under anaerobic conditions, PbS and elemental lead concentrations mediate aqueous lead solubility. Lead may also exist in soluble organic complexes (i.e., humic and fulvic acids) in aqueous matrices. At the Circuitron site, lead will likely be present as the divalent cation, Pb(+2). Lead containing organometallic complexes may be another form of dissolved lead in the groundwater.

- Copper

Copper(+2), is the most prevalent form of copper in aqueous systems since most of the stable cuprous (+1) forms in oxic waters are very insoluble, with the exception of $CuCl_2$, $Cu(NO_3)_2$ and $CuSO_4$. Copper may also exist in water as the hydrated divalent cupric ion. However, in general, most copper in aqueous solution is in a complexed form with organic and/or inorganic ligands and these are expected to be the predominant dissolved aqueous species of copper at the site. Under the site average pH-Eh conditions, Cu most probably will be present as divalent cations. However, under certain pH-Eh conditions, the copper may also be present as Cu(+1) and Cu(0).

- Nickel

  Nickel is usually divalent in compounds which are predominantly ionic in character with Ni(+2) almost always found in aquatic environments. Although Ni(+2) is most common, Ni(0),(+1),(+3) and (+4) have been reported, but are extremely rare. Ionic nickel is very stable in aqueous solutions. Divalent nickel Ni(+2), is the predominant dissolved species expected in the groundwater at the site. The site conditions seem to favor the presence of nickel in the aqueous form. However, nickel in aqueous matrices may also be associated with the particulate phases.

- Beryllium

  Beryllium is always found in the +2 valence state in aqueous matrices and may form stable compounds with small anions (i.e., fluoride) if they are present. At low pH, Be^{+2} ions are the predominant species, whereas at high pH, $HBeO_2$ is the more prevalent form in water. Within normal pH ranges in the environment, $Be(OH)_2$ is the major species which typically exhibits a low solubility unless polynuclear hydroxide complexes form (at the higher pH values) and increase aqueous solubility. Considering the conditions at the Site, $Be(OH)_2$ is expected to be the predominant aqueous beryllium species, with most beryllium in solution probably being associated with particulates rather than being present in dissolved form. This expectation is substantiated by higher frequency of occurrence in the total metal analysis relative to the dissolved metal analysis.

- Chromium

  Chromium is discussed in a previous section under the site groundwater geochemical condition is mainly present as CrIII.

- Cadmium

  Cadmium may exist in soluble organic complexes or as an ionic species in water. Cadmium ions in solution are always present in the +2 valence state in aqueous environmental matrices and are expected to be the predominant species in on-site aqueous matrices.

- Mercury

  Mercury typically may exist in the 0, +1, and/or +2 valence states in natural waters, depending upon pH and Eh conditions. Above pH 5 and under moderately oxidizing conditions, the predominant aqueous species would be dissolved elemental mercury, depending upon environmental conditions. The site pH-Eh conditions suggest that Hg is a predominantly aqueous species. Mercury readily complexes with organic water via biologically and/or non-biologically mediated processes. As a result, dissolved methyl mercury ion and/or undissociated dimethyl mercury are commonly encountered in aqueous matrices if mercury is present. At the Site, mercury probably is associated with the particulate phase.

- Silver

  Silver exhibits a very high adsorptive affinity to MnO_2. Ferric hydroxide, iron oxides, and clay minerals also adsorb silver with clays typically showing weak adsorption. Additionally, organic compounds also will adsorb silver.

Volatilization

With the exception of arsenic and lead, volatilization of inorganic analytes does not occur. Arsenic and lead are capable of being biomethylated and the methylated derivatives of these metals can volatilize. Once in the atmosphere, removal of volatilized organic-metallic compounds is principally via wet and/or dry deposition. Additionally, arsenic under extremely reducing conditions can exist as arsine gas (AsH_3) which is volatile. However, this compound, once formed, is rapidly oxidized in aerobic conditions.

In summary, limited volatilization of biomethylated arsenic and lead may occur at the site. For all other metals associated with the site, volatilization will not occur. While limited volatilization of As and Pb compounds is possible, volatilization of these compounds would be an insignificant environmental fate process, considering existing site conditions.

Photolysis

Photolytic reactions do not occur for arsenic, beryllium, cadmium, lead, nickel and silver. Some copper compounds are photosensitive; however, there are insufficient data at this time to conclude that photolysis is an important degradative mechanism for copper-containing compounds. However, considering site conditions, photolysis would be an insignificant degradative process.

Adsorption/Desorption

In general, metals readily adsorb to inorganic mineral surfaces and organics. Adsorption for most metals is highly pH-dependent, with desorption being favored at low pH and adsorption dominating at higher pH conditions. The types of clays, their surface areas, and surface changes dictate the extent of the adsorption

(Karickhoff et al, 1979). Consequently, adsorption (quantitated as the Kd) also varies with chemical speciation. A brief discussion of the important aspects of adsorption/desorption for the metals of interest at the site (i.e., arsenic, beryllium, lead, copper, cadmium, silver and nickel) follows in subsequent paragraphs.

- <u>Arsenic</u>

  Arsenic is adsorbed principally onto clays, aluminum hydroxides, iron oxides, and organic compounds. In general, pentavalent arsenic has a greater adsorptive affinity than trivalent arsenic. For arsenic, adsorption is most important in aerobic, acidic fresh water with adsorption decreasing above pH 9 for As(+3) and above pH 7 for As(+5).

- <u>Lead</u>

  Lead adsorbs principally to clays, hydrous iron and manganese oxides, mineral surfaces, and organic compounds. Lead adsorption is very pH-dependent, with low pH conditions favoring desorption.

- <u>Copper</u>

  Copper adsorbs to mineral surfaces, organics, carbonate, and precipitating iron and manganese oxides. In general, copper complexes with naturally occurring organic acids are more easily adsorbed by clays and free mineral surfaces than the hydrated cations. Copper adsorption is highly pH dependent and the presence of other anionic species can increase copper adsorption.

- <u>Nickel</u>

  Nickel adsorbs to hydrous iron, manganese oxides, clay minerals, and organic material. However, the adsorption of nickel to these materials occurs only to a limited extent.

  Considering the above, it is apparent that adsorption/desorption will be a significant environmental fate process for inorganics at the Circuitron site.

- <u>Beryllium</u>

  Very little data exist for beryllium, however some of the available data suggest that beryllium sorbs to clay at low pH. At high pH, complexation into insoluble compounds appears to be favored over adsorptive mechanisms.

- <u>Chromium</u>

  Chromium may adsorb to mineral surfaces and organics, however it is generally weakly adsorbed, with Cr(+3) exhibiting a higher affinity for adsorption than Cr(+6). Chromium (+6) is usually only adsorbed to organic matter.

- Mercury

  Mercury is sorbed greatly to many inorganic surfaces and is strongly adsorbed to organic compounds. Like lead, mercury may be desorbed under low pH condition.

- Cadmium

  Cadmium is principally adsorbed by clays, organics, carbonates, and aluminum and iron oxides with adsorption generally increasing as the pH increases.

- Silver

  Silver exhibits a very high adsorptive affinity to MnO_2. Ferric hydroxide, iron oxides, and clay minerals also adsorb silver with clays typically showing weak adsorption. Additionally, organic compounds also will adsorb silver.

Complexation

In general, the metals of interest associated with the site are capable of forming numerous inorganic and organic complexes in the natural environment. All of the metals of interest readily form organo-metallic complexes, especially with naturally-occurring organic acids (e.g., humic and fulvic acids). Some of the metals associated with the site may also form metallo-inorganic complexes with inorganic ligands such as carbonate, chloride, hydroxyl and sulfate (i.e., copper, lead, arsenic, and cadmium). Among lead, arsenic, and cadmium, metallo-organic complex formation is usually favored over metallo-inorganic complexes. Beryllium typically forms complexes with hydroxide ions and may, at elevated pH, form poly-nuclear hydroxide complexes. Below pH 9, nickel forms soluble metallo-inorganic complexes with the inorganic ligands hydroxide, carbonate and sulfate. All of the various complex formations mentioned above alter the aqueous solubilities of the metals of interest. Therefore, complexation with various organic and inorganic ligands is a significant environmental fate process for the metals of interest at the site.

Precipitation/Coprecipitation

Precipitation and/or coprecipitation are important removal mechanisms of dissolved aqueous metal species. Coprecipitation with hydrous iron, manganese, and/or aluminum oxides may occur for arsenic, cadmium, copper, nickel, and beryllium, particularly under non-reducing or basic conditions.

With regard to precipitation, cadmium typically precipitates as $Cd(OH)_2$ above pH 9, $CdCO_3$ above pH 10, and CdS under reducing conditions. In the environment, copper usually precipitates as malachite (Cu_2 $(OH)_2$ CO_3), whereas lead may precipitate as $PbCO_3$ and/or $PbSO_4$, depending upon environmental conditions. Beryllium may precipitate as the insoluble hydroxide or oxide. Above pH 9, the hydroxide or carbonate of nickel will precipitate and under reducing conditions, nickel sulfide will precipitate out of aqueous solutions. Similarly, silver will also precipitate as the sulfide in reduced aqueous environments. Silver may also precipitate as the halide or at high pH, as AgO_2.

Considering the above, and depending upon numerous aqueous environmental conditions (i.e., pH, metallic and anionic species present, etc.), precipitation and/or coprecipitation can be important environmental fate processes for the metals associated with the site. This phenomenon would be reflected in comparison of the filtered and unfiltered water samples.

Cationic Exchange

All the metals of interest are capable of undergoing isomorphic substitution with cations present in the lattice structure of crystalline soils and sediments. This process can be an effective means of removal from solution depending upon environmental conditions. Similar to sorption processes, numerous factors such as pH, and type of clay, will influence cationic exchange processes. Bcause the clay content of the soils from the Circuitron Corporation Site is low (less than 1.5%) it is likely that catonic exchange represents a minor removal mechanism.

Biotransformation/Biodegradation

Biomethylation of lead, and arsenic mediated by microbial populations can occur to a limited extent in the environment and this process may occur under aerobic and/or anaerobic conditions. Additionally, biogenic ligands have been reported to form complexes with some metals, particularly with lead. Biotransformation of copper does not occur; and cadmium can be complexed in vivo by polydentate ligands that are normally involved in the binding sites of essential metal ions such as Fe, Cu, Zn, Mn, etc. The other metals of interest at the site are not susceptible to biotransformation mechanisms. Considering the characteristics of the Circuitron site, the known biotransformation processes mentioned above will be insignificant environmental fate processes.

Summary

In general, the metals of interest associated with the Circuitron Corporation Site are typically persistent within environmental matrices. This persistence is primarily related to recycling mechanisms within environmental matrices for some metals (e.g., arsenic, lead, and copper), and removal mechanisms (precipitation, cationic exchange adsorption, etc.) which decrease mobility. Chemical speciation of metals in the environment can result in metal concentrations in both solid and aqueous media or preferrential presence entirely in one medium. However, the fate reactions and the behavior of these metals under site geochemical conditions may lead to an increase and/or decrease in their concentrations in specific matrices.

7.3 TRANSPORT AND MECHANISMS OF MIGRATION

Considering the physical/chemical characteristics, the geological/geohydrological/geochemical and hydrological conditions, and the distribution and concentrations of contaminants in various site media, contaminants may migrate via several mechanisms from the potential source areas. These include: percolation of contaminants that are leached from the soil, and, airborne transport via entrained dust or the volatilization of contaminants from contaminated soil. Most on-site open areas are paved. Therefore, contaminant's transport via surface run-off, volitalization, and airborn dust is not significant. Aside from surface runoff, contaminants may also enter surface water via the discharge of contaminanted groundwater. However, no surface water bodies were identified as a potential receptor to the groundwater. Accordingly, the primary pathway of contamination at the Circuitron Corporation Site is the percolation of contaminants into the soil and the leaching into the groundwater. This potential for migration of the contaminant groups found on-site is described in the following subsections.

7.3.1 Percolation and Migration into Groundwater

Chemicals present in the soils at the Circuitron Corporation Site can migrate into groundwater by the percolation of rainwater through contaminated soil or sediments. Halogenated and non-halogenated aliphatics, monocyclic aromatics, phthalate esters, PCBs and metals above background concentrations have been found in the soils and sediments on the Circuitron Corporation Site.

In order to determine whether the compounds in the soils from the site can be a source of contamination to the groundwater, the recently developed "Groundwater Ubiquity Score (GUS)" was applied. Gustafson (1989) developed GUS as a screening method to determine the potential leachability of soil applied pesticides. The author reviewed a large database of 44 pesticides and noted that those generally regarded to be "leachers" and "non-leachers" clustered separately on the graph comparing log (half-life in soil) versus log Koc. From this relation, the author developed the following equation to calculate GUS:

$$\text{GUS} = \log(\text{half-life in soil})\,(4 - \log K_{oc})$$

GUS values greater than 2.8 are considered "probable leachers", those values less than 1.8 are considered "improbable leachers", and those values between 1.8 and 2.8 are "transition leachers", The author also developed a nomogram to aid in the classification of the compound.

The GUS equation is a simplification of model equations which account for percolation rates, Koc, depth to groundwater, etc. However, on a theoretical basis, it is a reasonable equation since it accounts for the partitioning to the solid phase (Koc-term) along with a term reflecting the environmental persistence of the chemical (soil half-life term). The model encompassed a large log Koc range (1.23 to 5.33) and soil half life range (4 to 38,200 days) and is thus representative of the characteristics of compounds typically found at hazardous waste sites.

Table 7-5 shows the calculated GUS-values and leachability score for compounds found in soils or sediments at Circuitron. The soil degradation data were obtained from data provided by Ghiorse and Wilson (1988). When soil degradation were not available, the half lives in surface water were used (USEPA, 1986). The latter will tend to underestimate the soil degradation half lives.

The results show that 1,2-dichloroethane, toluene, ethylbenzene, the PAHs and PCBs are non-leachers and would not pose a significant contamination source to the groundwater. These compounds were not detected in the groundwater at the site. They will not be further considered in the groundwater assessment. The remaining compounds are leachers and thus, if present in contaminated soils or sediments exposed to percolating water (e.g., from rainfall or road surface runoff) they can leach and thus contaminate the underlying groundwater.

7.3.2 Groundwater Off-Site Migration

Once the leachable substances are in the groundwater, they are transported in the direction of groundwater flow which is towards the southeast of the site. The rate of transport of these chemical constituents in groundwater is determined, in part, by partitioning between the mobile aqueous phase and the stationary soil particles and the organic matter content of the soils. The overall effect of this partitioning process is a reduction of the rate of contaminant transport relative to groundwater flow.

Properties of volatile organic chemicals of potential concern (summarized in Table 7-1) show high water solubilities and low organic carbon partition coefficients (K_{OC}), suggesting high mobility in the groundwater with minimum retardation.

In order to estimate the migration of organic and inorganic chemicals in the aquifer, the following retardation equation was used:

$$Vc = V\,[1 + Kd\,(b/P_T)]^{-1}$$ where,

TABLE 7-5
CIRCUITRON CORPORATION SITE

GROUNDWATER UBIQUITY SCORES FOR SELECTED VOLATILE ORGANICS FOUND IN SOILS

Compound	Half life (days)[1]	log Koc[2]	GUS	Leachable[4]
Chloroform	24	1.49	3.46	Y
1,1-dichloroethane	5[3]	1.48	1.86	Y/N
1,2-dichloroethane	0.7[3]	1.15	-0.44	N
1,1-dichloroethene	162	1.81	4.83	Y
trichloroethene	>485	2.10	5.10	Y
tetrachloroethene	5390	2.56	5.37	Y
1,1,1-trichloroethane	>485	2.18	4.89	Y
benzene	24	1.92	2.87	Y
toluene	4	2.48	0.91	N
ethylbenzene	24	3.04	1.32	N
benzo(a)pyrene	480	6.74	-7.55	N

Notes:

1/ Half lives in subsurface soils from Ghiorse and Wilson (1988)

2/ Data from Table 7-1

3/ Half-lives in surface waters from USEPA (1986)

4/ Leach score: GUS >2.8 = Y (leacher), GUS <1.8 = N (non-leacher), 1.8 < GUS < 2.8 = Y/N (transition leacher)

Vc = The steady state velocity of the chemical at the point where C/Co = 0.5, where C is the concentration and C_o is the initial concentration.

V = Average linear velocity of the groundwater = ft/day or ft/year (1.6 ft/day)

Kd = soil-water partition coefficient
Calculated as Kd = K_{oc} f_{oc}, where the soil organic carbon content was 0.058% (f_{oc} = 0.00058)

b = Sand bulk density
= 2.0 g/cm^3

P_T = Sand total porosity (USEPA, 1986)
= 0.4

Kd-values for organics were obtained by multiplying the Koc-value (Table 7-1) by the average organic carbon content of soils from the site (f_{oc} = 0.058%). Both the bulk density (2.0 g/cm^3) and total porosity (0.4) values were literature values. An effective porosity of the value 0.25 is estimated for the aquifer material (Section 5.5.3).

Table 7-6 summarizes the migration rates of contaminants in the groundwater. The calculated velocity of groundwater in the Upper Glacial aquifer was 1.6 ft/day. All the volatile contaminants, with the exception of tetrachloroethane, are calculated to migrate at a rate slightly retarded relative to groundwater. Migration rates of the selected volatiles range between 1.11 and 1.47 ft/day, whereas tetrachloroethene migrates at arate of 0.78 ft/day. This was due to the comparatively low Koc-values and low organic carbon contents of the soils at the Circuitron site which lead to insignificant retardation of the contaminats relative to the groundwater. Tetrachloroethene has a higher relative Koc-value so this compound will migrate slower relative to the other volatile organics. Similarly, other contaminants such as phthalate esters, PAHs, and pesticides are expected to migrate at very slow rates.

Metals, as shown in Table 7-2, have high Kd values. Therefore, metals projected to migrate more slowly in the groundwater than the volatile organics. As the contaminants migrate downgradient within the groundwater, their observed concentrations will decrease due to dispersion and biodegradation.

The discussion of the nature and extent of contamination (Section 6.0) confirms the calculated migration rates and showed that groundwater in the vicinity of the site and downgradient of the site exhibits contamination attributable, in part, to discharge activity from the Circuitron Corporation Site. Although, the plume was not defined, based upon the chemicals present, these results also showed that there are contaminants in the deeper portion of the Upper Glacial aquifer which do not

TABLE 7-6

CIRCUITRON CORPORATION SITE

MIGRATION RATES FOR SELECTED VOLATILE ORGANICS FOUND IN GROUNDWATER

Compound	Kd	Migration Velocity (ft/day)[a/]
Chloroform	0.018	1.47
1,1-dichloroethane	0.017	1.47
1,1-dichloroethene	0.038	1.34
Trichloroethene	0.073	1.17
Tetrachloroethene	0.211	0.78
1,1,1-trichloroethane	0.088	1.11
Benzene	0.048	1.29

a/ The calculated velocity of groundwater in the Upper Glacial aquifer is 1.6 ft/day.

appear to be attributable to site activity. Thus vertical migration of contaminants in the groundwater from the Circuitron Corporation Site is not great. Volatile compounds already exist upgradient of the site, with the contaminated soils and sediments from the site discharges contributing to the existing contaminants. Furthermore, the analyses of the groundwater suggests that the contribution to the existing contaminants does not extend a great distance downgradient of the site, although off-site migration was evident. No groundwater modeling beyond this discussion will be performed to estimate the dispersion and longitudinal transport of these contaminants.

7.3.3 Migration into Air

Contaminants that are found in surface soils (vadose zone) may either volatilize to the air directly or become suspended in the air on soil particles entrained in the atmosphere during dry, windy days. Airborne transport via direct volatilization will be insignificant for volatile organic compounds due to the low concentrations within on-site vadose zone soils; minimal for PAHs and phthalates, due to their low vapor pressures and concomitant low volatilization rates; and insignificant for pesticides and PCBs due to their low concentrations and frequency of detection in vadose zone soils in conjunction with their low vapor pressures. In addition, because the site is paved, this exposure pathway is not complete, therefore, is not considered.

Volatilization rate from the unsaturated soil may be calculated using the Arnold diffusion equation. However, as previously discussed, the site is paved. Therefore, these calculations are not performed.

On-site surface soils were primarily contaminated with PAHs, metals, and phthalate esters at numerous on-site locations. Therefore, it is possible that contaminants adsorbed to soil particles at these locations may become entrained into the atmosphere during dry, windy days. This possibility is assessed to be insignificant at the Site since most on-site open areas are paved.

In summary, groundwater transport of contaminants (primarily volatile organics and metals associated with the particulate phase) is the major mechanism of contaminant migration at the Site. Airborne transport mechanisms are not significant at the Circuitron Corporation site under current conditions.

8.0 BASELINE RISK ASSESSMENT

The National Contingency Plan requires that a Risk Assessment (RA) be conducted to document and justify whether an imminent and substantial risk to public health or the environment may exist at Superfund sites. It is important to note at this juncture that imminent does not mean immediate harm; rather it means an impending risk of harm. Sufficient justification for the determination of an imminent risk may exist if harm is threatened; no actual injury need have occurred or be occurring. An RA estimates that potential magnitude and probability of actual or potential harm to public health, and the environment, caused by a threatened or actual release of a hazardous substance. This RA addresses the potential human health impacts associated with the Circuitron Corporation Site.

The purpose of the baseline risk assessment is to evaluate exposures and potential risks that surrounding residents are currently subject to or could be subject to under continued site use. As such, the assessment is site-specific and provides a baseline evaluation of the site under a 'no-action' remedial alternative (i.e., absence of any remediation) as required under Section 300.68 (f)(v) of the National Contingency Plan. The no-action alternative functions as the baseline against which potential source control and/or groundwater migration remedial alternatives considered in the FS are compared. The public health evaluation also anticipates potential future uses for the site, given current land uses in the areas around the site. The procedures and methodologies used in this RA follow the Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989c).

Results presented in Sections 6.0 and 7.0 have shown that chemical discharges to the underground authorized and unauthorized SPDES pools, storm drains and near an abandoned plating tank from the Circuitron Corporation facility have contributed to the contamination of the site soil and sediment. As a result, the groundwater underlying the site has become contaminated. This section draws upon these conclusions to evaluate the potential risks to the public posed by the site.

Risk assessment is an essential methodology used in the RI/FS process to characterize and evaluate hazardous waste sites. The lack of explicit relevant toxicity and/or exposure data, the uncertainty in measurements of chemicals in both the environment and the laboratory, coupled with the need to extrapolate experimental end-points pertinent to assumed human exposures and potential responses, make precise quantification of risk difficult. Section 8.4 identifies major sources of uncertainty inherent to the risk assessment process. The section also quantifies the effects of these uncertainties on the overall conclusions of the risks associated with the Circuitron Corporation Site.

8.1 PUBLIC HEALTH EVALUATION

Consistent with guidelines from the Office of Emergency and Remedial Response and federal guidelines for risk assessment as defined in the Risk Assessment Guidance for Superfund (USEPA, 1989c), the quantitative risk assessment consists of several steps. The first step is an exposure assessment which includes (a) characterization of the physical setting of the site, (b) identification of the potentially exposed population(s), (c) identification of potential exposure pathways, (d) an estimate of the exposure concentrations and (e) the estimate of chemical intakes. The Circuitron Corporation Site is located in an industrial area and is surrounded by residential areas a short distance from the site. A demographic analysis along with existing "background" mortality data was presented in Section 5-1. These analyses were used in the evaluation of the potential exposed populations, suitability of exposure pathways, and significance of the risk estimates.

The second step is a toxicity assessment of the chemicals present at the Circuitron Corporation Site. This step includes (a) acquisition of qualitative and quantitative toxicity data for the contaminants of interest, (b) identification of exposure periods for which the toxicity values are necessary, (c) determination of the toxicity values for the non-carcinogenic effects of contaminants of interest and (d) determination of the toxicity values for the contaminant's carcinogenic effects.

Health effects from chemical exposures are classified into two categories: carcinogenic and noncarcinogenic toxicity effects. This classification is a direct function of the currently-held opinion in the scientific community that the biological mechanisms of action differ between carcinogens and noncarcinogens. Despite these distinctions, chemicals can induce both carcinogenic and noncarcinogenic effects. For example, arsenic has been associated with an number of noncarcinogenic end-points such as embryotoxicity, fetotoxicity and gastrointestinal and neurological disorders. However, it is also considered a human carcinogen as inhalation exposures in occupational settings have been linked to lung cancer, while laboratory investigations suggest that arsenic may also be linked to skin and bladder cancers. In this analysis, both carcinogenic and non-carcinogenic end-points are considered in the risk evaluation.

USEPA has adopted the policy position of a 'no-threshold' mechanism in assessing risks associated with potential carcinogens (USEPA, 1989c); i.e., it is assumed that any level of exposure to a carcinogen will result in some finite probability of cancer. The conventional measure of a chemical's carcinogenicity is the slope factor (formerly called the "cancer potency factor" or CPF).

Noncarcinogenic chemicals are assumed to induce threshold effects, recognizing that organisms have protective mechanisms that must be overcome before the toxic end-point is manifested. A threshold effect implicitly assumes that a range of exposures from just above zero to some finite value can be tolerated without appreciable risk of disease (USEPA, 1987). The standard measure used to define chronic noncarcinogenic effects of a chemical is the reference dose (RfD). RfDs typically define a concentration which can be tolerated over a lifetime without adverse effect to human health. RfD values for different chemicals do not necessarily reflect a common end-point because biological responses to individual chemicals differ. In addition to chronic effects, chemical exposures may also result in subchronic and/or acute effects. Given the lack of verified subchronic toxicity values for many contaminants of concern at Circuitron, acute/subchronic effects are evaluated only qualitatively.

The final step is a risk characterization and includes (a) discussion of the significance of the toxicity and exposure assessment for the contaminants from the site, (b) quantification of the risks from individual and multiple chemical exposures, (c) quantification of the total risk across all exposure pathways and (d) an assessment of the uncertainty associated with the risk quantifications.

For non-carcinogens, the pathways were evaluated by comparing site-specific intake rates of contaminants with the RfD, based on available toxicological, chemical and physical characteristics of the contaminants of concern. Exposure pathway and matrix-specific intake rates for these chemicals were calculated utilizing pathway modeling. The acceptable intake rates were then compared to the actual matrix-specific intake rates to determine whether a potential human health risk may exist.

Risks for non-carcinogenic effects are quantified by a unitless weighting function by calculating the ratio of the chronic daily intake (SI) and the reference dose (RfD). The sum of the SI/RfD ratios is the Hazard Index as shown below:

$$HI = \frac{SIi}{RfDi}$$

where

HI = Hazard Index
SIi = Chronic daily intake for chemical i (mg/kg-day)
RfDi = Reference dose for chemical i (mg/kg-day)

A hazard index less than one, whether it is for a specific chemical or a total for all chemicals from the site, indicates that health risks are less likely to be of concern than when the hazard index exceeds a value of one. The value for the HI is not definitive, that is, an HI of less than one does not necessarily mean that the risks are acceptable and that an HI greater than one that health risks will occur, for two reasons.

First, there are uncertainties associated with the determination of the SI and RfD. Second, a total hazard index assumes that the individual exposures are additive. Many chemicals interact resulting in a toxic effect greater (a synergism) or less than the sum of their individual exposures.

Potential for excess lifetime cancer risk is calculated by multiplying the SI by the slope factor as follows:

$$\text{Excess lifetime cancer risk} = SI \times q^*i$$

where

SI = Chronic daily intake of chemical (mg/kg-day)
q*i = Cancer slope factor for chemical $(\text{mg/kg-day})^{-1}$

This linear equation is valid for excess lifetime cancer risks less than 10^{-2} (i.e., one in one hundred). Above this level, individual excess cancer risks should be calculated using the following equation which accounts for the non-linear portion of the dose-response curve:

$$\text{Excess lifetime cancer risk} = 1- EXP(SI \times q^*i).$$

In accordance with USEPA guidelines for evaluating the potential toxicity of chemical mixtures (USEPA, 1986a), in the absence of specific information on the toxicity of the mixture to be assessed or on similar mixtures, it will be assumed that the effect of the chemicals of concern would be additive. Synergistic or antagonistic interactions may be taken into account if there is specific information on particular combinations of chemicals. In this RA, it is assumed that the effects of the chemicals are additive, since there are no documented quantifiable interactions known to occur among any of the pollutants found at the site. Thus, lifetime excess cancer risks and the SI:RfD ratios will be summed across chemicals within each pathway to indicate potential risks associated with exposure to mixtures of potential carcinogens and noncarcinogens, respectively.

8.1.1 Selection of Contaminants of Concern

Rationale

According to USEPA (RAGS, 1989c), all contaminants detected at the site should be considered contaminants of concern. Review of the data tables presented in Section 6.0 shows that the list of contaminants would be lengthy. Furthermore, potential risks may be overestimated from site contamination if infrequently detected compounds contribute significantly to the total potential risk. Consequently, the option of reducing the number of contaminants of concern was applied to the Circuitron Corporation data set in accordance with the guidelines outlined by the USEPA in RAGS (1989c).

The selection of contaminants of concern for the RA is a multi-step process which includes (1) an evaluation of the analytical quality of the reported data (e.g., laboratory blank contamination, sample quantitation limits), (2) a comparison of the observed contaminant concentrations to typical "background" concentrations, (3) an evaluation of the frequency of detection and (4) a concentration-toxicity screen. A selection process is performed to reduce the number of contaminants to be evaluated while still representing the risks associated with the site contamination.

The analytical quality of all chemical data provided by the CLP system was determined during the validation of the samples. Samples were validated according to current USEPA Region II organic and inorganic validation protocols. The validation procedure incorporates an evaluation of laboratory blank contamination, calibration accuracy, and other QC procedures which may affect the accuracy of the reported concentration and even the presence of the particular compound. For example, acetone is a commonly used solvent in CLP laboratories for the preparation of samples for pesticides/PCB analyses. As a consequence, it is often detected in the volatile analyses of samples due to elevated background in the laboratory when not a true constituent of the sample. Acetone hits are often changed to non-detect during the validation procedure because of the potential introduction of this solvent during sample analysis.

An evaluation of the observed contaminant concentrations to typical "background" concentrations allows for the elimination of a chemical which may or may not be attributable to site activities. This evaluation is appropriate only for the TAL inorganics since TCL organics are not typically found as a "background" in soils. The only exception to this is the presence of TCL organics in air (Shah and Singh, 1988) which was evaluated in Section 6.0.

An evaluation of the frequency of detection of the contaminant in the different sampled matrices is also important to the selection process. Contaminants which are present sporadically may not be representative of site contamination and/or site activity. On the other hand, the toxicity of the less frequently found contaminant may warrant its inclusion in the RA.

The last step in the evaluation is a concentration-toxicity screen of the contaminants at the site. This is accomplished by calculating the "risk factor" for each chemical by using the following equation:

$$Rij = (Cij)(Tij)$$

where,

Rij = risk factor for chemical i in medium j;
Cij = concentration of chemical i in medium j; and
Tij = toxicity value for chemical i in medium j (the slope factor or 1/RfD).

The total risk factor is calculated for each medium and then the ratio of the chemical-specific risk factor to the total risk factor (Rij/Rj) is calculated. Those chemicals with a low Rij/Rj ratio contribute less to the total risk of the site then those chemicals with high Rij/Rj ratios. Thus, this screen weights the concentration of the contaminant and its toxicity to determine whether the contaminant should be retained for analysis in the RA.

Current guidance for CERCLA risk assessments (EPA, 1989) no longer requires an evaluation of the risks associated with average and the maximum contaminant concentrations but rather requires that the evaluation incorporate the upper 95% confidence limit on the concentration distribution as the contaminant concentration. Furthermore, non-detect analytical results are included in this distribution as one-half the reported Sample Quantitation Limit (SQL) of the contaminant in each sample. This provides a more realistic distribution of the contaminants at the site than calculating the average (or geometric average) of the hits only or incorporating non-detects as zero (McNichols and Davis, 1988). However, when the upper 95% confidence limit exceeds the maximum observed concentration, then the latter value is used. Therefore, for the calculation of the risk factors, the upper 95% confidence limit (or maximum observed) will be used as the representative concentration of the contaminant.

Contaminant Selection

The range of chemical concentrations, the frequency of detections, and the upper 95% confidence limits for TAL inorganics and TCL organic compounds are shown in Tables 8-1 and 8-2, respectively.

The Risk Assessment Guidance for Superfund (USEPA, 1989c) recommends that a frequency of detection of 5% be used as a cutoff for eliminating contaminants from the risk assessment. This criterion was applied to the samples from the site but contaminants of known high toxicity were carried further in the selection process. Inorganic analytes in the soils which exceed this criterion were then compared to reported background concentrations for soils similar to those from the site (Brown, 1983; Kabata-Pendias and Pendias, 1984). If the inorganic analyte concentrations did not exceed typical background concentrations they were eliminated from the risk assessment. Organic and inorganic analyte concentrations in the groundwater were also compared to existing state and federal ARARs.

TABLE 8-1

CIRCUITRON CORPORATION SITE

RANGE, FREQUENCY OF DETECTIONS AND UPPER 95% CONFIDENCE LIMITS FOR INORGANIC ANALYTES

	SURFACE/SUBSURFACE SOILS 1/			SEDIMENTS 1/ 4/			GROUNDWATER-ROUND 1 2/			GROUNDWATER-ROUND 2 2/		
ANALYTE	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT
Aluminum	82/82	92.4-5780.0	1180.6J	6/6	900-10400	7116.8J	11/15	42.5-8450	3073	14/14	14-731	361.7J
Antimony	1/85	13.8	3.4J	3/			1/20	50	23	3/		
Arsenic	76/85	0.3-6.6	1.3J	7/7	1.5-6.3	5.4J	10/20	2.2-6.6	3.2	5/14	1-5.1	2.3J
Barium	60/63	0.5-37.4	6.5J	7/7	7.2-80.6	64.0J	16/16	25.6-148	99.3J	14/14	14.6-146	100J
Cadmium	5/85	0.8-1.1	0.5J	2/7	2.8-3.8	2.7J	3/			1/14	2.5	1.3J
Chromium (III)	77/85	1.1-38.6	4.9J	7/7	8.6-88.1	62.3J	11/18	6-870	161J	10/14	3.1-21.3	11J
Chromium (VI)	1/8	7.0	7.0	3/			1/19	15.3	15.3	3/		
Cobalt	15/85	0.9-7.9	1.3J	3/			3/			5/14	1.1-8.2	3.4J
Copper	78/85	1.2-71200.0	2644.8J	7/7	648-23900	14928J	14/18	9.3-538	150.9J	10/14	3.9-287	81.1J
Iron	83/83	870.0-16600.0	3419.2J	7/7	4190-11900	13427J	14/14	188-19300	9731J	17/14	44-14900	6486J
Lead	77/77	0.4-1450.0	73.0J	5/6	21.2-2650	1969.1J	8/13	1.2-61.4	20.9J	7/14	3.4-14.6	9.7J
Magnesium	66/69	13.2-30700	2359.3J	7/7	931-11900	8973.8J	16/16	830-7200	4639	14/14	1610-5240	4023J
Manganese	76/76	3.5-170.0	46.4J	7/7	15.8-75.7	69.5J	19/20	32.5-1640	480J	14/14	30.1-15.10	495J
Nickel	42/85	1.3-119.0	8.7J	7/7	9.0-109.0	80.3J	9/20	15-70.2	24.8	3/14	17.2-36.7	16.2J
Potassium	75/80	30.4-1330.0	176.6J	3/			14/16	1222-4160	3081J	14/14	2440-6030	4707J
Silver	6/85	2.7-9.5	1.2J	6/7	3.1-160.0	83.2J	1/16	134	5.9	-3/		
Sodium	21/84	13.4-1130.0	215.9J	7/7	117-302	277.2J	14/14	2830-24800	20597J	14/14	5360-25500	18874
Zinc	19/23	1.4-181.0	37.1J	1/1	66.8	66.8	10/12	18-110	60J	9/9	5.5-99.6	62J
Cyanide	2/85	2.2-2.9	0.5J	3/			6/20	10-25	10	3/		
Mercury	9/85	0.1-1.5	0.1J	6/7	0.3-6.6	5.1J	1/20	0.3	0.1J	3/		

1/ Units are mg/kg
2/ Units are ug/l
3/ Not detected
4/ Leaching pools, sanitary cesspools and storm drains

TABLE 8-2

CIRCUITRON CORPORATION SITE

RANGE, FREQUENCY OF DETECTIONS AND UPPER 95% CONFIDENCE LIMITS FOR ORGANIC ANALYTES

	SURFACE/SUBSURFACE SOILS1/			SEDIMENTS1/ 3/			GROUNDWATER-ROUND 12/			GROUNDWATER-ROUND 22/		
ANALYTE	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT
Acetone	5/72	22-1200	305J	—						—		
1,1-Dichloroethene	4/72	2-5	3J	—			8/12	0.6-12	7J	12/16	0.8-11	5.8J
1,1-Dichloroethane	3/72	2	3.1J	2/5	6-65	50.1J	8/12	0.4-17	7.1J	13/16	0.6-6.6	2.8J
Chloroform	30/72	1-12	3J	1/5	3	10.3J	4/11	2-31	17.2J	5/16	1.2-207	42.5J
1,1,1-Trichloroethane	11/72	3-1000000	4485J	4/5	9-19000	14474	12/14	2-4600	1113J	14/16	5.4-1181	268J
Trichloroethene	4/72	1-9	3.2J	—			9/12	0.9-18	13.6J	11/16	0.9-27	12.1J
1,1,2-Trichloroethane	2/72	1-2	3.1J	—			—			—		
Tetrachloroethene	9/72	1-100	8.1J	2/5	8-21	17.4J	8/12	7-110	41.5J	13/16	0.7-87	29.8J
Toluene	30/72	0.6-87	9.2J	—			—			—		
Chlorobenzene	1/72	2	3.1J	—			—			—		
Xylenes	1/72	20	3.4J	—			—			—		
Benzene	—			1/5	8	18.9J	1/11	3	9.3J	—		
Trans-1,2-dichloroethene	—			—			—			1/16	46	9.4
2-Butanone	—			—			1/12	1	8.4J	—		
1,2-Dichloroethane	—			—			2/13	1-2	8.2J	1/16	25	5.3
Chloroethane	—			—			—			1/16	1.1	0.6
Carbon disulfide	—			—			—			2/16	0.7-0.8	0.6
Styrene	—			—			—			1/16	0.6	0.5
DCDFM	—			—			—			1/16	20	4.3
TCFM	—			—			—			3/16	1.3-72	14.6
N-Butylbenzene	—			—			—			1/16	0.6	0.5J
Cis-1,2-dichloroethene	—			—			—			5/16	3-9.8	3.7
Hexachlorooctadiene	—			—			—			1/16	0.7	0.5J

TABLE 8-2 (Cont'd)

CIRCUITRON CORPORATION SITE

RANGE, FREQUENCY OF DETECTIONS AND UPPER 95% CONFIDENCE LIMITS FOR ORGANIC ANALYSIS

	SURFACE/SUBSURFACE SOILS 1/			SEDIMENTS 1/ 4/			GROUNDWATER-ROUND 1 2/			GROUNDWATER-ROUND 2 2/		
ANALYTE	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT
Phenol	1/71	17000	938	1/6	110	341J	—			—		
Benzyl alcohol	1/72	21000	1091	1/6	40	353J	—			—		
Benzoic acid	3/70	65-2900	1268J	6/6	76-3100	1964J	—			—		
Acenaphthylene	1/72	160	266J	2/6	59-150	321J	—			—		
Pentachloro-phenol	1/71	43	1274J	—			—			—		
Phenanthrene	1/72	54	265J	6/6	420-7600	5903J	—			—		
Di-n-butyl-phthalate	3/72	41-120	253J	2/6	180-630	468J	3/19	1-2	5.3J	—		
Fluoranthene	1/72	110	266J	6/6	590-4800	4820J	—			—		
Pyrene	1/72	91	265J	6/6	1100-27000	18262	—			—		
Butylbenzyl phthalate	6/72	5-25000	1286J	6/6	220-5200	3957J	—			—		
BEHP	35/72	35-20000	1844J	6/6	2700-39000	27512J	—			6/14	1-4	4.8J
Di-n-octyl phthalate	1/72	230	262J	6/6	85-5400	3606J	—			—		
Benzo(b) fluoranthene	1/72	160	261J	6/6	350-9100	6146J	—			—		
Benzo(a)pyrene	1/72	52	259J	6/6	270-6100	4134J	—			—		
1,1-Dichloro-benzene	—			1/6	62	349J	—			—		
4-Methylphenol	—			2/6	28-70	345J	—			—		
Naphthalene	—			3/6	20-120	309J	—			—		
4-Chloro-3-methylphenol	—			2/6	19-22	350J	—			—		
2-Methyl naphthalene	—			2/6	31-120	324J	—			—		
Dimethyl phthlate	—			3/6	38-160	305J	—			—		
Acenaphthylene	—			6/6	21-620	420J	—			—		
Dibenzofuran	—			6/6	11-390	269J	—			—		
Fluorene	—			2/6	160-300	305J	—			—		
Pentachloro-phenol	—			1/6	110	1543J	—			—		
Anthracene	—			6/6	55-1300	920J	—			—		
Benzo(a) anthracene	—			6/6	280-6100	4069J	—			—		
Chrysene	—			6/6	210-9500	6232J	—			—		
Benzo(k) fluoranthane	—			5/6	35-6600	4210J	—			—		
Indeno(123-cd) pyrene	—			3/6	620-5800	3757J	—			—		

TABLE 8-2 (Cont'd)

CIRCUITRON CORPORATION SITE

RANGE, FREQUENCY OF DETECTIONS AND UPPER 95% CONFIDENCE LIMITS FOR ORGANIC ANALYSIS

	SURFACE/SUBSURFACE SOILS 1/			SEDIMENTS 1/ 4/			GROUNDWATER-ROUND 1 2/			GROUNDWATER-ROUND 2 2/		
ANALYTE	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT	FREQUENCY OF DETECTIONS	RANGE	UPPER 95% LIMIT
Dibenzo(ah) anthracene	—			1/6	280	292J	—			—		
Benzo(ghi) perylene	—			3/6	680-8400	5945J	—			—		
Delta-BHC	1/73	29	5.8	—			—					
Heptachlor	1/72	20	5.5	—			—					
Aldrin	1/72	7.9	5.1J	—			—					
Heptachlor epoxide	1/73	24	5.8	—			—					
4,4-DDE	1/73	25	10.3J	—			—					
Endosulfan sulfate	3/73	18-240	20.4J	—			—					
4,4-DDT	4/73	20-41	11.9J	—			—					
Gamma-chlordane	1/73	21	49.9J	2/6	120-340	232.8J	—					
Aroclor 1248	1/73	1200	94.8J	—			—					
Aroclor 1254	1/73	170	102.7	—			—					
Aroclor 1260	2/73	170-280	107	—			—					
Endsulfan I	—			1/6	11	25.8	—					

1/ Units are in ug/kg

2/ Units are in ug/l

3/ Leaching pools, sanitary cesspools and storm drains

If the concentrations from the site were below these standards, they were dismissed from further consideration in the risk assessment provided that the ARAR did not provide an unacceptable carcinogenic or non-carcinogenic risk. The risk factors are then calculated for contaminants which pass this criterion for final contaminant selection. To be a contaminant of concern the analytes must (1) satisfy all three test criteria, or (2) have a risk factor which contributes greater than 1% to the total risk factor while being present at greater than 5% of the samples. If the contaminant did not exceed background it was not considered a contaminant of concern.

o Inorganic Analytes

A total of 23 inorganic analytes (including cyanide) were identified in the soils, sediments or groundwater from the site. In the surface and subsurface soil samples, three inorganic analytes (antimony, beryllium and cyanides) were found at a frequency less than 5%; none of these analytes were found in the sediments from the leaching pools, sanitary cesspools or storm drains.

Background inorganic concentrations for soils of the Eastern U.S. and those typical of sandy soils are shown in Table 8-3. Comparison of Tables 8-3 and 8-1 show that the following 12 inorganic analytes in the soils and sediments were below or near "background" concentrations: arsenic, barium, beryllium, cadmium, chromium (total), cobalt, lead, manganese, nickel, selenium, vanadium and zinc. For this analysis it was assumed that the sediments can also be compared to the background levels for sandy soils since the sediments were sandy in appearance. There were no reported background concentrations in the literature for six analytes (calcium, iron, cyanide, magnesium, potassium and sodium). However, all of these analytes except for cyanide can be considered essential nutrients and do not require further evaluation in the risk assessment; as cyanide was detected at a frequency less than 5%, it was also removed from consideration in the risk assessment.

Table 8-4 compares the range of observed organic and inorganic analyte concentrations to existing federal MCLs and New York state groundwater standards. Generally an MCL for a toxic chemical represents the allowable lifetime exposure to the contaminant for a 70-kg adult who is assumed to ingest two liters of water per day. MCLs are enforceable drinking water standards and are not strictly health-based. In addition to health factors, an MCL is 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 1986b). While all volatiles exceed their ARARs only two of the ten inorganic analytes exceeded these ARARs in the groundwater, these being lead and nickel. Copper and chromium were retained for further evaluation in this risk assessment because the site history indicated that the

TABLE 8-3

CIRCUITRON CORPORATION SITE

BACKGROUND SOIL CONCENTRATIONS FOR INORGANIC ELEMENTS(1)

ELEMENT	SOILS FOR EASTERN U.S. RANGE (mg/kg)	SANDY SOILS Range (mg/kg)	SANDY SOILS Mean (mg/kg)
Aluminum	-	0.45-10	-
Antimony	1.3-10	0.05-4.0(2)	-
Arsenic	8-13	0.1-30	5.1
Barium	-	20-1500	400
Beryllium	2-15	1-3	1.9
Cadmium	<1-3.5	0.07-1.1(2)	0.5
Chromium	100-1,000	3-200	40
Cobalt	-	0.4-20	3.5
Copper	50-700	1-70	14
Lead	50-700	<10-70	17
Manganese	-	7-2000	345
Mercury	0.042-0.066	0.01-0.54	0.08
Nickel	30-700	5-70	13
Selenium	<0.1-0.1	0.005-3.5	0.5
Silver	-	-	<5(2)
Vandium	-	7-150	4.7
Zinc	120-3,500	10-300(2)	50(2)

Note: 1) Kabata - Pendias and Pendias (1984)
2) Brown et al (1983)

TABLE 8–4

CIRCUITRON CORPORATION SITE

POTENTIAL FEDERAL AND STATE HEALTH–BASED ARARs IN COMPARISON TO LEVELS DETECTED IN GROUNDWATER (ug/l)

	FEDERAL			STATE	RANGE OF GROUNDWATER CONTAMINATION	
COMPOUND	ARAR: SAFE DRINKING WATER ACT MAXIMUM CONTAMINANT LEVEL	OTHER GUIDANCE MCLG	AMBIENT WATER QUALITY CRITERIA FOR PROTECTION OF HUMAN HEALTH	AMBIENT WATER QUALITY CRITERIA FOR CLASS GA WATERS	ROUND 1	ROUND 2
INORGANICS:						
Cadmium	10	5(1)	10	10	-	ND - 2.5
Chromium	50 (as VI)	50 (as VI)	179,000, 50(2)	50 (as VI)	ND - 870	ND - 21.3
Copper	1000 (organoleptic)	1,300(1)	1,000 (c)	1,000	ND - 538	ND - 287
Lead	50	20(1)	50	25	ND - 61.4	ND - 14.6
Mercury	2	3(1)	10	2	ND - 0.3	-
Nickel	—	—	15.4	—	ND - 70.2	ND - 36.7
Silver	50	—	50	50	ND - 13.4	-
Zinc	—	—	5,000(3)	5,000(3)	ND - 110	5.5 - 99.6
Cyanide	—	—	200	200	ND - 25	-
Arsenic	50	—	—	25	ND - 6.6	ND - 5.1
ORGANICS:						
Trichloroethene	5.0	0	0.28(4)	5	ND - 18	ND - 27
Tetrachloroethene	—	0	0.88(4)	5	ND - 110	ND - 87
Benzene	5.0	0	0.67(4)	5	ND - 3	-
1,2-dichloroethane	5.0	0	0.94(4)	5	ND - 2	ND - 25
1,1-dichloroethane	—	—	—	5	ND - 17	ND - 6.6
1,1,1-trichloroethane	200	200	19 mg/1(4)	5	ND - 4600	ND - 1181
1,1-dichloroethene	7.0	—	—	5	ND - 12	ND - 11
Chloroform (Total Trihalomethanes)	100	—	—	5	ND - 31	ND - 207

NOTES:
(1) Proposed
(2) Applies for Chromium (III) and Chromium (VI), respectively
(3) Organoleptic–based on taste and odor effects
(4) Concentrations resulting in 10^{-6} risk
ND None Detected at CRDL

Circuitron Corporation exceeded their SPDES permit discharge limits for these analytes. Only the unfiltered analyte results are reported in this table since these results were used for the risk assessment. Review of the results from the individual samples showed that the iron was removed to below detection limits by filtering the samples. Iron was dismissed from further consideration in this risk assessment because it was clearly associated with the particulate phase and is not toxic <u>per se</u>, but produces changes in the aesthetic quality of water (e.g., taste, discoloration of laundry).

To calculate the risk factors for the inorganic analytes, the slope factors (q*) and RfDs are required; these values are summarized in Table 8-5. These values were obtained from the fourth quarter 1989 HEAST tables provided by EPA. Only 11 of the 23 qualified inorganic analytes have either a reported q* or RfD. The May 1988 RfD for arsenic was included in this evaluation even though the value has been withdrawn so that potential risk could be handled qualitatively. The risk factors for individual contaminants for each sampled matrix are shown in Appendix G (Table G-1).

Table 8-6 presents the contaminant selection matrix for the inorganic analytes. Only copper is an inorganic contaminant of concern in the surface and subsurface soils at Circuitron.

Table 8-7 presents the contaminant selection matrix for the inorganic analytes in the sediments from the SPDES pools, leachate pools and storm drains. Applying the same criteria as with the soils, it was determined that the following four inorganic analytes are contaminants of concern in the sediments at Circuitron:

arsenic
cadmium
copper
mercury

Table 8-8 presents the contaminant selection matrix for the inorganic analytes in the groundwater from all wells sampled at the Circuitron Corporation Site. Applying the three step evaluation and all historical information, it was determined that the following four inorganic analytes are contaminants of concern in the groundwater at Circuitron:

chromium
copper
lead
nickel

Although arsenic is listed as a contaminant of concern for the sediment matrix outlined above, the exposure pathways evaluated in Section 8.1.2 do not include inhalation of arsenic from soil, sediment or groundwater which are the only exposure pathways by which arsenic could be considered carcinogenic. This risk assessment would have evaluated arsenic's non-carcinogenic

TABLE 8-5

CIRCUITRON CORPORATION SITE

REFERENCE DOSES (RfDs) AND SLOPE FACTORS (q*) FOR SELECTED INORGANIC CONTAMINANTS

Analyte	q* (mg/kg/day)$^{-1}$	Group 4/	Exposure 1/	RfD (mg/kg/day)	Exposure
Antimony				4E-4	0
Arsenic	5E+1	A	I	1E-3 2/	0
Barium				5E-2	0
Cadmium	6.1	B1	I	5E-4	0
Chromium					
III				1E+0	0
VI	4.1E+1	A	I	5E-3	0
Copper				3.7E-2 3/	0
Manganese				2E-1	0
Mercury				3E-4	0
Nickel	8.4E-1	B1	I	2E-2	0
Zinc				2E-1	0
Cyanide				2E-2	0

Notes:

1/ Exposure routes - I: inhalation, 0: oral.

2/ The arsenic RfD is currently under review.

3/ Calculated from the Water Quality Criteria (1.3 mg/l) assuming a 70-kg individual ingesting 2 l/day.

4/ Carcinogen groups - A: human epidemiological data supports a causal link between exposure and human cancer; B1: limited epidemiological data supports a causal link between exposure and human cancer.

TABLE 8-6

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX INORGANIC ANALYTES IN SURFACE AND SUBSURFACE SOILS

Analyte	Frequency Greater Than 5%	Concentration Exceeds Background	Carcinogenic Risk Factor Greater than 1%	Non-Carcinogenic Effect Risk Factor Greater Than 1%	Contaminant of Concern
Antimony				X	
Arsenic	X		X	X	
Barium	X				
Cadmium	X		X	X	
Chromium	X				
Copper	X	X		X	X
Manganese	X				
Mercury	X				
Nickel	X				
Zinc	X				

TABLE 8-7

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX
INORGANIC ANALYTES IN SEDIMENTS

Analyte	Frequency Greater Than 5%	Carcinogenic Risk Factor Greater than 1%	Non-carcinogenic Risk Factor Greater than 1%	Contaminant of Concern
Arsenic	X	X	X	X
Barium	X			
Cadmium	X	X	X	X
Chromium (total)	X			
Copper	X		X	X
Manganese	X			
Mercury	X		X	X
Nickel	X			
Zinc	X			

TABLE 8-8

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX
INORGANIC ANALYTES IN GROUNDWATER

Analyte	Frequency Greater Than 5%	Concentration Exceeds MCL	Non-carcinogenic Risk Factor Greater than 1%	Contaminant of Concern
Barium	X		X	
Chromium (total)	X	X		X
Copper	X	X	X	X
Manganese	X		X	
Nickel	X	X	X	X
Zinc	X		X	
Cyanide	X		X	
Lead	X	X	X	X

effects using the RfD value for ingestion or dermal absorption pathways, however, because the May 25, 1988 verified RfD has been withdrawn from HEAST and IRIS, arsenic cannot be quantitatively evaluated. Therefore, arsenic will be qualitatively addressed in the risk characterization sections for exposure to sediment if the exposure pathways are complete.

Hexavalent chromium was detected in the shallow groundwater sample of well MW-11, located just east of the Circuitron building, at a concentration of 15.3 ug/l. This concentration falls below the State and Federal MCLs, the MCLG and the ARAR allowable concentration of 50 ug/l. (Table 8-4). Hexavalent chromium will be quantitatively evaluated in this risk assessment for both its carcinogenic risk and non-carcinogenic health effects.

- Organic Analytes

Up to 12 volatile organics, 30 semi-volatiles organics and eleven pesticide/PCB compounds were identified in the soils, sediments or water from the site. In the sludge and subsurface soils, three volatile organics (1,1,2-trichloroethane, chlorobenzene and xylenes) were present at a frequency of less than 5%. The remaining volatile compounds were also present in the sediments from the leaching pools, sanitary cesspools or storm drains, and in the groundwater. Benzene was detected in one sediment sample and was retained for risk analysis because of its carcinogenicity.

Two phthalate compounds [butyl benzyl phthalate and bis(2-ethylhexyl) phthalate] and a pesticide (4,4-DDT) were present at a frequency greater than 5% in the surface and subsurface soil samples. All of the semi-volatile compounds (n = 30) and pesticides (n = 2) identified on site were present at a frequency greater than 5%. As discussed in Section 6.0, all the sediments in the leaching pools, sanitary cesspools and storm drains received road surface runoff which likely represented the principal source of semivolatile contaminants to these sediments. Eighteen of the thirty semi-volatile compounds quantified in the semi-volatile fraction were polycyclic aromatic hydrocarbons (PAHs), four were phthalates, with the remainder aromatics and aromatic acids (e.g., benzoic acid).

Background concentrations of organic compounds in the environment are usually considered to be negligible. The PAHs present in the pools and drains outside of the building could be considered "background" since they were clearly attributable to roadway runoff. Jones et al (1989) analyzed PAH compounds in surficial soils in Wales and found that they were common in both rural and urban areas, although the latter PAH concentrations were usually greater. The PAH concentrations were also correlated with clay and organic contents of the soils. Table 8-9 summarizes the data from this study. This table is presented to show that

TABLE 8-9

CIRCUITRON CORPORATION SITE

BACKGROUND SOIL CONCENTRATIONS FOR POLYCYCLIC AROMATIC HYDROCARBONS [2]

Compound	Mean	Median	Range[1]
Naphthalene	8.7	2.4	<1.0-131
Acenaphthylene	3.0	<1.0	<1.0-23
Acenaphthene/fluorene	61	37	12.4-453
Phenanthrene	72	22	7.7-772
Fluoranthene	7.7	2	0.6-72
Anthracene	156	42	17-1550
Pyrene	63	29	11-456
Dibenzanthracene/ chrysene	123	36	13.4-1120
Benzo(b)fluoranthene	66	20	8.0-605
Benzo(a)pyrene	36	13	3.6-285
Dibenz(a,h)anthracene	33	5.6	<1.0-383
Benzo(g,h,i)perylene	88	33	11.3-927
Total	720	253	108-6740

Notes: [1] Units are ug/kg

[2] Data from Jones et al (1989)

TABLE 8-10

CIRCUITRON CORPORATION SITE

SLOPE FACTORS (q*) AND REFERENCE DOSES (RfDs) FOR SELECTED ORGANIC CONTAMINANTS

Analyte	q* (mg/kg/day)$^{-1}$	Group[1/]	Exposure	RfD (mg/kg/day)	Exposure
A. Volatiles					
Acetone	-	-		1E-1	0
Benzene	2.9E-2	A	0,I	-	
Dichlorodifluoromethane	-			2E-1	0
				5E-2	I
1,1-Dichloroethene	6E-1	C	0	9E-3	0
	1.2E+0	C	I		
1,1-Dichloroethane	9.1E-2	B2	0	1E-1	0,I
Chloroform	6.1E-3	B2	0	1E-2	0
	8.1E-2	B2	I	-	
1,1,1-Trichloroethene	-			9E-2	0
	-			3E-1	I
Trichloroethene	1.1E-2	B2	0	-	
	1.7E-2	B2	I	-	
1,1,2-Trichloroethane	5.7E-2	C	0,I	4E-3	0
Tetrachloroethene	5.1E-2	B2	0	-	
	3.3E-3	B2	I	-	
Toluene	-			3E-1	0
	-			2E+0	I
Chlorobenzene	-			2E-2	0
	-			5E-3	I
Xylenes	-			2E+0	0
	-			3E-1	I
1,2,3-Trichloropropane	-			6E-3	0
B. Semi-volatiles					
Phenol				6E-1	0
Benzoic acid				4E+0	0
Benzo(a)pyrene	11.5	B2	0		
Di-n-butyl phthalate				1E-1	0
Butylbenzyl phthalate	—	C	0	2E-1	0
Bis(2-ethylhexyl)phthalate	1.4E-2	B2	0	2E-2	0

TABLE 8-10 (Cont'd)

CIRCUITRON CORPORATION SITE

SLOPE FACTORS (q*) AND REFERENCE DOSES (RfDs) FOR SELECTED ORGANIC CONTAMINANTS

Analyte	q* (mg/kg/day)$^{-1}$	Group[1/]	Exposure[2/]	RfD (mg/kg/day)	Exposure
C. Pesticides/PCBs					
Heptachlor	4.5E+0	B2	0,I	5E-4	0
Aldrin	1.7E+1	B2	0,I	3E-5	0
Endosulphan I				5E-5	0
44'-DDT	3.4E+1	B2	0,I	5E-4	0
Gamma-chlordane	1.3E+0	B2	0,I	5E-5	0
Aroclor 1248	(7.7E+0)[3/]	(B2)	0		
Aroclor 1254	(7.7E+0)	(B2)	0		
Aroclor 1260	7.7E+0	B2	0		

1/ Carcinogen "weight-of-evidence" group as assigned by the Carcinogen Assessment Group (CAG); A: Epidemiological studies support a link between exposure and human cancers,
B2: evidence of carcinogenicity in animals but inadequate data for humans,
C: limited evidence of carcinogenicity in animals

2/ Exposure routes - I: inhalation, 0: oral

3/ Slope factor based upon Aroclor 1260

TABLE 8-11

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX
ORGANIC ANALYTES IN SURFACE AND SUBSURFACE SOILS

Analyte	Frequency Greater Than 5%	Carcinogenic Risk/Outer Greater than 1%	Non-Carcinogenic Effect Risk Factor Greater Than 1%	Contaminant of Concern
Acetone	X		X	
1,1-Dichloroethene	X	X		X
1,1-Dichloroethane	X			
Chloroform	X			
1,1,1-Trichloroethane	X		X	X
Trichloroethene	X	X		X
1,1,2-Trichloroethene				
Tetrachloroethene	X			
Toluene	X			
Chlorobenzene				
Total xylenes				
Benzene				
Di-n-butyl phthalate				
Butylbenzyl pthalate	X			
Bis(2-ethylhexyl) phthalate	X	X	X	X
Heptachlor			X	
Aldrin		X	X	
4,4'-DDT		X	X	
Gamma-chlordane			X	
Aroclor 1248		X		
Aroclor 1254		X		
Aroclor 1260		X		

background contamination of PAHs can occur but will not be used for quantitative comparisons since (1) the data are for welsh soils which likely differ geologically from Long Island soils and (2) the lowest measured organic carbon content (approximately 2.7% TOC) exceeds those observed from the site by forty times, which indicates general organic enrichment of Welsh soils relative to those sampled at Circuitron. Because there is no reference in the published literature for local background concentrations of organic compounds these compounds were carried to the next step in the evaluation process.

To calculate the risk factors for the organic compounds the slope factors (q*) and RfDs are required. The slope factors and RfDs for the organic contaminants are summarized in Table 8-10. As in the inorganic risk factor calculations, these values were obtained from the fourth quarter 1989 HEAST tables provided by EPA. Slope factors or RfDs were available for all the volatile organics from the site, five of the semi-volatiles, and five of the pesticide/PCBs. Compounds which lack slope factors or RfDs (e.g., PAHs) can not be evaluated in the quantitative risk assessment. To calculate the risk factors, only the oral slope factors and RfDs were used. This was done to provide intercomparisons between the chemicals.

Table 8-11 presents the contaminant selection matrix for the organic analytes present in the surface or subsurface soils from the site. Of the 12 volatile organics, eight were present at a frequency greater than 5% in these samples. Two phthalate compounds and none of the pesticide/PCBs satisfied this selection criteria. Four volatile organics (acetone, 1,1-dichloroethene, 1,1,1-trichloroethane and trichloroethene), one phthalate compound (bis(2-ethylhexyl)phthalate), and all of the pesticide/PCBs contributed greater than 1% of the total carcinogenic or non-carcinogenic risk factors. From this matrix, it was determined that the following organic analytes are contaminants of concern in the surface and subsurface soils:

1,1-dichloroethene
1,1,1-trichloroethane
trichloroethene

Acetone was not included in this group even though it satisfied both the frequency of occurrence and risk factor criteria since it is a common laboratory contaminant and can not be attributed to previous site activity.

The contaminant selection matrix for organic analytes in the sediments of the storm drains, SPDES and cesspools is shown in Table 8-12. Five volatile organics, three phthalate compounds, and two pesticides (endosulfan I, gamma-chlordane) were found in these sediments at a frequency greater than 5%. As discussed previously, these samples showed an abundance of PAHs and related compounds which were attributable to road surface runoff. Thus, these compounds were dismissed from further assessment in the RA. From the matrix it was determined that the following organic analytes are contaminants of concern in the sediments at the Circuitron Corporation Site:

TABLE 8-12

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX ORGANIC ANALYTES IN SEDIMENTS

Analyte	Frequency Greater Than 5%	Carcinogenic Risk Factor Greater than 1%	Non-carcinogenic Risk Factor Greater than 1%	Contaminant of Concern
1,1-Dichloroethane	X	X		X
Chloroform	X			
1,1,1-Trichloroethane	X		X	X
Benzene	X	X		X
Tetrachloroethene	X	X		X
Di-n-butyl phthalate	X			
Butylbenzyl phthalate	X		X	X
Bis(2-ethylhexyl) phthalate	X	X	X	X
Endosulfan I	X		X	X
Gamma chlorodane	X	X	X	X

1,1-dichloroethene
1,1,1-trichloroethane
benzene
tetrachloroethene
butylbenzyl phthalate
bis(2-ethylhexyl)phthalate
endosulfan I
gamma-chlordane

Table 8-13 presents the contaminant selection matrix for organic analytes in the groundwater for all wells sampled during the Circuitron Corporation RI. Nine volatile organics and one phthalate compound were present at a frequency greater than 5%. No pesticide/PCBs were detected in the groundwater. All volatile compounds but one (2-butanone) exceeded federal MCLs or New York State groundwater criteria. Of this group, four volatile compounds and the phthalate contribute significantly to the total risk factor. Benzene, trichloroethene, tetrachloroethene, and 1,1,2-trichloroethane were retained for evaluation due to their carcinogenicity. Therefore, the organic contaminants of concern in the groundwater are:

1,1-dichloroethene
1,1-dichloroethane
benzene
chloroform
1,1,1-trichloroethane
trichloroethene
tetrachloroethene
1,1,2-trichloroethane

Table 8-14 summarizes the contaminants of concern by matrix for the Circuitron Corporation Site. As provided from site disposal history, these contaminants are predominantly volatile organics and inorganics. The potential risk from exposure to these compounds in each of the matrices follows in subsequent sections.

8.1.2 Identification of Exposure Pathways

The purpose of this section is to identify the most significant potential pathways through which individuals may be exposed to the specific contaminants of concern in various media at the Circuitron Corporation Site. By definition (USEPA, 1989c), an exposure pathway is composed of the following four elements:

- A source and mechanism of chemical release to the environment;
- A retention or transport medium (e.g., soils; goundwater) for the released chemical;
- A point of potential human contact with the contaminated medium; and
- An exposure route (e.g., inhalation of contaminated soils) at the point of potential human contact.

TABLE 8–13

CIRCUITRON CORPORATION SITE

CONTAMINANT SELECTION MATRIX
ORGANIC ANALYTES IN GROUNDWATER

Analyte	Frequency Greater Than 5%	Concentration Exceeds MCL	Carcinogenic Risk Factor Greater than 1%	Non-carcinogenic Risk Factor Greater than 1%	Contaminant of Concern
1,1–Dichloroethene	X	X		X	X
1,1–Dichloroethane	X	X	X	X	X
Chloroform	X	X		X	X
1,2–Dichloroethane	X	X			
2–Butanone	X				
1,1,1–Trichloroethane	X	X		X	X
Trichloroethene	X	X			
Benzene	X	X			
Tetrachloroethene	X	X			
Di–n–butyl phthalate	X			X(1)	

(1) As Di–n–butyl phthalate was the only semivolatile contaminant used in calculating the risk factor, no comparison to other compounds will be made; therefore it was dropped from further consideration.

TABLE 8-14

CIRCUITRON CORPORATION SITE

SUMMARY OF ORGANIC AND INORGANIC CONTAMINANTS OF CONCERN BY SAMPLE MATRIX(1)

Surface/Subsurface Soils	Sediments	Groundwater
1,1-Dichloroethene	1,1-Dichloroethane	1-1-Dichloroethene
1,1,1-Trichloroethane	1,1,1-Trichloroethane	1,1-Dichloroethane Benzene
Trichloroethene	Benzene Tetrachloroethene	Chloroform 1,1,1-Trichloroethane Trichloroethene Tetrachloroethene
Bis(2-ethylhexyl) phthalate		
Copper	Butylbenzyl phthalate Bis(2-ethylhexyl) phthalate	1,1,2-Trichloroethane
	Endosulfan I Gamma-chlordane	Copper Chromium Nickel Lead Hexavalent chromium
	Arsenic (inhalation only) Cadmium Copper Mercury	

(1) Contaminants of concern to be carried through the quantitative assessment. Arsenic was removed from the non-carcinogenic quantitative assessment because the RfD has been withdrawn from IRIS and HEAST for evaluation.

Exposure pathways are developed and identified for the "No Action" remedial alternative - i.e., under the assumption that no site remediation occurs. In the development of these pathways, it is further assumed that the site is accessible and that no preventive measures are taken to eliminate the potential for an exposure to be manifested. This baseline risk assessment is performed for present and future land use conditions. A current land use risk assessment is defined as an evaluation of the risks associated with site contamination in the current, undisturbed condition. For example, an evaluation of the potential risks associated with the ingestion of water from an actively used potable well on-site would be warranted if the well reflects contamination associated with the site. A future land use risk assessment is defined as the evaluation of risks associated with site contamination under future and potential conditions. For example, an evaluation of the risks associated with the ingestion of water from a well which is screened in the contaminated portion of an aquifer would be performed even if that portion of the aquifer was not serving currently as a potable water source, if the aquifer was of sufficient quantity and quality to support a well.

There are three general routes through which individuals could be potentially exposed to the chemicals of concern at the Circuitron Corporation Site: inhalation, ingestion and dermal absorption. An identified pathway does not imply that the exposures are occurring, but rather that the potential exists for a pathway between the contaminated medium and human receptor to be complete. Current conditions indicate no exposure pathway is now complete; therefore, this risk assessment will be limited to future land use scenarios involving: (1) the groundwater exposure pathway for children and adults; and, (2) potential exposure to sediments during construction activities. It was assumed that both present and future use in the vicinity of the site would be similar. Justification for this rationale is presented in the following subsections.

Ingestion/Inhalation of Soil and Sediment

Site characteristics play a critical role in the development of exposure pathways. The Circuitron Corporation Site is located in an industrial area surrounded by similar small manufacturers. Only a small portion of the site is exposed with most of the site area covered by the former Circuitron Corporation building and the asphalt parking lot. The present building structure on the site is in good condition and can be used for light industrial purposes; therefore, exposure of workers to contaminated subsurface soil is not expected to occur. Thus, contacts with contaminated soils with their subsequent ingestion or inhalation is highly unlikely under present site conditions. Furthermore, the population most likely to be exposed via this pathway (i.e., children) are not likely to frequent the areas for two reasons: (1) the site is an industrial area several miles from the residential areas, and

(2) there are no elementary schools nearby. Therefore, exposure to surface or subsurface soils is eliminated from further consideration. In addition, the ingestion and inhalation of contaminated sediments is eliminated from further consideration due to the exposure pathway being incomplete as the sediments are contained in inaccessible underground structures. The sediments are not dry and easily resuspended to provide a mechanism for exposure, and workers are not expected to accidentally ingest the sediments during their removal.

Ingestion of Groundwater

For this pathway, it is assumed that development around or on the site would require drinking water from a well screened in the Upper Glacial Aquifer (the aquifer sampled in this investigation) and/or that contaminants identified in the Upper Glacial aquifer will migrate downward into the Magothy Aquifer. The latter aquifer is the present drinking water source for Long Island. Several nearby municipal wells are screened in this aquifer.

The exposure scenario assumes that (1) the Upper Glacial aquifer is developed for use as a water supply for residential use in the area of the site, (2) a new industrial concern will use the site groundwater for its workers, and (3) the contaminants migrate into the Magothy aquifer. For the adult residential pathway, it was assumed that a 70 kg individual ingests two liters of groundwater 365 days per year, which contains the contaminants of concern at the Upper 95% confidence limits (or maximum values if this value exceeds the maximum value). The upper 95% confidence limit (UCL) was calculated using current USEPA criteria (M. Stefanidis, pers. comm.) as the back-transformed UCL from the natural log transformed average, variance and standard error using the following equation:

$$\mathrm{UCL} = \mathrm{EXP}\ [\bar{x} + 0.50s^2 + HS_e]$$

where $\bar{x}$ was the average of the natural log transformed data, s^2 was the variance on the transformed data, Se was the standard error on the transformed data, and H was the t-value for the transformed data. The latter value differs from the tabulated t-values because of the natural log transformation of the data.

This pathway was evaluated to examine any spatial variation in potential risks by subdividing the site into three components: upgradient well, on-site wells, and downgradient wells. For the residential children pathway, it was assumed that 0-17 year olds with a body weight of 35 kg ingest two liters of groundwater a day for 365 days per year. For the adult worker pathway, it was assumed that a 70 kg individual consumes 1 liter of water per day (i.e. half of waking hours spent at work) and the workers may drink other fluids during work hours (i.e., soda), for 250 days per year (i.e., 260 working days per year, less 10 day vacation). During the remainder of their working day, the workers are not exposed to contaminated groundwater from the site. All exposure variables were obtained from the Exposure Factors Handbook (USEPA, 1989b). The ingestion volume for children approximated the weighted average ingestion volume over the age range evaluated (0-17 year olds).

Table 8-15 summarizes the equations used to calculate the intake rates of contaminants from the groundwater ingestion pathway. Baseline assumptions are shown below.

Exposure Assumptions - adult residential

Body weight:	70 kg
Exposure duration (carc. only):	9 years (ave); 30 years (max)
Uptake efficiency:	100%
Ingestion rate:	2 liters per day

Exposure Assumptions - child residential

Body weight:	35 kg
Uptake efficiency:	100%
Ingestion rate:	2 liters per day

Exposure Assumptions - adult worker

Body weight:	70 kg
Exposure duration:	250 days/year
Update efficiency:	100%
Ingestion rate:	1 liter/work day

Inhalation of Contaminants in Groundwater

During water usage in a home, volatile organic contaminants contained in groundwater can volatilize during activities such as washing, bathing, laundering, cooking and showering. Foster and Chrostowski (1987) have shown that inhalation exposures to volatile organic compounds during typical home usage may be more important than groundwater ingestion. Since the groundwater has been found to contain volatile organic contaminants above acceptable concentrations, and the potential exists that the aquifer may be developed for potable water use, this pathway was included in this human health evaluation as a future use scenario. The groundwater is not currently used as a potable water supply.

A method to help evaluate potential health impacts of inhaling volatile organic compounds from groundwater was based on the methods of Foster and Chrostowski (1987). Table 8-16 presents the equation, parameters and assumptions utilized to calculate the intake rates and carcinogenic risks of the contaminants of concern.

TABLE 8-15

CIRCUITRON CORPORATION SITE

VARIABLES AND ASSUMPTIONS USED TO CALCULATE SITE-SPECIFIC INTAKE RATES FOR CHEMICAL CONSTITUENTS

INGESTION OF GROUNDWATER

Equation:

$$SI = \frac{(CW)\ (IR)\ (EF)\ (ED)}{(BW)\ (AT)}$$

Variables:

SI = Site specific intake for groundwater constituents (mg/kg-day)

CW = Chemical concentration in water (mg/l)

IR = Ingestion rate (l/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (period over which exposure is averaged; days).

TABLE 8-16

CIRCUITRON CORPORATION SITE

PARAMETERS AND ASSUMPTIONS USED TO CALCULATE SITE SPECIFIC INTAKE RATES FOR CHEMICAL CONSTITUENTS

INHALATION OF VOLATILE ORGANICS IN GROUNDWATER

Equation (Foster and Chrostowski, 1987):

$$E_{inh}=(VR)\ (S)\ /\ [(BW)\ (R)\ (10^{6})]x(Ds+exp(-RDt)/R-exp[Ds-Dt)]/R)$$

Parameters:

E_{inh} = Inhalation exposure per shower (mg/kg/shower)
VR = Ventilation Rate (l/min)
S = Indoor VOC generation rate (ug/m^3/min)
Determined by S = Cwd (FR)/SV
Where: Cwd = Concentration leaving shower droplet after time Ts (mg/l)
FR = Shower Flow Rate (l/min)
SV = Shower Room air volume (m^3)
BW = Body weight (Kg)
R = Air exchange rate (min^{-1})
Ds = Shower Duration (min)
Dt = Total Duration in shower room (min)

o Cwd is calculated by the following equation:

Cwd = Cwo (1 - exp [-Kal ts/60d])

Where: Cwo = shower water concentration (ug/l)
d = shower droplet diameter (mm)
ts = shower drop time (sec)
Kal = adjusted overall mass transfer for coefficient (cm/hr)

o KaL is determined by the following equation:

$KaL = K_L\ (TiUs/TsUi)^{-0.5}$

Where: T_i = calibration water temperature of K_L in ^oK
Ts = shower water temperature (^oK)
Ui = water viscosity at T_i (cp)

TABLE 8-16 (Cont'd)

CIRCUITRON CORPORATION SITE

PARAMETERS AND ASSUMPTIONS USED TO CALCULATE SITE SPECIFIC INTAKE RATES FOR CHEMICAL CONSTITUENTS

INHALATION OF VOLATILE ORGANICS IN GROUNDWATER

Parameters (Cont'd):

Us = water viscosity at T_S (cp)
K_L = overall mass transfer coefficient (cm/hr)

o K_L = = $(1/K_1 + RAT/Hkg)^{-1}$

Where:
H = Henry's Law Constant (atm-m^{-3}/mol-K)
RT = 2.4×10^{-2} atm-m^3/mole
Kg = gas-film transfer coefficient (cm/hr)
k_i = liquid film mass transfer coefficient (cm/hr)

Typical values of K_1 = 20 cm/hr and Kg = 3,000 cm/hr

Assumptions:

Input Parameter	Value
Shower Water Temperature	45°C (318°K)
Water Viscosity	0.596 cp
Shower Flow Rate	10 l/min
Droplet Diameter	1 mm
Droplet Time	2 sec
Air Exchange Rate	1.0 hr^{-1}
Shower Room Air Volume	6 m^3
Shower Duration	15 min
Duration in room after shower is turned off	5 min
Ventilation Rate	15 l/min
Inhalation Absorption Factor	100%
Body Weight	70 kg (adult) 35 kg (child)

Dermal Absorption From Soils/Sediments

Dermal absorption of contaminants from soils is not a complete pathway since most of the site is currently covered with the Circuitron Corporation building or parking lots. Therefore, direct contact of soils from the site is not likely.

However, dermal absorption of contaminants from the sediments and water in the storm drains, SPDES pools and cesspools were evaluated since these may require removal at some future date. As such, the purpose of this pathway was to determine the health and safety of workers involved in the removal. Table 8-17 summarizes the equation and parameters used for this pathway.

For dermal exposure, soil deposition rates of 0.5 and 1.0 mg/cm^2 were used for representative average and worst-case exposures, respectively (Schaum, 1985). A dermal absorption efficiency of 30% was used for all volatile and semi-volatile organic contaminants of concern detected in sediments as per M. Stefanidis.

Actual dermal absorption rates for contaminants from soil/sediment should be below values determined in experiments, because compounds are often dissolved in solvents "vehicles" such as acetone and hexane, which allow greater permeation of compounds into the skin than soil or water media. Dermal permeability was assumed to be 0 for all the inorganics compounds contained in soils except for mercury since it can be readily absorbed through the skin; the same absorption efficiency as used for the organics was applied to this analyte.

Dermal absorption of contaminants solubilized in the water of the storm drains and cesspools was also assessed. The skin surface areas exposed were the same as that for soil content. The dermal permeability of the contaminant was assumed to be the same as that of water. The duration of exposure was the same as that for soil contact. The amount of a compound absorbed through the skin is assumed to be proportional to the concentration of the compound in surface water. The amount absorbed per exposure event is given by the following formula:

Amount Absorbed (mg/event)=

$$\text{SSA}\ (\text{cm}^2) \times \text{WC}\ \frac{\text{mg}}{\text{l}} \times \text{DP}\ \frac{\text{cm}}{\text{hr}} \times \text{T}\ (\text{hrs}) \times \frac{\text{1 liter}}{1000\ \text{cm}^3}$$

where SSA = Skin surface area immersed in water (cm^2)
WC = Water concentration of contaminant of concern (mg/l)
DP = Dermal permeability (cm/hr)
T = Length of exposure (hr)

TABLE 8-17

CIRCUITRON CORPORATION SITE

PARAMETERS AND ASSUMPTIONS USED TO CALCULATE SITE SPECIFIC INTAKE RATES FOR CONTAMINANTS OF CONCERN

DERMAL CONTACT WITH SEDIMENTS

Equation:

$$SI = \frac{(SC)\ (SSA)\ (Eff)\ (SD)\ (EF)\ (ED)}{BW}$$

Variables:

SI = Site specific intake for sediment constituents (mg/kg-day)
SC = Soil concentration (mg/kg)
SSA = Skin surface area exposed (cm^2)
Eff = Uptake efficiency
SD = Skin deposition (mg/cm^2)
BW = Body weight (kg)
EF = Exposure frequency [days exposed $(days/yr)^{-1}$]
ED = Exposure duration (yr/yr)

Assumptions:

SC = Upper 95% confidence limit on mean contaminant concentration
SSA = 2000 cm^2 (ave); 5300 cm^2 (max)
Eff = 30% (ave, max)
SD = 0.5 mg/cm^2 (avg); 1 mg/cm^2 (max)
BW = 70 kg (ave)
WF = 5 days/365 days (ave, max)
ED = 1 year/70 years (ave, max)

Generally, only lipid soluble, non-ionized compounds are absorbed significantly through the skin. Therefore, all inorganic contaminants of concern were eliminated from further consideration in this pathway.

8.2 TOXICITY ASSESSMENT

In this section, brief summaries of the potential health effects of each selected chemical of concern are presented. In addition, the health effects criteria (i.e., dose-response values) that will be used to evaluate human health risks are provided.

For risk assessment purposes, individual pollutants are separated into two categories of chemical toxicity, depending on whether they exhibit the potential for non-carcinogenic or carcinogenic effects in humans.

8.2.1 Health Effects Criteria for Noncarcinogenic Effects

For chemicals that exhibit noncarcinogenic (e.g., systemic) effects, many authorities consider organisms to have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the health effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

Health criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessment are generally USEPA reference doses (RfDs) developed by the RfD Work Group. For those chemicals for which USEPA has not derived verified RfDs, health criteria used in a risk assessment may be derived from information provided in USEPA Health Effects Assessments (HEAs), IRIS, Office of Drinking Water Health Advisories (HAs), Office of Drinking Water Maximum Contaminant Level Goals (MCLGs), or National Ambient Air Quality Standards (NAAQS). The RfD is expressed in units of mg chemical/kg body weight/day. In general, the RfD is an estimate of an average daily exposure to an individual (including sensitive individuals) below which there will not be an appreciable risk of adverse health effects. The RfD is derived using conservative safety factors (e.g., to adjust from animals to humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects to occur. The purpose of the RfD is to provide a benchmark against which estimated doses (e.g., those projected from human exposure to various environmental conditions) might be compared. Doses that are significantly higher than the RfD may indicate that an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

8.2.2 Health Effects Criteria for Potential Carcinogens

For chemicals that exhibit carcinogenic effects, USEPA as well as other scientific authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to malignancy. This is the non-threshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of causing cancer. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of carcinogenic action for the chemical.

USEPA's Carcinogen Assessment Group (CAG) has developed cancer potency estimates (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The slope factor [in units of $(\text{mg/kg body weight/day})^{-1}$] is a number which, when multiplied by the lifetime average daily dose of a potential carcinogen (in mg/kg body weight/day), yields the upper-bound lifetime excess cancer risk associated with exposure at that dose. Upper-bound is a term used by USEPA to reflect the conservative nature of the cancer potency factors; risks estimated using slope factors are considered unlikely to underestimate actual risks but they may overestimate actual risks for a given exposure. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of 1×10^{-6} (one in one million), for example, represents the incremental probability that an individual will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specified exposure conditions. USEPA has suggested developing remedial alternatives for cleanup of Superfund sites to achieve total excess lifetime cancer risks ranging from no more than 10^{-4} (one in ten thousand) to 10^{-7} (one in ten million) (USEPA 1986c).

In practice, slope factors are derived from the results of human epidemiology studies or chronic animal bioassays. The animal studies must usually be conducted using relatively high doses in order to detect possible adverse effects. Since humans are expected to be exposed at lower doses than those used in the animal studies, the data are adjusted by using mathematical models. The data from animal studies are typically fitted to the linearized multistage model to obtain a dose-response curve.

The 95th percentile upper confidence limit slope of the dose-response curve, subject to various adjustments and an interspecies scaling factor is applied to conservatively derive the slope factor for humans. 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 on lifetime risk. Cancer potency estimates based on human epidemiological data are also derived using very conservative assumptions and, as such, they too are considered unlikely to underestimate risks.

Therefore, while the actual risks associated with exposures to potential carcinogens are unlikely to be higher than the risks calculated using a slope factor, they could be considerably lower (if exposure estimates are conservative).

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. USEPA (1986c) has proposed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data. The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies and (2) the quality of evidence from animal studies which are combined into a characterization of the overall weight of evidence for human carcinogenicity, and then (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. USEPA's final classification of the overall weight of evidence has the following five categories:

Group A--Human Carcinogen

> This category indicates that there is sufficient evidence from human epidemiological studies to support a causal association between an agent and cancer.

Group B--Probable Human Carcinogen

> This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans with sufficient data in animals (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C--Possible Human Carcinogen

> This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D--Not Classified

> This category indicates that the evidence of carcinogenicity in animals is inadequate.

Group E--No Evidence of Carcinogenicity in Humans

> This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies.

Slope factors are developed based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. For some chemicals, such as tetrachloroethylene and benzene, sufficient data are available to develop route-specific slope factors for inhalation and ingestion. For chemicals with only one route-specific slope factor but for which carcinogenic effects may also occur via another route, the available value may be used to evaluate risks associated with both potential routes of exposure (except in cases where evidence of carcinogenicity is highly route-specific, such as for cadmium and nickel).

8.2.3 Range of Potential Health Effects of Selected Chemicals of Concern

This section of the RA presents a brief summary of the critical human health effects associated with long-term (chronic) exposure to each of the selected chemicals of concern. Although exposures to chemicals at Superfund sites are not generally associated with adverse effects from high level short term exposures (acute effects), this section includes information on acute effects for completeness. In addition, the available health effects criteria for use in risk assessment (slope factors and RfDs) for each chemical of concern are presented. The data that provide the basis for the health criteria values are also discussed. Information on potential human health effects is primarily obtained from information in USEPA reports (e.g., Health Effects Assessment Documents, Health Effects Criteria Documents, Health Assessment Documents, Health and Environmental Effects Profiles, and Ambient Water Quality Criteria Documents), and from published and unpublished toxicological and epidemiological studies.

Some chemicals exhibit different health effects depending upon the route of exposure (e.g., inhalation versus oral). For example, a chemical may be associated with an increased risk of cancer when inhaled but may have no evidence of carcinogenicity when ingested [e.g., nickel and cadmium (USEPA 1987a,b)]. For these chemicals, route-sepcific health effects criteria where available are used, such as oral- and inhalation-specific slope factors and RfDs.

8.2.3.1 Organic Contaminants

- Benzene

Benzene is radily absorbed following oral and inhalation exposure (USEPA 1985). The toxic effects of benzene in humans and other animals following exposure by inhalation include central nervous system effects, hematological effects and immune system depressions. In humans, acute exposures to high concentrations of benzene vapors has been associated with dizziness, nausea, vomiting, headache, drowsiness, narcosis, coma, and death (NAS, 1976). Chronic exposure to benzene vapors can produce reduced leukocyte, platelet, and red blood cell counts (USEPA, 1985). Benzene induced both solid tumors and leukemias in rats exposed by gavage (Maltoni, et al., 1985). Many studies have also described a causal relationship between exposure to benzene by inhalation (either alone or in combination with other chemicals) and leukemia in humans (IARC, 1982).

Applying USEPA's criteria for evaluating the overall evidence of carcinogenicity to humans, benzene is classified in Group A (Human Carcinogen) based on adequate evidence of carcinogenicity from epidemiological studies. USEPA (1988) derived both an oral and an inhalation slope factor for benzene of 2.9 x 10^{-2} (mg/kg/day)$^{-1}$. This value was based on several studies in which increased incidences of nonlymphocyctic leukemia were observed in humans occupationally exposed to benzene principally by inhalation (Rinsky, 1981; Ott et al., 1978; Wong, 1983).

o <u>1,1-Dichloroethane</u>

Limited toxiciological testing of 1,1-dichloroethane has been conducted. The literature indicates that 1,1-dichloroethane is one of the least toxic of the chlorinated ethanes (Clement Associates, 1985). General symptoms following exposure to this volatile organic chemicals include salivation, dizziness, nausea, vomiting, eye irritation and irritation of the respiratory tract and skin (CHRIS, 1984). Human inhalation of high doses of 1,1-dichloroethane results in central nervous system depression and may be hepatotoxic. High doses as well as chronic exposure in animals have been shown to cause liver and kidney damage along with slight embryotoxicity and the retardation of fetal development (Clement Associates, 1985; CHRIS, 1984). According to a study by Schwetz et al. (1974), inhalation exposure to over 16,000 mg/m^3 of 1,1-dichloroethane caused retarded fetal development in rats (Clement Associates, 1985).

1,1-dichloroethane was found to be mutagenic using the Ames assay (Clement Associates, 1985). Maltoni et al. (1985) and Oesch et al. (1983) found this agent to be carcinogenic in mice, leading to kidney and liver tumors, particularly in males, as well as lung and liver angiosarcomas. However, tests in rats appeared to be negative (Casarett and Doull, 1986). 1,1-dichloroethane is categorized in Group B2 - Possible Human Carcinogen based on limited evidence of carcinogenicity in animals by the EPA (1988). The EPA's Health Effects Assessment document (1988) has derived an oral cancer slope factor of 9.1 x 10^{-2} (mg/kg/day)$^{-1}$ and an oral reference dose (RfD) of 1 x 10^{-1} mg/kg/day for 1,1-dichloroethane.

o <u>Tetrachloroethene</u>

Tetrachloroethene is absorbed following inhalation (IARC, 1979) and oral exposure (USEPA, 1985a,b). Tetrachloroethene vapors and liquid also can be absorbed through the skin (USEPA, 1985,a,b). The principal toxic effects of tetrachloroethene in humans and animals following acute and longer-term exposures include central nervous system (CNS) depression and fatty infiltration of the liver and kidney with concomitant changes in serum enzyme activity levels indicative of tissue damage (USEPA, 1985a,b). Humans exposed to doses of between 136 and 1,018 mg/m^3 for 5 weeks develop central nervous system effect, such as lassitude and signs of inebriation (Stewart et al., 1974). The offspring of female rats and mice exposed to high concentrations of tetrachloroethene for 7 hours daily on days 6-15 of gestation developed toxic effects, including a decrease in fetal body weight in mice and a small but significant increase in fetal resorption in rats (Schwetz et al. 1975). Mice also exhibited developmental effects, including subcutaneous edema and delayed ossification of skull bones and sternebrae (Schwetz et al., 1975). In a National Cancer Institute bioassay (NCI, 1977), a high incidence of hepatocellular carcinoma was observed in both sexes of B6C3F1 mice administered tetrachloroethene in corn oil by gavage 5 days per week for 78 weeks. Increased incidences of mononuclear cell leukemia and renal adenomas and carcinomas (combined) have also been observed in long term bioassays in which rats were exposed to tetrachloroethene by inhalation (NTP, 1986).

USEPA (1988b) classifies tetrachloroethene as a Group B2 carcinogen (Probable Human Carcinogen). USEPA (1985b) has derived an oral cancer slope factor (q_1*) of 5.1 x 10^{-2} (mg/kg/day)$^{-1}$ based on liver tumors observed in the NCI (1977) gavage bioassay for mice. The inhalation cancer slope factor for tetrachloroethene of 3.3 x 10^{-3} (mg/kg/day)$^{-1}$ is based on an NTP (1986) bioassay in rats and mice in which leukemia and liver tumors were observed (USEPA, 1988b). USEPA (1988a) also has derived an oral reference dose for tetrachloroethene based on a study by Buben and O'Flaherty (1985). In this study, liver weight/body weight ratios were significantly increased in mice and rats treated with 71 mg/kg/day tetrachloroethene in corn oil but not in animals treated with 14 mg/kg/day.

o <u>Trichloroethene</u>

Trichloroethene has caused carcinogenic responses in rats exposed by gavage and in mice exposed by inhalation. Trichloroethene also acts as a central nervous system depressant following both acute and chronic exposure by both ingestion and inhalation. Occupational exposure to concentrated trichloroethene vapors may result in dermatitis.

USEPA has classified trichloroethene as a Group B2 agent (Probable Human Carcinogen). Cancer slope factors of 1.1 x 10^{-2} (mg/kg/ day)$^{-1}$ and 1.7 x 10^{-2} (mg/kg/day)$^{-1}$ have been developed for oral and inhalation exposures, respectively (USEPA 1989f). These values are based on an increased incidence of liver tumors in mice exposed by gavage (NCI, 1976; NTP, 1983; USEPA, 1984). USEPA (1987) has also derived an oral reference dose (RfD) of 7.4 x 10^{-3} mg/kg/day for trichloroethene based on a subacute inhalation study in rats, in which elevated liver effects were observed (Kimmerle and Eben, 1973). A safety factor of 1,000 was used to calculate the RfD.

- 1,1,1-Trichloroethane

The most notable toxic effects of 1,1,1-trichloroethane in humans are central nervous system depression, including anesthesia, at very high concentrations and impairment of coordination, equilibrium, and judgement at lower concentrations (350 ppm and above). 1,1,1-Trichloroethane may also exert cardiovascular effects, including premature ventricular concentrations, decreased blood pressure and sensitization to epinephrine-induced arrhythmia; and adverse effects on the lungs, liver and kidneys. Irritation of the skin and mucous membranes resulting from exposure to 1,1,1-trichloroethane has also been reported (Clement Associates, 1985).

There is evidence that 1,1,1-trichloroethane is mutagenic in Salmonella typhimurium and causes transformation in cultured rat embryo cells (USEPA, 1980). 1,1,1-Trichloroethane was retested for carcinogenicity because in a previous study by NCI (1977) early lethality precluded an assessment of carcinogenicity. Preliminary results indicated that 1,1,1-trichloroethane increased the incidence of combined hepatocellular carcinomas and adenomas in female mice when administered by gavage (NTP, 1984). The EPA (1989) currently has classified 1,1,1-trichloroethane in Group D - Not Classified based on no reported human data and inadequate animal data. The EPA (1989) determined an oral reference dose (RfD) for 1,1,1-trichloroethane of 9.0×10^{-2} mg/kg/day based on a study by Torkelson et al. (1958) in which no effects were observed in guinea pigs exposed to 500 ppm (2730 mg/m^3 or 90 mg/kg/day) 1,1,1-trichloroethane for 7 hours per day, 5 days per week, for 6 months.

- Chloroform

Chloroform, a trihalomethane, is rapidly absorbed through the respiratory tract and gastrointestinal tract in humans and experimental animals; dermal absorption from contact of the skin with liquid chloroform can also occur (EPA 1985). Chloroform has been reported to induce renal epithelial tumors in rats and hepatocellular carcinomas in mice. 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 (EPA 1985). In humans, acute exposure to high concentrations of chloroform may result in death caused by ventricular fibrillation. Exposure to chloroform may also cause irritation of the skin, eyes, and gastrointestinal tract (EPA 1984, 1985). In experimental animals, chronic exposure may lead to hepatic, renal, and cardiac effects and central nervous system depression (EPA 1985).

Chloroform has been classified by EPA as a Group B2 Carcinogen-Probable Human Carcinogen (EPA 1988). EPA (1988) developed an oral cancer potency factor for chloroform of 6.1 x 10^{-3} (mg/kg/day)$^{-1}$ based on a study in which kidney tumors were observed in rats exposed to chloroform in drinking water (Jorgenson et al. 1985). EPA (1988) also developed an inhalation cancer potency factor of 8.1 x 10^{-2} (mg/kg/day)$^{-1}$ based on an NCI (1976) bioassay in which hepatocellular carcinomas were observed in mice. EPA (1988) also derived an oral RfD of 0.01 mg/kg/day for chloroform based on a chronic bioassay in dogs in which liver effects were observed (Heywood et al. 1979).

- Di-n-Octyl Phthalate

Di-n-octyl phthalate is not particularly toxic to humans. It is a severe eye and a mild skin irritant in rabbits (NIOSH 1985, NTP/IRLG 1982, USEPA 1980). In a teratogenic study by Singh et al. (1972), rats were administered 5 and 10 ml/kg of di-n-octyl phthalate intraperitoneally on days 5, 10 and 15 of gestation. Such doses for di-n-octyl phthalate were chosen due to its low acute toxicity. Upon examination of the offspring, dose-related developmental abnormalities and fetotoxici effects were observed (USEPA, 1980).

- Diethyl Phthalate

Diethyl phthalate is toxic via ingestion and inhalation exposure and is an irritant to the eyes and mucous membranes (Sax and Lewis 1987).

The Carcinogen Assessment Group (CAG) has classified diethyl phthalate in Group D - Not classified due to inadequate evidence of carcinogenicity in animals (USEPA, 1989). The USEPA (1989) has drived an oral reference dose of 0.8 mg/kg/day for diethyl phthalate based on a chronic study in which rats exposed to 1% in the diet for 16 weeks (750 mg/kg/day) showed reduced terminal body weight.

- Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs occur in the environmental as complex mixtures of many components with varying noncarcinogenic and carcinogenic potencies. Only a few components of these mixtures have been adequately characterized, and only limited information is available on the relative potencies of different compounds. The PAHs are often separated into two categories for the purposes of risk assessment: carcinogenic and noncarcinogenic PAHs.

PAH absorption following oral or inhalation exposure is inferred from the demonstrated toxicity of PAHs following ingestion or inhalation (USEPA 1984a). It has been suggested that simultaneous exposure to carcinogenic PAHs such a benzo[a]pyrene and particulate matter can increase the effective dose of the compound (ATSDR 1987). PAHs are also absorbed following dermal exposure (Kao et al. 1985).

Acute effects from direct contact with PAHs and related materials are limited primarily to phototoxicit, with the principal effect being dermatitis (NIOSH 1977). PAHs have also been shown to cause cytotoxicity in rapidly proliferating cells throughout the body (Santodonato et al. 1981). As a consequence of this, the hematopoietic system, lymphoid system and tests are frequent targets. Some of the noncarcinogenic PAHs have been shown to cause systemic toxicity but these effects are generally seen only at rather high doses (Santodonato et al. 1981). Slight morphological changes in the livers and kidneys of rats have been reported following oral exposure to acenaphthene. Oral administration of naphthalene to rabbits and rats has resulted in cataract formation (USEPA 1984b). Nonneoplastic lesions are seen in animals exposed to more potent carcinogenic PAHs only after exposure to levels well above those required to elicit a carcinogenic response. Carcinogenic PAHs are believed to induce tumors both at the site of application and systemically. Neal and Rigdon (1967) reported that the oral administration of benzo[a]pyrene led to forestomach tumors in mice. thyssen et al. (1981) observed respiratory tract tumors in hamsters exposed by benzo[a]pyrene.

Benzo[a]pyrene is representative of the carcinogenic PAHs and is classified by the EPA as B2-Probable Human Carcinogen, based on sufficient evidence of carcingenicity from animal studies and inadequate evidence from human carcinogenicity studies (USEPA 1988). The EPA (1984a) calculated a cancer potency factor of 11.5 $(mg/kg/day)^{-1}$ for oral exposure to carcinogenic PAHs (specifically benzo[a]pyrene) based on the study by Neal and Rigdon (1967). The EPA (1984a) calculated an inhalation cancer potency factor of 6.1 $(mg/kg/day)^{-1}$ for benzo[a]pyrene based on the study by Thyssen et al. (1981). These potency factors are currently undergoing a re-evaluation by the EPA Carcinogen Assessment Group and thus the PAHs were not evaluated in the quantitative risk assessment.

Of the noncarcinogenic PAHs, naphthalene is the only compound that has had any systematic toxicity assessment for noncarcinogenic effects. The EPA's Health Effects Assessment document (1988) has recommended an oral reference dose (RfD) for naphthalene of 0.4 mg/kg/day. For the purpose of this risk assessment, concentrations of all PAHs will be summed and the naphthalene RfD will be used to evaluate noncarcinogenic health effects of these compounds. (The rationale for including all PAHs, including carcinogenic PAHs, in the assessment for non-carcinogenic risks, is that the carcinogenic PAHs may also display noncarcinogenic effects).

o Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate also known as diethylhexyl phthalate (DEHP) is readily absorbed following oral or inhalation exposure (EPA 1980). 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 1980). Reduced fetal weight and an increased number of resorptions have been observed in rats exposed orally to DEHP (EPA 1980).

DEHP has previously been classified in Group B2 -- Probable Human Carcinogen (EPA 1986a). EPA (1989) has recommended an oral reference dose (RfD) for DEHP of 2 x 10^{-2} mg/kg/day based on a chronic study in guinea pigs in which increased liver weight was observed after exposures of 19 mg/kg/day (0.04% diet for 1 year). EPA (1989) has also developed an oral cancer potency factor of 1.4 x 10^{-2} $(mg/kg/day)^{-1}$ based on a 103-week mouse dietary study in which liver effects were observed.

o Butylbenzyl Phthalate

Limited data exist on the absorption of butyl benzyl phthalate following exposure. A review of the existing literature indicates that butyl benzyl phthalate is not highly toxic. In male rats fed 50,000 or 100,000 mg/kg in their diet, testicular degeneration was observed. Thymic atrophy was also reported in both male and female rats given 100,000 mg/kg. Male rats fed 25,000 mg/kg for 90 days exhibited depressed body weight gain and testicular degeneration. No adverse effects were noted in female rats or mice in either study (National Toxicology Program 1981).

Butyl benzyl phthalate has been tested for carcinogenicity in chronic feeding studies using mice and female rats, and via intraperitoneal injection in male mice (IARC 1982). In female rats, an increased incidence of myelomonocytic leukemia was observed in the high exposure group. No increased tumor incidence was noted for mice (IARC 1982). The EPA's Health Effects Assessment document (1989) has classified butyl benzyl phthalate in Group C - possible human carcinogen and has recommended an oral reference dose (RfD) of 0.2 mg/kg/day based in a dietary study by the NTP (1985) in which exposed rats showed weight gain as well as testicular, hepatic and kidney effects.

o Endosulfan

Endosulfan is a chlorinated cyclodiene insecticide whose technical form is a mixture of two isomers. It is light to dark brown in color and exists as a crystalline solid. Endosulfan is a broadly active contact and stomach poison and has found wide application in agriculture, forestry and ornamental plant growing. Owing to its lack of toxicity toward bees, it is very suitable for use in flowering and fruit crops (Buchel and Holmwood, 1983; Sittig, 1985).

Exposure to endosulfan can occur via several routes including inhalation, ingestion, skin absorption and eye contact (Sittig, 1985). According to Clark et al. (1981) it is rapidly absorbed from the gastrointestinal tract. As dust, it is probably only moderately toxic by inhalation, but in solution, especially in alcohol or aromatic solvents like xylene, it is considered toxic by ingestion and by percutaneous absorption (Gosselin et al., 1976). At least some of the agent ingested by mammals is excreted in an unchanged form (Buchel and Holmwood, 1983).

Human acute exposure to endosulfan results primarily in central nervous system toxicity causing such symptoms as hyperirritability, convulsions and/or coma. Ingestion, inhalation and skin absorption will induce headache, dizziness, nausea and vomiting. Occasional epileptiform convulsions of grand mal or petit mal type have occurred in workers from skin absorption (CHRIS Hazardous Chemical Data, 1984).

In a study by Sobti et al. (1983) human lymphoid cells of the LAZ-007 cell line were incubated with a concentration of endosulfan which resulted in mitotic depression, cell cycle traverse inhibition and had dose related cytotoxicity. A statistically significant increase in sister chromatid exchange was also observed in exposed cells.

The oral dosing of male rats with endosulfan by Dikshith and Datta (1978) did not reveal any cytogenetic effects.

The mutagenicity of endosulfan was tested in mice via the micronucleus test by Usha et al. (1980). No significant effect on the frequency of micronuclei occurred.

Ensosulfan was tested for its ability to induce mutation, metotic crossing over and gene conversion in the yeast Saccharomyces cerevisiae by Yadav et al. (1982). Treatment of cells with 1% did not induce mitotic crossovers but reduced survival and increased the percent of aberrant colonies as well as the frequency of gene convertants and revertants over controls. Endosulfan was not only toxic to yeast cells but also genetically effective without activation. The genotoxic effects where more pronounced with increasing duration of cell exposure (Yadav et al., 1982).

Endosulfan tested negative in each of five strains of Salmonella tymphimurium and a strain of Escherichia coli for mutagenicity in bacterial reversion-assay systems (Moriya et al., 1983).

Available data indicate a lack of teratogenicity due to endosulfan.

In a study by the National Cancer Institute (NCI, 1978), rats and mice were administered technical grade endosulfan in their feed. Carcinogenicity in the male animals could not be assessed due to high early mortality, however, ensosulfan was not found to be carcinogenic in the females.

Sufficient evidence does not exist to determine the carcinogenic potential of endosulfan.

The ambient water quality criteria (AWQC) for endosulfan is 74.0 ug/l (EPA, 1980). (Sittig, 1985).

In 1983/84, the American Conference of Governmental Industrial Hygienists (ACGIH) set a time-weighted average (TWA) occupational exposure to endosulfan at 100 ug/m^3 and a short-term exposure limit (STEL) at 300 ug/m^3. The notation "skin" is added to indicate the possibility of cutaneous absorption (Sittig, 1985).

Summary of Endosulfan Criteria

Ambient Water Quality Criteria (AWQC)	74.0 ug/l
Occupational Exposure Standard (TWA)	100 ug/m^3
Short-Term Exposure Limit (STEL)	300 ug/m^3

8.2.3.2 Inorganic Contaminants

- <u>Chromium</u>

Gastrointestinal absorption of chromium (III) is low, whereas chromium (VI) is more readily absorbed following exposure (USEPA, 1987). Chromium is an essential micronutrient and is not toxic in trace quantities (USEPA, 1980). High levels of soluble chromium (VI) and chromium (III) can produce kidney and liver damage following acute oral exposures, but target organs follow- ing chronic oral exposures have not been identified (USEPA, 1984). Chronic inhalation exposures may cause respiratory system damage (USEPA, 1984). Further, epidemiological studies of worker populations have clearly established that inhaled chromium (VI) is a human carcinogen, with the respiratory passages and the lungs as the target organs (USEPA, 1984). Inhalation of chromium (III) or ingestion of chromium (VI) or (III) have not been associated with carcinogenicity in humans or experimental animals (USEPA, 1984). Certain chromium salts have been shown to be teratogenic and embryotoxic in mice and hamsters following intravenous or intraperitoneal injection (USEPA, 1984).

USEPA has classified inhaled chromium (VI) in Group A--Probable Human Carcinogen (USEPA, 1988). Inhaled chromium (III) and ingested chromium (III) and (VI) have not been classified with respect to carcinogenicity. USEPA (1989f) developed an inhalation cancer potency factor of 41 $(mg/kg/day)^{-1}$ for chromium (VI) based on an increased incidence of lung cancer in workers exposed to chromium over a six-year period, and followed for approximately 40 years (Mancuso 1975). USEPA (1989f) derived an oral reference dose of 0.005 mg/kg/day for chromium (VI) based on a study by MacKenzie et al. (1958) in which no observable adverse effects were observed in rats exposure to chromium (VI) in drinking water for 1 year. USEPA (1988) developed an oral RfD of 1 mg/kg/day for chromium (III) based on a study in which rats were exposed to chromic oxide baked in bread; no effets due to chromic oxide treatment were observed at any dose level (Ivankovic and Preussman, 1975).

- <u>Arsenic</u>

Arsenic is readily absorbed via the oral and inhalation routes. Both inorganic and organic forms of arsenic are readily absored from the gastrointestinal tract with the more soluble forms being more readily absorbed than the insoluble forms (USEPA, 1984). Approximately 95 percent of soluble inorganic arsenic administered to rats is absorbed from the gastrointestinal tract (Coulson et al. 1935, Ray-Bettley and O'Shea 1975. The EPA (1984) assumes that, on the average, 70-80 percent of arsenic is absorbed in the respiratory tract. Dermal absorption is not significant (USEPA, 1984).

Acute exposure of humans to high levels (71 mg/kg) metalloid arsenic has been associated with gastrointestinal effects, hemolysis, and neuropathy. Chronic exposure of humans to arsenic can produce toxic effects on both the peripheral and central nervous systems, keratosis, hyperpigmentation, precancerous dermal lesions and cardovascular damage (USEPA, 1984). Arsenic is embryotoxic, fetotoxic, and teratogenic in several animal species (USEPA, 1984). Arsenic is a known human carcinogen. Epidemiological studies of workers in smelters and in plants manufacturing arsenical pesticides have shown that inhalation of arsenic is strongly associated with lung cancer and perhaps with hepatic aniosarcoma (USEPA 1984). Ingestion of arsenic has been linked to a form of skin cancer and more recently to bladder, liver and lung cancers (Tseng et al. 1968, Chen et al. 1986).

The EPA has classified arsenic in Group A -- Human Carcinogen, and has developed an inhalation cancer potency factor of 50 $(mg/kg/day)^{-1}$ (USEPA, 1989). This value is based on a human study in which respiratory tract tumors developed after continuous exposure to 100-5000 ug/m^3 of arsenic (USEPA 1989). A unit risk of 5×10^{-5} $(ug/l)^{-1}$ has been proposed by the Risk Assessment Forum and this recommendation has been scheduled for SAB review (USEPA 1989) ingestion slope factor = 1.5 mg/kg/day.

o Copper

Copper is an essential nutrient; however, it is toxic to humans at high levels. Copper usually causes gastrointestinal irritation following acute exposure and anemia following chronic exposures. Exposure to metallic copper dust by inhalation can cause a short-term illness similar to metal fume fever that is characterized by chills, fever, aching muscles, dryness of the mouth and throat, and headache. Exposure to copper fumes can produce upper respiratory tract irritation, a metallic or sweet taste, nausea, metal fume fever and sometimes discoloration of skin and hair. Individuals exposed to dust and mists of copper salts may exhibit congestion of nasal mucous membranes, sometimes congestion of the pharynx, and occasionally ulceration with perforation of the nasal septum. If sufficient concentrations of copper salts reach the gastrointestinal tract, they act as irritants and can produce salivation, nausea, vomiting, gastritis and diarrhea. The elimination of ingested ionic copper by vomiting and diarrhea generally protects the patient from more serious systemic toxic effects, which can include hemolysis, hepatic nercrosis, gastrointestingal bleeding, oliguria, azotemia, hemoglobinuria, hematuria, proteinuria, hypotension, tachycardia, convulsions and death. Chronic exposure may result in anemia. Copper salts act as skin irritants upon dermal exposure, producing an itching eczema. Conjuctivitis or even ulceration and turbidity of the cornea may result from the direct contact of ionic copper with the eye (Clement Associates 1985).

Copper appears to increase the mutagenic activity of triose reductase and ascorbic acid in bacterial test systems. However, copper itself does not appear to have mutagenic or teratogenic effects in animals or humans (Clement Associates 1985). The EPA (1988) has classified copper in Group D - Not Classified based on inadequate animal data from assays of copper compounds, equivocal mutagenicity data and lack of any human data. The EPA has recommended an oral reference dose (RfD) for copper and copper-containing compounds of 3.7×10^{-2} mg/kg/day (USEPA 1986).

o Nickel

Nickel compounds can be absorbed following inhalation, ingestion or dermal exposure. The amount absorbed depends on the dose administered and on the chemical and physical form of the particular nickel compound (USEPA, 1986e). Adverse effects associated with acute exposure in animals have included depressed weight gain, altered hematological parameters, and increased iron deposition in the blood, heart, liver and testes (USEPA, 1987b). Chronic or subchronic exposures of experimental animals to nickel salts have been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthema, nasal septal perforations, rhinitis, decreased iodine uptake, and vasoconstriction of the coronary vessels. Dermal exposure of humans to nickel produced allergic contact dermatitis (USEPA, 1986). Teratogenic and fetotoxic effects have been observed in the offspring of exposed animals (USEPA, 1986e). Inhalation exposure of experimental animals to nickel carbonyl or nickel subsulfide induces pulmonary tumors (USEPA, 1986e). Several nickel salts 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, kidney and prostate (USEPA, 1986e).

Nickel subsulfide and nickel refinery dust (the compound used in this risk assessment) by inhalation are both categorized in Group A - Human Carcinogen. These materials have inhalation slope factors of 1.7 $(mg/kg/day)^{-1}$, and 0.84 $(mg/kg/day)^{-1}$ respectively (USEPA, 1987b). Nickel carbonyl by inhalation is categorized in Group B2 - Probable Human Carcinogen; however, a slope factor has not been derived for nickel carbonyl (USEPA, 1986e). The USEPA (1989) derived an oral reference dose (RfD) for nickel (subsulfide form) of $2x10^{-2}$ mg/kg/day based on a chronic study in which rats administered 100 ppm nickel from nickel sulfate in the diet for two years (5 mg/kg/day) experienced reduced body and organ weight.

o <u>Lead</u>

Absorption of lead from the gastrointestinal tract is principally influenced by age and nutritional status, and is estimated to range between 5 and 15 percent in adults and approximately 40 to 50 percent in children (Goyer, 1986; USEPA, 1986a). Absorption of lead from the lungs is governed by the rate of pulmonary deposition which for lead is approximately 30 to 50 percent of the inhaled quantity, with absorption of essentially all of the lead deposited in the lower respiratory tract (USEPA, 1986c; ATSDR, 1988). A considerable fraction of the inhaled lead is absorbed through the stomach.

Acute lead toxicity is not as common as chronic toxicity due to lead's relatively insoluble nature and accumulation potential in the body (Carson, et al., 1986). However, symptoms of acute toxicity include fatigue, sleep disturbance, constipation, followed by anemia and neuritis (Stokinger, 1981). Occassionally, acute lead encephalopathy (brain disorder) occurs, producing an array of serious and life-threatening neurological effects (Tsuchiya, 1977).

Lead is an inhibitor of many enzymes in different organs and organ systems, leading to wide-ranging chronic toxic effects. The major effects of occupational and environmental exposures are peripheral neuropathy (a nonflammatory lesion of the peripheral nervous system), anemia and gastrointestinal and reproductive effects (Goyer, 1986). The critical organ for lead toxicity is the hematopoietic (blood forming) system (Carson et al., 1986). In red blood cells, lead interferes with heme synthesis at several enzymatic steps, resulting in decreased blood cell survival and potentially leading to anemia and pallor (Carson et al., 1986). Irreversible kidney effects have been associated with chronic, long-term exposure to lead (Goyer, 1971). Chronic high-level lead exposure has been associated with central nervous system (CNS) impairment (Goyer, 1986). Subclinical effects of lead toxicity are manifested in a variety of neuropsychologic behaviors, including hyperactivity, poor classroom behavior and even small decrements in IQ scores in children (Goyer, 1986). Threshold levels that will not produce cognitive or motor neurological deficits in children (Goyer, 1986) have not yet been established with certainty.

No clear evidence of an association between lead and congenital malformations is available.

The data on human carcinogenicity are considered inadequate, since available studies failed to quantify exposures, did not correct for the presence of other toxic metals (e.g., cadmium, arsenic) or smoking. The EPA has evaluated the available carcinogenicity data and has classified lead as a Probable Human Carcinogen - Group B2 (USEPA, 1989g). The Cancer Assessment Group (CAG) of the EPA recommends that due to a lack of understanding and perhaps unique nature of the pharmacokinetics of lead, a numerical estimate of the cancer potency should not be used (USEPA, 1989g). The USEPA has indicated that a reference dose value (RfD) for lead will not be available until some time in 1990. In the meantime, they recommend that media-specific concentrations of lead be compared with the background concentrations (500-1000 ppm), the National Ambient Air Quality Standard (1.5 ug/l), and the proposed water quality occur, then lead does not need to be included in the risk assessment. If an exceedance does occur, there are no defensible RfD values existing with which to characterize potential health risk. In the light of this absence of EPA verified RfD values, an Allowable Daily Intake rate (ADI) of 4.3 x 10^{-4} mg/kg/day for inhalation of lead was computed using the National Ambient Air Quality Standard of 1.5 ug/m^3, a reference breathing rate of 20 m^3/day and a reference bodyweight of 70 kg (USEPA, 1986d). Similarly, an oral ADI of 1.43 x 10^{-4} mg/kg/day was computed by using the proposed National Drinking Water Standard of 5 ug/l (USEPA, 1988e), and a reference drinking rate of 2.0 l/day (USEPA, 1986d). These values are similar to the RfD values presented in the EPA's Superfund Public Health Evaluation Manual (USEPA 1986d), with the exception that using the proposed Drinking Water Standard resulted in a ten-fold reduction in the oral ADI. It should also be noted that use of adult reference values in the computation of ADIs are considered protective of children since they result in lower (more conservative) ADIs than use of the reference values for children.

Oral Chronic Intake Rate: 1.4×10^{-4} mg/kg/day (Computer from Drinking Water Standard).

Inhalation Chronic Intake Rake: 4.3×10^{-4} mg/kg/day (Computed from Air Quality Standard).

8.3 HEALTH RISK CHARACTERIZATION

According to guidelines for preparing risk assessments as part of the RI/FS process, the potential adverse effects on human health should be assessed by evaluating the toxicity of contaminants at the site and where possible by comparing chemical concentrations found in environmental media at or near the site and at receptor locations with applicable or relevant and appropriate requirements (ARARs) or other guidance that has been developed for the protection of human health or the environment. In the following subsections, both a comparison to ARARs and quantitative risk estimates are presented.

8.3.1 Health-Based Applicable or Relevant and Appropriate Requirements (ARARs)

In this section, ARARs or other guidance are first identified for the chemicals of potential concern. Where chemical-specific or ambient ARARs are available for an environmental medium, they are compared with average and maximum concentrations observed in that medium at points of potential exposure. USEPA interim guidance on ARARs (USEPA, 1987) defines them 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" mean 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 a 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 <u>part</u> 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 the environment.

Only those ARARs or advisories or guidance that are ambient or chemical-specific requirements [i.e., those requirements which "set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants" (USEPA, 1987)], as opposed to ARARs which are classified as action-specific or locational requirements, are used in this risk assessment.

The classes of ambient or chemical-specific health-based ARARs or guidance that are considred pertinent to the risk assessment for the Circuitron Corporation Site are discussed below.

<u>Groundwater</u>

Federal ARARs for drinking water are Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act (SDWA), and human health-based Ambient Water Quality Criteria (AWQC) set under the Clean Water Act. MCls are enforceable drinking water standards and are not strictly health-based. Technologies and economic feasibility are also taken into account in developing MCLs. USEPA states that "MCLs, the enforceable standards under the SDWA, are the appropriate standards for cleanup of groundwater because they represent the level of quality for the nation's drinking water supplies."

Maximum Contaminant Level Goals (MCLGs) which may only be "relevant and appropriate", are promulgated under the SDWA as chemical-specific health criteria used in setting MCLs and other enforceable drinking water standards. An MCLG for a toxic chemical is based only on health considerations (i.e., technological and economic considerations are not included) and represents a level at which no adverse effect occur (USEPA, 1987).

State drinking water and groundwater standards that may be health-based ARARs for specific chemicals at the Circuitron Corporation Site include Groundwater Quality Criteria established under the New York State Official Compilation of Codes, Rules and Regulations (Part 703) and the New York State Division of Water Quality Standards and Guidance Series (1.1.1).

The New York Groundwater Quality Criteria establish allowable levels of certain chemical pollutants for groundwater in New York aquifers. The Criteria employed depend on the expected use and total dissolved solids and contents of the water in the evaluated aquifer.

Groundwater ARARs include federal and state Maximum Contaminant Level (MCLs), and State groundwater quality standards. Other guidance includes federal Ambient Water Quality Criteria (AWQC) for the protection of human health and Federal Maximum Contaminant Level Goals (MCLGs).

Groundwater Contamination Compared with ARARs

A comparison of the observed concentration ranges of chemicals in the groundwater with the ARARs is found in Table 8-4. Although not all the contaminants of concern exceed ARARs, they will all be retained, evaluated and modeled in this Risk Assessment because most of them are potential carcinogens.

8.3.2 Quantitative Risk Characterization

To quantitatively assess the risks to human health associated with present and future site and land use conditions, chronic or subchronic average daily intakes (SIs) are estimated for each exposure pathway and scenario using the estimated exposure point concentrations where appropriate. SIs are expressed as the amount of a chemical an individual may be exposed to per unit body weight per day, or mg/kg day. An SI is averaged over a lifetime for carcinogens (USEPA, 1986a) and over the exposure period for noncarcinogens (USEPA, 1986a).

The estimated daily intakes are then combined with health effects criteria (RfDs and Slope factors) to quantitatively estimate potential human health risks. For potential carcinogens, excess lifetime cancer risks are obtained by multiplying the SI for the contaminant under consideration by its slope factor. USEPA has implemented actions under Superfund associated with total cancer risks ranging from 10^{-4} to 10^{-7} (i.e., the incremental probability of developing cancer over a 70-year lifetime is one in 10,000 of one in 10,000,000, respectively, under the conditions of exposure) (USEPA, 1986b). A cancer risk of 10^{-6} will be used in this RA to evaluate the potential cancer risk of the exposure pathway.

Potential risks for noncarcinogens are presented as the ratio of the SI to the reference dose (RfD); i.e., SI:RfD. The sum of all of the ratios of chemicals under consideration is called the hazard index. The hazard index is useful as a reference point for gauging the potential noncarcinogenic effects of environmental exposures to complex mixtures. In general, hazard indices which are less than one are not likely to be of concern than hazard indices greater than one. If the hazard index is greater than one, the compounds will be segregated according to their critical effects (target organs) and separate hazard indices will be derived for each effect (USEPA 1986a). A conclusion should not be categorically drawn, however, that all indices of greater than one are "acceptable" or that hazard indices of greater than one are "unacceptable". This is a consequence perhaps of the one order of magnitude or greater uncertainty inherent in estimates of the RfD and SI.

In accordance with USEPA's guidelines for evaluating the potential toxicity of complex mixtures (USEPA, 1986), it was assumed that the toxic effects of the site-related chemicals would be additive. Lifetime excess cancer risks and the SI:RfD ratios were summed to indicate the potential risks associated respectively. In the absence of specific information on the toxicity of the mixture to be assessed or on similar mixtures, USEPA guidelines generally recommend assuming that the effects of different compounds on the mixtures are additive when affecting a particular organ or system. Synergistic or antagonistic interactions may be taken into account if there is specific information on particular combinations of chemicals. In this risk assessment, it was assumed that the potential effects of the site-related chemicals would be additive.

Chronic daily intakes, excess lifetime cancer risks, and SI:RfD ratios for the chemicals of concern considered in this assessment, are presented for each of the selected exposure pathways, in the subsections that follow.

Ingestion of Groundwater

For the ingestion of groundwater pathway, it was assumed that future development around or on the site would require the installation of a well in the glacial aquifer and/or that the contamination found in the upper aquifer had migrated downward and entered the Magothy Aquifer.

This pathway was evaluated in several different ways. First, the analytical results from the shallow and deep wells were evaluated separately to determine the risks associated with shallow or deep groundwater contamination. The existing wells (MW-8 through MW-12) were all shallow wells based upon the documentation included in the Site Inspection Report (EA, 1987). Third, the analytical results from Rounds 1 and 2 groundwater sampling were treated separately to determine whether there were any temporal changes in the potential risk from the Circuitron Corporation Site. Finally, the analytical results from the monitoring wells and well clusters were subdivided in the following manner to evaluate risks associated with the placement of wells upgradient of the site, on the site, or downgradient of the site:

Upgradient - MW-1
On-site - MW-2, MW-3, MW-4, MW-8, MW-9, MW-10, MW-11, MW-12
Downgradient - MW-5, MW-6, MW-7

The spreadsheets for the evaluation of the groundwater ingestion pathway are presented in Appendix G (Tables G-3 through G-14 and G-23 through G-26).

Table 8-18 summarizes the carcinogenic risks associated with the ingestion of groundwater for the residential pathways for both Round 1 and Round 2 samples. All upgradient, downgradient and on-site shallow and deep wells with the exception of the upgradient Round 1 shallow wells in which no carcinogenic compounds were detected, showed carcinogenic risk levels greater than 1E-6. A value greater than 10^{-6} indicates that exposure to contaminant concentrations used in the scenario may result in an increase in the background cancer incidence. Overall, the groundwater ingestion pathway potential carcinogenic risks spanned two orders of magnitude (1E-4 to 1E-6). Two volatile compounds, 1,1-dichloroethene and tetrachloroethene, were responsible for approximately 85-95% of the cancer risk in this pathway (Table 8-19).

Groundwater from the deep wells of both rounds of sampling (depth of approximately 100 feet) showed fairly comparable cancer risks upgradient of the site, on-site and downgradient of the site. Therefore, it appears that groundwater from shallow wells (depth of approximately 35 feet) had a major influence on the on-site and downgradient cancer risks especially since a number of carcinogenic compounds (trichloroethene, tetrachloroethene, benzene and 1,1,2-trichloroethene), besides the two detected upgradient (1,1,-dichloroethane and 1,1,-dichloroethene), were detected in on-site and/or downgradient shallow wells.

Review of Tables G-7 and G-13 showed that on-site risk was due chiefly to the contributions of 1,1-dichloroethene and (to a lesser extent) tetrachloroethene. Cancer risks decrease by approximately one order-of-magnitude in the downgradient shallow samples (Tables 6-5 and G-11) indicating that the site may contribute to a potential downgradient cancer risk if the shallow groundwater were to be used as a potable water source. In addition to the shallow groundwater in the immediate vicinity of the site, it appears that drawing water from the deep aquifer would also cause potential cancer risks which are not influenced by site contamination.

TABLE 8-18

CIRCUITRON CORPORATION SITE

GROUNDWATER INGESTION PATHWAY
CARCINOGENIC EFFECTS
RESIDENTIAL AND SITE WORKER

MW SAMPLES	CASE	UPGRADIENT ADULT-RES	ON-SITE ADULT-RES	ON-SITE ADULT-WORKER	DOWNGRADIENT ADULT-RES
Round I:					
Shallow wells	Ave	— 1/	7.87 E-5 *	2.70 E-5 *	5.43 E-6 *
	Max	— 1/	2.62 E-4 *	8.98 E-5 *	1.81 E-5 *
Deep wells	Ave	1.36 E-5 *2/	2.06 E-5 *	1.41 E-5 *	2.45 E-5 *
	Max	4.55 E-5 *	6.86 E-5 *	4.70 E-5 *	8.17 E-5 *
Round II:					
Shallow wells	Ave	2.01 E-5 *	7.06 E-5 *	4.84 E-5 *	5.98 E-6 *
	Max	6.69 E-5 *	2.35 E-4 *	1.61 E-4 *	1.99 E-5 *
Deep wells	Ave	1.26 E-5 *	3.13 E-5 *	2.14 E-5 *	2.15 E-5 *
	Max	4.21 E-5 *	1.04 E-4 *	7.13 E-5 *	7.18 E-5 *

Notes:

1/ No carcinogens detected in upgradient shallow wells.

2/ The "*" indicates a carcinogenic risk greater than 1 x 10^{-6}.

TABLE 8–19

CIRCUITRON CORPORATION SITE

PERCENT CONTRIBUTION TO TOTAL CANCER RISK OF VOLATILE COMPOUNDS FOR THE GROUNDWATER INGESTION PATHWAY

Compound	Round 1 Mean 1/	Round 2 Mean
Residents:		
1,1–Dichloroethene	61.8	71.9
Chloroform	1.3	2/
Trichloroethene	2.0	1.8
Tetrachloroethene	27.7	21.1
1,1–Dichloroethane	6.4	5.3
Benzene	0.2	2/
1,1,2–Trichlorethane	0.6	2/
Site Workers:		
1,1–Dichloroethene	64.4	73.5
Chloroform	0.9	2/
Trichloroethene	1.7	1.4
Tetrachloroethene	26.2	21.2
1,1–Dichloroethane	5.8	3.9
Benzene	0.3	2/
1,1,2–Trichloroethane	0.7	2/

Notes:

1/ Values shown are mean contributions to total cancer risk.

2/ Not detected in Round 2 samples.

Table 8-20 summarizes the total hazard indices for the different exposure scenarios. A total hazard index of less than one indicate that this pathway would not pose a significant hazard potential. Round 2 sample results show that a significant hazard potential exists in deep wells upgradient of the site for adult residents and children. As stated above, this potential hazard is due to an outside source, not the site. On-site hazard index values for adults residents, children and site workers exceeded 1 in every case when considering both Round 1 and 2 shallow and deep samples, with the exception of the Round II shallow well scenario for adults. Downgradient hazard index values exceeded 1 for children when considering both Round 1 and 2 samples for the deep wells and exceeded 1 for children in the Round I shallow well samples. For adults, only the deep wells showed significant hazard potential in Round 1 and 2 samples.

Round 2 sampling efforts did not yield non-carcinogenic results comparable to those in Round 1 when wells were subdivided by location and depth. Although in both rounds most of the potential non-carcinogenic effects were attributable to lead and 1,1,1-trichloroethane, the locations and depths at which significant hazard index values were detected varied with the rounds. Thus, there exists temporal variation in the non-carcinogenic effects from the site.

In summary, the shallow portions of the aquifer shows an influence on the site for both carcinogenic risks and non-carcinogenic effects. The deeper portions of the aquifer, although showing unacceptable carcinogenic risks to residents and workers, do not appear to be influenced by site contamination. The upgradient, on-site and downgradient wells all exhibited unacceptable cancer risks to residents and workers. Based upon the results of this remedial investigation, the source(s) of the deep aquifer contamination were not identified. Remediation of the shallow aquifer contaminantion is warranted; source control at the site will reduce both the carcinogenic and non-carcinogenic risks associated with site contamination. Deep aquifer contamination should also be remediated; however, since the source(s) was not identified in this investigation source control is not possible.

Inhalation of Groundwater

For this pathway, it was assumed that future development of the area would require the installation of a well in the upper glacial aquifer and/or that the contamination found in the upper aquifer had migrated downward into the Magothy aquifer. This pathway complements the groundwater ingestion pathway, and examines the risk associated with the inhalation of contaminants present in the groundwater while showering. This pathway was evaluated in a manner similar to the ingestion pathway. The spreadsheets for this evaluation are shown in Appendix G (Tables G-15 through G-20 and G-27 through G-32).

TABLE 8-20

CIRCUITRON CORPORATION SITE

GROUNDWATER INGESTION PATHWAY NON-CARCINOGENIC EFFECTS

MW	UPGRADIENT		ON-SITE			DOWNGRADIENT	
SAMPLES	CHILD-RES	ADULT-RES	CHILD-RES	ADULT-RES	ADULT-WORKER	CHILD-RES	ADULT-RES
Round I:							
Shallow wells	0.963 1/	0.482	28.2 *2/	14.1 *	4.83 *	1.23 *	0.614
Deep Wells	0.198	0.099	2.80 *	1.40 *	0.958	11.5 *	5.74 *
Round II:							
Shallow wells	0.750	0.375	25.2 *	0.950	0.651	0.269	0.135
Deep wells	4.50 *	2.25 *	5.88 *	2.94 *	2.01 *	6.38 *	3.19 *

NOTES:

1/ Values shown are the total hazard index. A value less than 1 indicates a non-hazardous situation.

2/ The "*" indicates that a potential hazard exists for this scenario.

Table 8-21 summarizes the total cancer risks associated with Rounds 1 and 2 groundwater samples in the inhalation of volatiles while showering. In all instances where carcinogenic compounds were present, the cancer risk exceeded 1E-6 which means that exposure to these contaminants at the observed concentrations, in this scenario, could cause a potential increase in cancer incidence. Review of this table also shows that contamination from the site may be contributing to the total cancer risk both for the shallow and deep wells. Most of this cancer risk can be attributed to the presence of 1,1-dichloroethene and chloroform in the groundwater. It should be noted that a cancer risk already exists upgradient of the site.

As was noted by Foster and Chrostowski (1987), inhalation of volatiles while showering yielded approximately the same cancer risks as via the ingestion pathway, which lends support to the importance of this exposure scenario.

Table 8-22 summarizes the non-carcinogenic hazardous values associated with inhalation of volatiles while showering exposure pathway. No hazard index values exceed the target level of 1 for Rounds 1 and 2 groundwater samples upgradient, on-site, or downgradient. In general, hazard indices are elevated for on-site wells relative to the upgradient wells. Overall, the hazard indices from the shallow wells decrease downgradient of the site but are still up to two orders of magnitude greater than the upgradient shallow groundwater hazard indices. The analysis clearly shows that the site is contributing to the non-carcinogenic effect level and that this level is still elevated downgradient of the site. Review of Tables G-15 through G-20 and G-27 through G-32 show that most of the non-carcinogenic effect levels can be attributed to 1,1,1-trichloroethane and to a lesser extent chloroform.

Dermal Contact During Remedial Activity

As part of the potential remediation of this site, sediments and water present in the storm drains or exterior SPDES pools may require removal. These basins received wastes from Circuitron and have been shown to be contaminated (see Section 5). As a health and safety concern, the potential risks associated with dermal contact of the sediments and water in these basins were evaluated. In addition, the site worker dermal contact exposure scenario was developed, since the site is still operational and workers may have occasion to clear the storm drains. The spread sheets for this pathway are shown in Appendix G (Tables G-21 and G-22).

Table 8-23 summarizes the carcinogenic risks and non-carcinogenic effects associated with dermal exposure to sediments and water in the storm drains and SPDES pools. The model predicts that there would be no carcinogenic or non-carcinogenic effects associated with dermal contact during remedial activities from site worker exposure to these matrices.

TABLE 8-21

CIRCUITRON CORPORATION SITE

INHALATION OF CONTAMINANTS WHILE SHOWERING CARCINOGENIC EFFECTS

MW SAMPLES	CASE	UPGRADIENT ADULT	ON-SITE ADULT	DOWNGRADIENT ADULT
Round 1:				
Shallow wells	Ave	— 1/	1.34 E-4 *2/	7.42 E-6 *
	Max	—	4.46 E-4 *	2.48 E-5 *
Deep wells	Ave	4.66 E-5 *	7.26 E-5 *	9.13 E-5 *
	Max	1.55 E-4 *	2.42 E-4 *	3.05 E-4 *
Round 2:				
Shallow Wells	Ave	7.13 E-5 *	2.05 E-4 *	1.09 E-5 *
	Max	2.38 E-4 *	6.84 E-4 *	3.62 E-5 *
Deep Wells	Ave	3.41 E-5 *	1.00 E-4 *	5.48 E-5 *
	Max	1.14 E-4 *	3.34 E-4 *	1.83 E-4 *

Notes:

1/ No carcinogens detected in upgradient shallow wells.

2/ Value exceeds risk of 1E-6.

TABLE 8-22

CIRCUITRON CORPORATION SITE

INHALATION OF CONTAMINANTS WHILE SHOWERING NON-CARCINOGENIC EFFECTS

MW SAMPLES	UPGRADIENT		ON-SITE		DOWNGRADIENT	
	CHILD	ADULT	CHILD	ADULT	CHILD	ADULT
Round 1:						
Shallow wells	7.65 E-4	3.82 E-4	6.66 E-1	3.33 E-1	6.99 E-2	3.49 E-2
Deep wells	5.33 E-2	2.67 E-2	2.50 E-1	1.25 E-1	3.42 E-1	1.71 E-1
Round 2:						
Shallow Wells	4.03 E-1	2.01 E-1	1.38 E-1	6.91 E-2	4.69 E-2	2.34 E-2
Deep Wells	8.80 E-3	4.40 E-3	2.26 E-2	1.13 E-2	8.11 E-3	4.06 E-3

Notes:

1/ A value less than 1 indicates a non-hazardous orientation.

TABLE 8-23

CIRCUITRON CORPORATION SITE

DERMAL CONTACT PATHWAY CARCINOGENIC AND NON-CARCINOGENIC EFFECTS

REMEDIAL ACTIVITIES/SITE WORKERS

MATRIX	CASE	CARCINOGENIC EFFECT[1]	NON-CARCINOGENIC EFFECT[2]
Round 1:			
Sediments	Ave	5.24E-09	1.28E-03
	Max	1.85E-07	6.79E-03
Water	Ave	—[3]	2.92E-06
	Max	—	1.55E-05

Notes:
[1] A value less than 10^{-6} indicates no carcinogenic effect
[2] A value less than 1 indicate no potential non carcinogenic hazard for the scenario
[3] No carcinogenic compounds were identified in the water samples from the storm drains.

8.4 UNCERTAINTIES IN RISK ASSESSMENT

The procedures and assumptions used in this risk assessment are subject to a wide variety of uncertainties. The main sources of these uncertainties include:

- Environmental chemistry sampling and analysis;
- Fate and transport modeling;
- Exposure parameter estimation; and
- Toxicological data and models.

Environmental chemistry analysis error can stem from several sources, including the errors inherent in the analytical methods, or the characteristics of the matrix being sampled. All analytical methods used during this RI were approved by the USEPA.

The analytical detection limits obtained during a sample analysis are also of concern. Although certain chemicals were not detected in soils and groundwater at the site, in some cases sample detection limits may have been several times higher than reported concentrations or the CLP detection limits. It is uncertain, therefore, whether these chemicals are present above or below a level of concern in these media. If chemicals of concern were present at levels below the detection limit but above the levels of concern, exclusion of these chemicals from the risk assessment would underestimate the risks associated with certain exposures. However, if chemical concentrations are below both the detection limit and the levels of concern, their exclusion would not significantly impact the risk estimates presented in this assessment.

The use of currently measured concentrations to represent potential future concentrations also contributes uncertainty, although in the conservative direction. For example, to evaluate exposures to future residents, current groundwater concentrations were assumed to persist throughout the residents assumed period of exposure. These exposure point concentrations do not, however, reflect the likely reduction in concentration over time due to migration and degradation of contaminants in the groundwater.

The determination of the "most representative" contaminant concentration to input into the models also provides some uncertainty. The Human Health Evaluation Manual (USEPA, 1989c) states that the contaminant concentration to use for quantification of risk is the upper 95% confidence limit (UCL) on the arithmetic mean. This value would provide a reasonable conservative estimate of the risk when coupled with the conservative exposure parameters used. However, difficulty is encountered when the recommended method is used to calculate the UCL (i.e., as the backtransformed upper 95% confidence limit of natural log transformed data) since different and inflated UCLs were calculated, relative to those calculated from the untransformed data. In this risk assessment none of the UCLs calculated by the recommended method were used since all exceeded the maximum contaminant concentration. Using these UCLs would result in overly conservative, unrealistic levels which are not representative of the actual site data. Therefore, maximum contaminant concentrations were used to calculate risks.

With respect to the exposure scenarios evaluated in this risk assessment, there are several uncertainties in determining the exposure parameters that will go into the scenario and that will ultimately be combined with toxicological information to assess risk. For example, there are a number of uncertainties regarding estimates of how often, if at all, an individual would come into contact with the chemicals of concern and the period of time over which such exposures would occur. These assumptions may yield risks which are overestimated or underestimated, depending on actual work habits. Uncertainties also exist regarding future land-use patterns; for example, the industrial zoning may give way to residential zoning. In addition, other standard assumptions used in this assessment (e.g., ingestion of 2 liters of water a day, 70-kg average body weight, and 70-year lifetime), are assumed to represent upper bounds of potential exposure and have been used when site-specific data are not available or when hypothetical situations are being investigated (e.g., a future on-site use). Risks for certain individuals within an exposed population will be higher or lower depending on their actual drinking water intakes, body weights, etc.

Toxicological models are always the largest sources of uncertainty in this risk assessment. As USEPA notes in its Guidelines for Carcinogenic Risk Assessment (USEPA, 1986a):

> "There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns and other cultural factors."

To compensate for these uncertainties, conservative assumptions are used in deriving the toxicity criteria applied in this assessment. The uncertainty in these criteria may, however, account for an order of magnitude or more uncertainty in the final risk estimates, although this is biased in the conservative direction (i.e., risks may be overestimated but are unlikely to be underestimated).

There is also a great deal of uncertainty in assessing the toxicity of a mixture of differing chemicals. In this assessment, the effects of exposure to each of the contaminants present in the environmental media have initially been considered separately. However, these substances occur together at the site, and individuals may be exposed to mixtures of the chemicals. Prediction of how these mixtures in toxicants will interact must be based on an understanding of the mechanisms of such interactions. The interactions of the individual components of chemical mixtures may occur during absorption, distribution, metabolism, excretion, or activity at the receptor site. Suitable data are not currently available to rigorously characterize the effects of chemical mixtures similar to those present at the Circuitron Corporation Site. Consequently, as recommended in USEPA's Human Health Evaluation Manual (USEPA, 1989c) and in USEPA's Guidelines for Health Risk Assessment of Chemical Mixtures (USEPA, 1986a), chemicals present at the Circuitron Corporation Site were assumed to act additively, and potential health risks were evaluated by summing excess cancer risks and calculating hazard indices for chemicals exhibiting carcinogenic and noncrcinogenic effects, respectively. This approach to assessing the risk associated with mixtures of chemicals assumes that there are no synergistic or antagonistic interactions among the chemicals considered and that all chemicals have the same toxic end points and mechanisms of action. To the extent that these assumptions are incorrect, the actual risk could be under- or overestimated.

As a result of the uncertainties described above, this risk assessment should not be construed as presenting absolute estimates of risks to human or environmental populations. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts to occur.

8.5 SUMMARY OF RISK ASSESSMENT

Risks from the above exposures were evaluated first by comparing concentrations of chemicals in the contaminated exposure medium (e.g., groundwater) at a point of potential exposure, to state or federal environmntal standards, criteria, or guidelines that were identified as "Applicable or Relevant and Appropriate Requirements" (ARARs) or other relevant guidelines.

A number of inorganic and organic indicator chemicals exceeded federal and state standards and guidelines for groundwater. The ARARs and other guidance that were used in this comparison were federal Maximum Contaminant Levels (MCLs) and MCL Goals (MCLGs), federal ambient water quality criteria for protection of human health adjusted for drinking water exposure only, state MCLs, and state ground water standards. The chemicals of concern which exceeded several of these ARARs and other guidelines included copper, chromium (III), chromium (VI) and the chlorinated solvents.

For the quantitative assessment of risks, exposure estimates were all combined with the health criteria for the selected chemicals of potential concern to estimate potential risks to human health. As for exposure, risks are estimated for an average and a maximum plausible exposure scenario case using the upper 95% confidence limit of the contaminant concentration. The average case combines the average case exposure estimates with generally upper bound cancer slope factors and conservatively derived reference doses. This average case is intended to represent the exposure of a typical individual; however, use of conservative health criteria may result in an overestimation of risk even for the average case. The maximum plausible case combines the maximum plausible exposure estimates with generally conservative reference doses. This scenario is intended to place a conservative upper bound on the potential risks. Although this maximum plausible scenario may have a chance of occurring, the likelihood is extremely small due to the unlikely combination of many conservative assumptions used and the fact that Long Island does not consider the Upper Glacial Aquifer a potable source of drinkable water.

It should also be kept in mind that the risks in this RA are not actual risks but rather they are conservative estimates of current or potential risks to human health under the specific average or maximum plausible exposure pathways evaluated.

Based on this risk assessment, the only potential exposure of concern would occur if the Upper Glacial Aquifer is developed for use as a potable water supply. These risks are due to the concentrations of inorganic elements and volatile organic contaminants found in the groundwater of the Upper Glacial Aquifer.

9.0 SUMMARY AND CONCLUSIONS

9.1 SUMMARY

Two separate site investigation activities were conducted by the USEPA and Ebasco Services Inc. at the Circuitron Corporation Site from February to May and from June to December, 1989, respectively. The collective data set was used to characterize the hydrogeological conditions at the site, determine the nature and extent of the soil and groundwater contamination, assess potential sources of contamination, evaluate contaminant fate and transport and conduct a baseline risk assessment. The major findings and conclusions are presented in the following subsections.

9.1.1 Nature and Extent of Contamination

The sediments and residual aqueous material in the leaching pools, sanitary cesspools and storm drains existing underneath the Circuitron Corporation Site were sampled for volatile organics, semivolatiles, pesticides, PCBs, inorganics, cyanide and hexavalent chromium. The evaluation of the analytical chemical results indicated the presence of 1,1-dichloroethane, 1,1,1-trichloroethane, benzene, tetrachloroethene, butyl benzyl phthalate, bis[2-ethylhexyl]phthalate, endosulfan I, gamma chlordane, arsenic, cadmium, copper and mercury at concentrations capable of posing a potential human health risk. 1,1,1-Trichloroethane was detected in the sediment of most of the underground structures at levels of concentration that ranged from 24 ug/kg (SD-2) to 19,000 ug/kg (SD-3). Hits of semivolatiles were also found with bis[2-ethylhexyl]phthalate as the dominant compound (9,900 ug/kg at SD-3). Metals were detected at concentrations exceeding published maximum background soil concentrations for the US sandy soils. Copper was the predominant inorganic compound found in all underground structures at levels which ranged from 648 mg/kg (CP-1) to 23,900 mg/kg (LP-1). The presence of the above contaminants in the leaching pools, sanitary cesspools and storm drains can be attributed to the illegal discharge of untreated wastes during the operations of the plating facility of the Circuitron Corporation.

Surface soils from the unpaved areas of the Circuitron Corporation Site were sampled during the Ebasco field investigations for volatile organics, semivolatiles, pesticides, PCBs, inorganic compounds and cyanide. Concentrations of 1,1,1-trichloroethane, bis[2-ethylhexyl]phthalate and copper were detected in the surface soils. In addition, PCB Arochlor 1248 and Arochlor 1260 were found at concentrations of 1,200 ug/kg and 280 ug/kg, respectively. The presence of the PCBs could be attributed to leaks or spills from the above ground tanks at the rear of the building which may have been a source of the remainder of the contaminants of concern mentioned above.

Subsurface soil samples were collected from soil borings and monitoring well borings drilled at locations upgradient, on and downgradient of the site. The samples were analyzed for volatile organics, semivolatiles, pesticides, PCBs, inorganics, cyanide, hexavalent chromium and TOC. Semivolatile contamination was detected at various depths in the deep upgradient well MW-1D. The soil contaminants detected beneath the site were found to be somewhat similar to the upgradient contamination. However, more contaminants were detected at concentrations higher than the upgradient levels. The evaluation of the analytical results indicates that the bulk of the subsurface soil contamination exists underneath the Circuitron building, extends to a depth of 10 to 12 feet below ground and consists primarily of 1,1,1-trichloroethane, bis[2-ethylhexyl]phthalate and copper. The elevated concentrations of these compounds could be attributed to the wastes contained in the authorized and unauthorized leaching pools and underground tanks.

The soils in the vicinity of deep well boring MW-4D at the southwest corner of the Circuitron Corporation Site by the old plating bath were found to be the most contaminated on-site. 1,1,1-trichloroethane was detected at elevated concentrations of 17,000 ug/kg at 30 to 32 feet and 100,000 ug/kg at 20 to 22 feet below grade; 1,1-dichloroethene, trichloroethene and bis[2-ethylhexyl]phthalate were detected at all depths down to 40 feet below grade. In addition, copper was found at MW-4D at levels ranging from 185 mg/kg to 485 mg/kg and is distributed in the depth zone of 5 to 17 feet below grade. The presence of these contaminants in the subsurface soils was probably caused by the discharge and leaking of the chemical plating wastes directed to storm drain SD-3 from the Circuitron building and to the drainage of solvents from the old plating bath.

In addition to the subsurface soil samples, the concrete slabs of the silkscreening and plating rooms were sampled and analyzed for volatile organics, semivolatiles, pesticides, PCBs, inorganics and cyanide. The analytical results indicate the presence of several volatiles and semivolatile compounds. The dominant contaminants, however, are aluminum, copper, lead and mercury. The plating room slab was detected to have much higher contamination than the silkscreening room. This can be attributed to the materials and chemicals used when the plating facility was in operation.

The groundwater table was encountered at an average depth of 25 to 27 feet below the ground surface. The two rounds of groundwater sampling of the 5 existing and the 14 newly installed monitoring wells at the Circuitron Corporation Site included analysis of lower detection limit volatile organics, semivolatiles, filtered and unfiltered inorganics, cyanide, and hexavalent chromium. The results of the groundwater sampling activities resulted in the detection of several contaminants in the shallow and the deep aquifers. These contaminants included 1,1-dichloroethane, 1,1-dichloroethene, 1,1,1-trichloroethane, chloroform, benzene, trichloroethene, tetrachloroethene, 1,1,2-trichloroethane, chromium, copper, lead, nickel and hexavalent chromium.

The analytical groundwater data from the upgradient shallow well MW-1S indicates the presence of contamination upgradient of the site. This contamination consists of several volatile organics, chromium and lead and is estimated to be moving in a southeast direction underneath portions of the Circuitron Corporation Site. The contamination of this plume appears to increase at the immediate area of the site and then decreases significantly downgradient of the site. This may indicate that the site is potentially contributing to the contamination of the groundwater. A second discrete contamination "plume" appears to exist in the area of the southwest corner of the site, where 1,1,1-trichloroethane was detected at a concentration of 4,600 ug/l (the highest concentration detected in the groundwater at the Circuitron Corporation Site). Chromium and lead were detected at concentrations similar to those found upgradient. This contamination is most probably caused by the surficial draining of spent solvents from the old plating bath to the nearby storm drain SD-3, to the subsurface soils and eventually to the shallow aquifer.

A contamination plume consisting of volatiles, copper and lead was found in the groundwater of the upper portion (95-97 feet) of the Magothy aquifer in the upgradient deep well MW-1D. This plume also appears to move to the southeast directly underneath the Circuitron Corporation Site. The contamination in the deep aquifer beneath the site appears to be similar to the upgradient one, with the exception of copper. Copper concentrations beneath the site were found to be elevated (3.9 ug/l to 332 ug/l) due to the illegal discharges from the site activities to the authorized and unauthorized leaching pools. It should be mentioned that the remainder of the groundwater contaminants of concern were detected at concentrations lower than the shallow aquifer levels. The deep well groundwater analytical data also supports off-site transport of this contamination at levels similar to the upgradient levels.

9.1.2 <u>Fate and Transport</u>

Groundwater transport of volatile organic contaminants and inorganics associated with particulates is the primary mechanism of contaminant migration at the Circuitron Corporation Site. The low organic carbon content of the soils beneath the site allows these contaminants to be highly mobile, both with percolating precipitation through the vadose zone and transport with the water upon reaching the aquifer. The presence of "bottomless" sewers and leaching pools which are exposed to percolating precipitation has contributed to groundwater contamination below the Circuitron Corporation Site. The contamination does not appear to have reached the deeper portion of the Upper Glacial aquifer and the top portion of the Magothy aquifer, but it has extended at least 1,500 feet to the off-site downgradient shallow well installed during this remedial investigation. Existing upgradient source(s) of contamination have contributed to the contamination of both the shallow and deep portions of the Upper Glacial and top portion of the Magothy aquifers.

9.1.3 Risk Assessment

Risks were evaluated first by comparing concentrations of chemicals in the contaminated exposure medium (e.g. groundwater) at a point of potential exposure, to Federal Maximum Contaminant Levels (MCLs) and MCL Goals (MCLGs), federal ambient water quality criteria for protection of human health adjusted for drinking water exposure only, state MCLs and state groundwater standards guidelines, that were identified as "Applicable or Relevant and Appropriate Requirements" (ARARs). The quantitative assessment of risks was conducted on the contaminants of concern.

Nearly all of the volatile organic compounds found in the groundwater exceeded federal or state standards and guidelines. Some exceedance of these standards or guidelines was noted for the inorganic analytes, but four of these (copper, chromium, nickel and lead) were retained for risk assessment since concentrations were elevated relative to other well samples and upgradient of the site. Based on this assessment the chemicals of concern which exceeded several of these ARARs and other guidelines included copper, chromium (III), chromium (VI), lead, nickel, 1,1-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, chloroform, benzene and 1,1,2-trichloroethane.

For the quantitative assessment of risks, exposure estimates were combined with the health criteria for the selected contaminants of concern to estimate potential risks to human health. Generally, the maximum plausible case was used to estimate risks, although for risks of carcinogens, average and maximum cases for exposures were evaluated.

Based on this risk assessment, the only potential exposure of concern in the future is developed for use of the Upper Glacial aquifer as a potable water supply. These risks are due to the presence of volatile organic compounds found in the groundwater of the Upper Glacial aquifer. Both carcinogenic and non-carcinogenic risks were present upgradient of the Circuitron Corporation Site, as well as on the perimeter and downgradient of the site.

9.2 CONCLUSIONS

9.2.1 Data Limitations

The samples taken by USEPA and Ebasco during the field investigations for this RI report, were analyzed and validated by a USEPA CLP laboratory. These analyses were considered confirmational level, that is, the highest level of data quality. The analyses required full CLP analytical and validation procedures, and were designed to be legally defensible.

The quantity estimates, results and conclusions presented in this RI report are based on this CLP validated analytical data. Data that were rejected in the validation process were not considered when drawing conclusions about the nature and extent of the site contamination. In addition, the validation of approximately 5% of the samples collected has not been completed as of this printing, and therefore, have not been included in the draft RI report. This data will be included in the final RI report.

Data previously obtained by the USEPA and others was also considered in the preparation of this report. While the chemical analyses presented in many of the previous studies may not have been performed to the same QA/QC standards as the samples taken for this RI report, nevertheless the previous body of existing data could not be ignored in attempting to define the contamination in the groundwater and the underground structures of the site. While the previous investigations provided significant assistance, the location of contamination and its fate are fully supported by the USEPA and the Ebasco validated analytical data.

9.2.2 Recommended Remedial Action Objectives

Based on evaluation of the chemical data and its associated risks, the following remedial action objectives have been developed:

- Elimination of sources of contamination by:
    - clean up of authorized leaching pool and its interconnected pools;
    - clean up of the two sanitary cesspools;
    - clean up of the three storm drains located in the west portion of the site;
    - removal of the top 35 feet of soil from the southwest corner of the site;
    - removal the buried drums from beneath the plating room; and
    - repair and top coating of floor slab; and,
- Long term groundwater monitoring program.
- Recommendation for additional groundwater investigations to further and more adequately delineate the upgradient and downgradient contamination.

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