
BASELINE RISK ASSESSMENT
HUMAN HEALTH EVALUATION
DRUM DISPOSAL AREA

COLUMBIA MILLS
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1.0 INTRODUCTION

This public health risk assessment evaluates the possible health impacts associated with contaminated media in the Drum Disposal Area at the Columbia Mills site. The objectives of this evaluation are to provide an analysis of baseline risks in the absence of any action to control or mitigate site contamination and to assist in determining the need for remediation. The evaluation will also provide an estimate of the magnitude of risk due to the site and the primary causes of that risk. Both the risks associated with present land use and possible future land use were evaluated.

There are four steps in the risk assessment process. The four steps include:

- data collection and evaluation,
- toxicity assessment,
- exposure assessment, and
- risk characterization.

The first step in the risk assessment process involves collection and analysis of relevant site data to identify potential chemicals of concern. In the toxicity assessment, qualitative and quantitative chemical toxicity data are summarized and appropriate guidance levels are identified. For the exposure assessment, contaminant releases are analyzed, potentially exposed populations and exposure pathways are identified and contaminant intakes are estimated. The final step is risk characterization, which combines the results of the previous steps in order to develop quantitative estimates of public health risks. These estimates are in the form of cancer risks and non-cancer hazard quotients.

The methodology described in the four steps above has been developed by the United State Environmental Protection Agency (USEPA) and others as the basic approach to conducting risk assessments. To the extent feasible at this stage of the RI/FS, the approach outlined in the current USEPA risk assessment guidance document was followed. The current guidance document, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), Interim Final (USEPA, 1989) replaces the Superfund Public Health Evaluation Manual (USEPA, 1986).

This baseline risk assessment was developed in accordance with the goals established by the USEPA. The information has been developed only to help determine what actions are necessary to reduce risks, and not to fully characterize site risks or eliminate all uncertainty from the analysis. Wherever appropriate, standardized assumptions, equations and values have been used.

1.1 LIMITATIONS

Several nonquantitative elements exist in the development of any risk assessment. Potential risks associated with the impact of a site on human health can be identified and evaluated based on available quantitative values and estimations. Nonquantitative elements which place limitations on a risk assessment include: uncertainties of exposure concentrations, uncertainties in predicting target populations, uncertainties resulting from the lack of published long-term exposure/effect data for some chemical parameters and the lack of any generally accepted model (extrapolation of dose-response experiments).

In addition, as will be seen in the following sections, this evaluation was based on the assumption that exposure to contaminated ground water could occur. However, at the present time, this does not seem likely to occur. The use of maximum detected values, while following the USEPA risk assessment procedures, does not reflect real-world conditions and significantly exaggerates the actual risk.

2.0 DATA COLLECTION AND EVALUATION

The purpose of this subsection is to identify those contaminants in the Columbia Mills Drum Disposal Area which have the potential to cause adverse health affects. Due to the number of analytes detected at the site, the risks were quantified for a reduced number of parameters (indicator parameters). The indicator parameters were selected based on knowledge of site contaminants, toxicity of contaminants detected, frequency of detection and essential nutrient information. This subsection also provides the rationale for the choice of indicator contaminants selected for the risk analysis. The rationale used to determine if a specific parameter was considered to be a potential "risk" requiring further evaluation is presented in the media subsections which follow.

A summary of the sampling activities and analytical data was provided in reports previously submitted to the New York State Department of Environmental Conservation (NYSDEC). If available, validated data was used in the quantitative portion of this risk assessment. In those areas where validated data exists, the historical data was considered in the selection of indicator parameters. In those areas where no validated data exists, the historical data was used to quantify risks.

The Drum Disposal Area is located in the western, undeveloped portion of the Columbia Mills site. A large number of rusted and mostly empty drums plus ash and debris are buried in the Drum Disposal Area. Some drums are exposed or submerged in Pond 1. The location of the Drum Disposal Area is shown on Figure 1.

The primary migration route for contaminants emanating from the Drum Disposal Area would be surface water and/or sediment transport. There are also a number of surface soil samples that showed elevated levels of inorganics. These locations ("hot spots") may serve as exposure points to trespassers and a source for migration of contaminants to the ground water. The ground water table in the area is high and comes into contact with the fill material (the water levels of the ponds are expressions of the water table).

In general, shallow ground water in the Drum Disposal Area flows into the surface water on-site. The flow is directed from Pond 3 toward Pond 1. Pond 1 discharges to an unnamed creek, which eventually discharges to the Oswego River.

A well inventory of the surrounding area was conducted and no known residential wells are located directly downgradient of the Drum Disposal Area (east of the Drum

Disposal Area). A number of wells used for drinking and/or other purposes were identified north and south of the site. However, there is no component of shallow or deep ground water flow toward those residences.

To evaluate possible ecological risks, a Phase II Habitat Assessment was performed during the late summer of 1991. The scope of work included both vegetation and tissue sampling and analysis. The results of the Assessment were summarized in the Ecological Risk Assessment Report which was submitted to the NYSDEC early in December. The analytical results of the vegetation and tissue samples (fish) were used to evaluate possible health risks to hunters and fishermen.

2.1 GROUND WATER INDICATOR SELECTION

The ground water sampling locations and analyses performed to date are summarized on Figure 2. Four wells were installed in the Drum Disposal Area to monitor the ground water quality. Two wells were installed to monitor the shallow ground water (B-7S and B-10S) and two to monitor the deep ground water (B-7D and B-10D). As discussed above, the shallow ground water flows into the surface water and ultimately discharges to the Oswego River. Water level and permeability data indicate that an upward gradient exists from the deep to the shallow well in the B-10S,D cluster. Due to the lack of a substantial low permeability unit between the shallow and deeper zone, the shallow and deep ground water can be considered to be in direct hydraulic communication with each other. Based on bedrock fracture density, the upward hydraulic gradient and analytical data, the upper bedrock zone represents a lower boundary for ground water contamination. The parameters detected in the ground water (shallow and deep wells), the frequency of detection, concentration ranges, quantitation limits and the applicable Standards, Criteria and Guidelines (SCGs) are shown in Appendix A. Tables are grouped as to whether or not the data was validated.

The risks associated with exposure to ground water were evaluated using the indicator parameters listed on the next page. The rationale for selection of the indicator parameters is discussed in the paragraphs that follow.

- Toluene
- Trichloroethene
- cPAHs (Carcinogenic PAHs)
- Phenanthrene
- Fluoranthene
- Pyrene
- Lead
- Manganese
- Zinc
- Cyanide

The USEPA lists acetone, methylene chloride and chloroform as common laboratory contaminants. Since these contaminants are not associated with the known site contaminants, these analytes were not included on the indicator parameter list.

Due to the low frequency of detection and low level reported relative to the detection limit 1,1-dichloroethylene was not included as an indicator parameter. Methyl ethyl ketone was not included on the list of indicator parameters. This analyte is not associated with the Drum Disposal Area (i.e. not detected in sediment, soil, surface water or fill samples).

Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were excluded from the ground water indicator list because they were detected at low levels and because these analytes are common field and laboratory contaminants. Bis(2-ethylhexyl)phthalate was not detected in the most recent analysis of the ground water. Di-n-butyl phthalate was detected in samples collected in February 1990, however, the data was qualitatively suspect since this analyte was also detected in the blank at a similar level.

Three inorganics (lead, manganese and zinc) were selected as indicator parameters for the ground water evaluation. These parameters were chosen based on the levels detected in comparison to the SCGs, the toxicity values, concentrations and frequency of detection.

It should be noted that the historical data (non-validated data), which included both filtered and unfiltered samples indicated that the majority of the metals are sorbed onto particulate matter and not dissolved in the ground water. The samples analyzed as part of the remedial investigation were collected in a manner that minimized turbidity of the sample. The wells were purged and allowed to stand overnight in order to allow particulate matter to settle. The validated data was used in the quantitative portion of the risk assessment.

Magnesium and iron were eliminated from the quantitative portion of the risk assessment because they are essential elements in human nutrition and normal consumption should not result in adverse health effects, even at the maximum levels found in ground water. In addition, the wells are constructed of black iron pipe, therefore, the well construction may have contributed to the high levels of iron.

Antimony was not included as an indicator parameter because the presence of this analyte is qualitatively suspect. The validated data showed that antimony was only detected in one sample, which was a duplicate sample of B-10D. The data validation report flagged this parameter with "B" indicating that this analyte was also detected in the blank at a similar level.

Some of the inorganics detected in the ground water were not included because they have low toxicity ratings (based on USEPA severity rating - rating scale which is based on toxic effect) and have a widespread dispersion in the environment. These include aluminum, calcium and sodium. Other inorganics excluded due to low frequency of detection and, low levels relative to SCGs include copper and nickel. Chromium was not included as an indicator parameter because the validated data indicated that the data was suspect since this analyte was detected in the blank at a similar level. Also, the historical data showed this parameter to be undetected in the filtered samples. Due to the toxicity and the level detected above SCGs, cyanide was included as an indicator parameter.

2.2 SEDIMENT INDICATOR SELECTION

A summary of the sediment data is presented in Appendix B. The summary tables (separate tables for validated and non-validated data) include frequency of detection information, range of concentrations detected and the sediment criteria (based on a NYSDEC Division of Fish and Wildlife Sediment Criteria Guidance Document). Figure 3 shows the sediment sampling locations and includes a summary table indicating the date of sampling and the analyses performed. The following sixteen analytes were chosen as indicator parameters for the risk assessment:

- Phenol
- Bis(2-ethylhexyl)phthalate
- cPAHs
- Phenanthrene
- Fluoranthene
- Pyrene
- Antimony
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Manganese
- Zinc
- Cyanide

The rationale for the selection of the sediment indicator parameters is outlined below.

The inorganics that were chosen as indicator chemicals were selected based on historical data, severity ratings, frequency of detection and levels above the sediment criteria. Cyanide was also included in the indicator parameter list due to the level detected and because it was detected in other media in the Drum Disposal Area.

Methylene chloride and acetone were eliminated from the risk analysis because they are common laboratory contaminants and both were detected in the blanks. Toluene was eliminated because it was detected at a low level relative to the detection limit and at low frequency.

Pesticides were detected, however, pesticides were not associated with site activities and were detected in background soil samples from the Drum Disposal Area, therefore, they were eliminated from the risk assessment.

Low levels (relative to the quantitation limit) of some semivolatile analytes were detected in the sample collected from the furthest downgradient sampling point in the stream. Those analytes which were detected in other media at the site were included in the risk analysis.

2.3 SURFACE WATER (INTERMITTENT CREEK & PONDS) INDICATOR SELECTION

The risks associated with dermal contact with surface water will be quantified using the following indicator parameters:

- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Zinc

Since no validated data exists for the surface water locations, non-validated data was used to quantify risks. The surface water sampling locations and analyses performed are shown on Figure 2. The analytical data for those parameters detected is presented in Appendix C. Since high levels of these parameters were recently detected in the sediment sampled from the intermittent stream and/or ponds, the inorganics detected in these areas were selected as indicator parameters. The remaining inorganics detected in the surface water samples were not included because they have widespread dispersion in the environment and low toxicity ratings.

All other parameters detected in the intermittent stream samples were included in the indicator parameter list except methylene chloride, chloroform and 1,1,1-trichloroethane (TCA). Methylene chloride and chloroform were detected at low levels and both are considered common laboratory contaminants. TCA was eliminated in the risk quantifications because it was detected at a low level.

2.4 SURFACE SOIL INDICATOR SELECTION

Heavy metals contamination of the surface soil in the Drum Disposal Area has been identified in the Phase II and the Remedial Investigation reports. In June of 1988 an area with high metals levels which had been frequented by trespassers was covered with clean soil.

The indicator parameters selected to evaluate the quantitative risk associated with the uncovered surface soil were selected based on comparison to background levels and historical data. Historical data includes test pit sample data and soil/fill sample data beneath the covered area.

Figure 4 shows the surface soil/fill sampling locations, sampling dates, analyses conducted and the covered area of soil. A summary of the analytical data, including background levels, is presented in Appendix D.

The following analytes were selected as indicator parameters for exposure to surface soil/fill.

- Bis(2-ethylhexyl)phthalate
- Phenol
- Phenanthrene
- Fluoranthene
- Pyrene
- Dioxins/Furans
- Cadmium
- Chromium
- Lead
- Nickel
- Zinc

Acenapthylene was not included in the indicator parameter selection because it was only detected in one sample and it was not detected in any other media in the Drum Disposal Area.

Bis(2-ethylhexyl)phthalate was included in the risk assessment since it was detected at levels significantly higher than background levels. It's presence can be attributed to the vinyl products produced at the mill. Although detected in soil samples above background levels, di-n-butylphthalate was not included in the risk assessment indicator parameter list.

Bis(2-ethylhexyl)phthalate is considered to be more toxic than di-n-butylphthalate and therefore it will be used to quantify risks due to exposure to phthalates.

Copper, nickel and silver were eliminated from the list of indicator parameters based on the levels detected in comparison to the background samples. The USEPA suggests that sample results should not be considered positive if the level is less than five times the maximum level detected in any blank. The level of cobalt detected in the sample is less than five times the level detected in the blank. Therefore, cobalt was not included as an indicator parameter.

PCBs were eliminated from the quantitative portion of the risk assessment because of the low level detected in comparison to the quantitation limit and because of the low frequency of detection. Although it is not apparent from the summary tables (since these tables only present surface soil data), a total of four samples collected in the Drum Disposal Area have been analyzed for PCBs. Of the four samples, only one showed detectable levels of PCBs. [Additional sampling locations for PCBs included a test pit sample between Ponds 1 and 3 and a sampling location which is underneath the cover soil.

As discussed previously, pesticides were detected in the background soil and are not associated with site activities. Therefore, they were not included as indicator parameters.

Table 1-1 summarizes the indicator chemicals selected for evaluation for each medium.

2.5 VEGETATION AND TISSUE INDICATOR SELECTION

The following six inorganics were selected as parameters of concern for the ecological risk assessment.

- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Zinc

The rationale for selection of these analytes is discussed in detail in the Ecological Risk Assessment. The potential risks associated with consumption of deer, rabbit and fish by hunters and fishermen were evaluated using the analytical results for the vegetation samples and fish samples collected at the site as part of the Phase II Habitat Assessment. These analytical results are presented in Appendix E. The vegetation samples (sumac and red raspberries) were selected for analysis due to their consumption by game species such as deer and rabbit. Samples were collected in both a control and hazardous area. Comparison of the data showed higher levels in the hazardous area for all parameters except copper for the berry samples and only a slight elevation of copper in the sumac samples. Therefore the risks to hunters who consume either rabbit or deer were evaluated for all parameters of concern except copper. The potential health risks to fishermen were evaluated using all six parameters of concern.

3.0 TOXICITY ASSESSMENT

Toxicity assessment consists of two steps, hazard identification and dose/response evaluation. Hazard identification determines whether exposure to a contaminant can cause an adverse health effect. The dose response evaluation characterizes the relationship between the magnitude of exposure and the potential that an adverse effect will occur. Since carcinogens and non-carcinogens differ in the way they produce toxic effects, a distinction is made in the assessment of the health risks of carcinogens and non-carcinogens.

3.1 HAZARD EVALUATION

The hazard evaluation for each indicator parameter is summarized in the following brief toxicity profiles. The information presented below was obtained from the respective Draft or Final Toxicological Profiles prepared by the U.S. Public Health Service's Agency for Toxic Substances and Disease Registry (1989 and 1990) if available and/or the Integrated Risk Information System (IRIS) data base.

ANTIMONY Toxic symptoms associated with exposure to antimony involve the gastrointestinal tract, heart, respiratory tract, skin and liver. Chronic exposures of laboratory animals to antimony has shown a reduction in lifespan and some effects on blood chemistry (blood glucose and cholesterol). Antimony has not been evaluated by the USEPA for evidence of human carcinogenic potential.

ARSENIC Low levels of exposure to inorganic arsenic may produce injury in several body tissues. When ingested, a common effect is irritation of the digestive tract leading to pain, nausea, vomiting and diarrhea. Other effects characteristic of oral exposure include decreased production of red and white blood cells, abnormal heart function, blood-vessel damage, liver and/or kidney injury and impaired nerve function that causes a "pins and needles" sensation in the feet and hands.

Direct dermal contact with arsenic compounds, frequently from inorganic arsenic dusts in the air, may result in mild to severe irritation of the skin, eyes or throat.

The singlemost characteristic effect of oral exposure to this compound is a pattern of skin abnormalities. Although these skin changes, called hyperkeratoses, are not considered to be a health concern, a small number of hyperkeratoses may ultimately progress to skin cancer. In addition, arsenic ingestion has been reported to increase the risk of cancer in the liver, bladder, kidney and lung.

Of much greater concern is the ability of inhaled arsenic to increase the risk of lung cancer. This has been observed mostly from high levels of airborne arsenic in or around smelters, but lower levels may increase lung cancer as well.

Based on increased lung cancer mortality in populations exposed primarily though inhalation and on increased skin cancer incidence in several areas consuming drinking water with high arsenic concentrations, the USEPA has designated arsenic as a Group A carcinogen (known human carcinogen).

BIS(2-ETHYLHEXYL)PHTHALATE (BEHP)

The phthalic acid esters and/or their metabolites are readily absorbed from the intestinal tract, the intraperitoneal cavity and the lungs. BEHP is poorly absorbed through the skin and no irritant response or sensitizing potential from dermal application has been noted in experimental animals or in humans (Clement Associates, 1985).

There are essentially no studies on the health effects of BEHP in humans. Animal studies conducted on exposure to BEHP has resulted in indications of reproductive, liver and developmental toxicity. The USEPA has designated BEHP as a Group B2 Carcinogen (probable human carcinogen - sufficient evidence in animals with inadequate evidence in humans).

CADMIUM Acute exposures to high levels of cadmium may cause nausea, vomiting, diarrhea, muscular cramps and salivation. Inhalation of high doses can cause severe irritation of the lungs. Other reported effects due to exposure to cadmium of humans or animals include anemia, kidney damage, lung damage (emphysema), high blood pressure (observed in animals only) and liver damage. There is inadequate evidence for carcinogenicity of this compound by the oral route. Lung cancer has been shown to occur in animals exposed for long periods of time to cadmium in air. Studies in humans also suggest that long term inhalation of cadmium can result in increased risk of lung cancer.

The USEPA has designated cadmium as a Group B1 carcinogen, probable human carcinogen by inhalation.

CHROMIUM There are three major forms of chromium {O (metallic), III (trivalent), VI (hexavalent)} which differ in their effects on health. Chromium can enter the body via oral, inhalation and dermal exposure.

Chromium (III) is considered to be an essential nutrient (when ingested in small amounts) that helps to maintain normal levels of glucose, cholesterol and fat in humans. The daily ingestion of 50-200 $\mu g/l$ per day has been estimated to be safe and adequate. Very large doses may be harmful.

Chromium (VI) is irritating and short-term high level exposure can result in adverse effects at the site of contact, such as ulcers of the skin, irritation of the nasal mucosa, perforations of the nasal septum and irritation of the gastrointestinal tract. Chromium (VI) may also cause adverse effects to the kidneys and liver.

Exposure to chromium (O) is less common and is not well characterized in terms of toxicity data.

Chromium (VI) compounds have been found to cause cancer in animal studies based on evidence in humans and animals. Chromium (VI) and compounds are classified by the USEPA as Group A, human carcinogen via inhalation exposure.

COPPER Copper is an essential nutrient for humans. A daily dietary intake of 2-3 mg/day by adults is considered safe and adequate. Exposure to drinking water which contains higher than normal levels of copper may cause nausea, vomiting, diarrhea and stomach cramps. Very high levels of copper in food and/or water can cause liver and kidney damage and possibly death. Exposure to copper dust can irritate the respiratory tract, nose, mouth and eyes and can cause headaches. USEPA's IRIS database classifies copper as Group D, not classifiable as to human carcinogenicity (inadequate or no evidence available).

CYANIDE Adverse effects to the central nervous system, respiratory system and cardiovascular system seem to be the primary effect of exposure to high levels of cyanide for a short period of time. Brief exposure to lower levels result in rapid deep breathing, shortness of breath, convulsions and loss of consciousness. These short-term effects are reversible over time because cyanide does not remain in the body. Skin contact with dust from certain cyanide compounds can cause skin irritation. Damage to the nervous system and thyroid gland have been reported in humans exposed to food containing low levels of cyanide for a period of time ranging from months to years. The USEPA ranks cyanide as Group D (not classified as to carcinogenicity).

DIOXINS/FURANS Polychlorinated dibenzo-p-dioxins (PCDDs) and -furans (PCDFs) constitute a family of 210 similar compounds, including 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). While 2,3,7,8-TCDD was not detected at Columbia Mills, the other PCDD/PCDF compounds are usually evaluated in terms of their relative toxicity to 2,3,7,8-TCDD. The USEPA classifies 2,3,7,8-TCDD as a "B2" carcinogen. Group B2 indicates that although evidence in humans is inadequate, there are sufficient data on animals to consider it a probable human carcinogen. Much less is known about the carcinogenicity of the other PCDDs/PCDFs, but prudence dictates that these compounds be treated similarly, although the degree of risk is likely to be substantially lower. The USEPA has stated that 2,3,7,8-TCDD is the most potent potential carcinogen and reproductive toxin yet evaluated. NIOSH (1984) has recommended that 2,3,7,8-TCDD be considered a potential occupational carcinogen and exposure should be limited to the fullest extent feasible.

The relative potency of PCDD/PCDF compounds is generally consistent over a variety of toxicity tests, and those compounds with chlorine occupying the 2,3,7,8- lateral positions are more active toxicologically than the other compounds. The international community has developed a weighting scheme whereby a mixture of PCDDs and PCDFs can be expressed in terms of an equivalent amount of 2,3,7,8-TCDD or "toxicity equivalents" (TEQs), and has assigned a "zero" ranking to all non-2,3,7,8-substituted congeners, both because of their demonstrated relatively low toxicity and because they are generally either not absorbed or quickly eliminated by the body (USEPA, 1989).

LEAD High levels of lead exposure may result in kidney and brain damage. Low-level exposure may result in neurobehavioral deficits and growth retardation in young children and hypertension in middle-aged men. Effects on heme (a constituent of hemoglobin) synthesis also occurs at very low exposure levels.

In addition, low-level exposure to lead decreases the circulating levels of an active form of Vitamin D in children. This form of Vitamin D is largely responsible for maintenance of calcium homeostasis in the body.

Lead exposure of a mother during pregnancy may result in preterm birth, reduced birth weight and decreased intelligence quotient (IQ) of the infant.

The USEPA has not derived a reference dose for oral exposure to lead. It appears that some of the effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development may occur at blood levels so low as to be essentially without threshold.

USEPA has determined that data were sufficient to consider lead an animal carcinogen, but inadequate for derivation of an estimate of carcinogenic potency in humans. Therefore lead is classified as a B2 carcinogen (probable human carcinogen - sufficient evidence in animals with inadequate evidence in humans).

MANGANESE Manganese is an essential element in human nutrition. Manganese is normally ingested as a trace nutrient in food. The average human intake of manganese is approximately 2 to 10 mg/day. Levels of 10 mg/day can be considered safe. However, this level is not necessarily acceptable if intake is from drinking water alone (manganese in drinking water is more bioavailable than manganese in food).

Data on toxicity of manganese relative to human health (by oral route) are limited to a few instances of very high exposure levels. Symptoms of manganese poisoning include lethargy, increased muscle tonus, tremor and mental disturbances. Inhalation of manganese dusts are associated with psychological and neurological disorders. The USEPA ranks manganese as Group D (not classified as to carcinogenicity).

NICKEL Nickel may be an essential element for human nutrition in trace amounts. Nickel is a skin sensitizer, and may cause skin allergies. Acute exposure may cause effects on the respiratory system and immune system. Studies in animals indicate that exposure to nickel compounds may effect the kidneys, blood and growth. Based upon limited animal studies, nickel and nickel compounds do not appear to be carcinogenic to animals by the oral route. For inhalation exposures, the USEPA classifies nickel refinery dust and nickel subsulfide as probable human carcinogen (Group A).

PAHs PAHs are a diverse class of compounds derived from both natural and manmade sources. Eight of fifteen PAHs are potentially carcinogenic (cPAHs). They are:

- Benzo(a)pyrene
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(g,h,i)perylene
- Chrysene
- Dibenzo(a,h)anthracene
- Indeno(1,2,3-cd)pyrene

Benzo(k)fluoranthene, although not regarded by USEPA as a potential carcinogen, is included in this list due to the inability of the analytical method to distinguish between benzo(b) and benzo(k)fluoranthene. Noncarcinogenic PAHs include:

- Anthracene
- Phenanthrene
- Acenaphthene
- Fluoranthene
- Acenaphthylene
- Fluorene
- Pyrene

Benzo(a)pyrene (B(a)P) is the most hazardous of the PAHs. Its carcinogenicity has been demonstrated in laboratory animals by all routes through which humans would normally be exposed.

B(a)P has high biological activity relative to other PAHs and is often characterized as a representative of the class of carcinogenic PAHs. B(a)P is a well-studied, well-established experimental carcinogen that is readily absorbed through all routes of exposure. Occupational exposures to complex mixtures and industrial processes that include PAHs have resulted in toxic effects including a variety of skin lesions and noncancerous lung diseases such as bronchitis. Results from studies in rodents indicate that in-utero exposure to B(a)P either by the oral route or by injection is associated with developmental toxicity and adverse reproductive effects.

Epidemiological studies have demonstrated increased mortality due to lung cancer in humans exposed to coke oven emissions; the mixture of PAHs contained in these emissions includes B(a)P, chrysene, benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene. Skin disorders are associated with contact with carcinogenic PAHs.

A variety of non-cancer adverse health effects have been demonstrated resulting from exposure to PAHs in animals, primarily to the hematopoietic and lymphoid systems. Adverse hematological and dermal effects have been observed in humans. USEPA has designated benzo(a)pyrene as Group B2 (probable human carcinogen -- sufficient evidence in animals with inadequate evidence in humans).

PHENOL Phenol is readily absorbed following inhalation, skin contact or ingestion. Studies have shown that most phenol that enters the body leaves the body in the urine within 24 hours of exposure. Systemic effects of exposure to phenol include gastrointestinal irritation, dermal necrosis, liver and kidney effects and cardiac arrhythmias. Application of phenol to the skin results in dermal inflammation and skin damage. Signs of gastrointestinal irritation, including mouth sores and diarrhea have been reported in humans repeatedly exposed to low levels of phenol in drinking water. The effects of exposure to phenol on human reproduction and the development of the fetus are unknown. Animal studies have shown that exposure to phenol in water by gavage resulted in reduced fetal body weight and birth defects. The USEPA cancer classification for phenol is Group D (not classified as to carcinogenicity).

TOLUENE Inhalation of toluene results in depression of the central nervous system. Toluene does not appear to exert other systemic effects at low concentrations. Humans exposed to toluene in the range of 100 to 500 ppm experience fatigue, confusion, incoordination, impairment to reaction time, perception and motor control and function effects. The liver and kidney do not appear to be primary target organs for toluene exposure. There is no evidence that toluene is a carcinogen. The USEPA ranks toluene as Group D (not classified as to carcinogenicity).

TRICHLOROETHYLENE (TCE) Inhalation exposure to TCE is associated with central nervous system effects including depression (narcosis). Other symptoms include drowsiness, headache, dizziness, nausea, confusion, facial numbness and blurred vision. Effects attributed to long-term exposure include decreased appetite and sleep disturbances. Liver damage, including necrosis, has resulted from acute occupational exposure. USEPA has concluded, however, that chronic exposure to TCE at concentrations found or expected in ambient air are unlikely to result in liver damage. Kidney dysfunction and failure have also been associated with acute occupational and intentional exposure. Anorexia, nausea, vomiting and intolerance of fatty foods have been associated with long-term occupational exposures. TCE may also be associated with mild eye irritation and dry throats. Skin contact may result in irritation, burns and rashes; it may also act as a sensitizer as well as a primary irritant. Available evidence indicates that TCE is carcinogenic in animals. The carcinogen assessment summary for this substance has been withdrawn from the IRIS data base. A new carcinogen summary is in preparation by the USEPA Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroup.

ZINC Zinc is an essential element in human nutrition. Excessive exposure to zinc is relatively uncommon. Gastrointestinal distress and diarrhea have been reported to result from consumption of canned fruit and juices in galvanized cans, with zinc contamination of the food on the order of 1000-2000 ppm.

Long-term human exposure to excessive levels of zinc are associated with anemia, digestive problems and difficulty in fighting infections. No relationship between the occurrence of cancer in humans has been demonstrated. The USEPA has designated zinc as a Group D carcinogen (not classified as to carcinogenicity).

3.2 DOSE-RESPONSE EVALUATION

Dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population.

Dose-response evaluations are facilitated by use of USEPA guidance levels. These include verified reference doses (RfDs), reference concentrations (RfCs) and slope factors. RfDs and RfCs are used to assess potential noncarcinogenic effects associated with chronic oral and inhalation exposure, respectively (seven years to a lifetime). Chronic RfDs and RfCs, which are accessed on the USEPA IRIS database, have been reviewed and verified by an intra-Agency RfD/RfC workgroup. These values, which are subthresholds of effect, are daily exposure levels believed to be protective of human health, including the health of sensitive individuals in the population. Subchronic RfDs/RfCs are used to assess the potential noncarcinogenic effects associated with subchronic exposure (two weeks to seven years). These values are provided in the USEPA's Health Effects Assessment Summary Tables (USEPA, 1990).

The USEPA has established a system for classifying evidence of carcinogenicity, and has developed toxicity values that define the relationship between dose and response (termed slope factor) for suspect carcinogens. The slope factor is a upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The USEPA

CRAVE workgroup reviews the data and establishes consensus values which are entered into IRIS.

Guidance levels for the indicator chemicals consisting of verified RfDs/RfCs and slope factors are provided in Tables 2-1 and 2-2. As a secondary source to IRIS, some of the referenced values are from USEPA's Health Effects Assessment Summary Tables (USEPA, 1990).

At the time that this risk assessment was prepared, oral RfDs were not available for the following analytes: TCE, cPAHs, phenanthrene and lead. Inhalation RfCs were not available for TCE and slope factors were not available for cPAHs (Benzo(a)pyrene) and lead. Both analytes are classified as B2 carcinogens.

No RfDs or slope factors are available for skin contact with contaminants. In this analysis, oral RfDs and slope factors have been applied in the evaluation of dermal exposure. This assumes that contaminants absorbed by the skin have the same toxicologic and carcinogenic potential as those contaminants absorbed by the gastrointestinal tract.

4.0 EXPOSURE ASSESSMENT

In the exposure assessment, contaminant releases are analyzed, potentially exposed populations and exposure pathways are identified and contaminant intakes are estimated. The subsections that follow discuss the elements of the exposure assessment.

4.1 EXPOSURE PATHWAYS

The determination of possible exposure pathways consists of the identification of three items, the transport media, the target receptors and exposure routes.

The potential transport/exposure media at the site include both physical modes and biological modes. Physical modes would include exposure to ground water, surface water, surface soil and sediment. Biological modes would include actions such as food chain transport.

The human receptors associated with the Drum Disposal Area would either be residents or trespassers. Trespassers are occasionally encountered on-site. Measures have been undertaken to minimize site entry and reduce the possibility of contact with contaminants. Trespassers have been seen on-site with guns indicating that hunting may occur.

The potential routes of exposure to contaminants originating, or possibly originating, from the site fall into three categories, direct contact (dermal absorption), ingestion and inhalation.

Based on current and possible future land use of surrounding areas, the potential pathways that could reasonably be attributed to the Drum Disposal Area at the Columbia Mills site were determined and are listed on Table 4-1. It should be noted that the items included on the table are exposures that could potentially occur, regardless of the contaminant levels of the transport medium. The subsections that follow discuss several of the potential pathways. The subsections are grouped by potential exposure routes.

INGESTION Although it is recognized that ground water quality has been impacted by the site there are no known wells downgradient of the site. Since the risk assessment must address both current and possible future land-use conditions, and ground water is currently used in the area of the site, exposure from ingestion of contaminated ground water was evaluated. Exposure from ingestion involves the use of ground water for drinking and cooking.

Ingestion of surface water during recreational use is also a possible exposure route. However, the stream is very shallow and exposure by this route is unlikely. Although the potential does exist for contamination to extend to the Oswego River, the risk is considered to be very low. Based on the low levels of contaminants found in the samples collected directly downstream of the Drum Disposal Area, the fate and transport of these contaminants and dilution factors associated with the River, the risk via the ingestion route is considered to be very low. Therefore exposure by ingestion of surface water was not included in the quantitative portion of the risk assessment.

Future use of surface water or ground water for irrigation purposes is unlikely. The area surrounding the site is mainly residential with some small businesses. There presently is no known use of either ground water or surface water in the area as an irrigation source, therefore, the potential for future use is also unlikely.

Trespassers may be exposed to analytes of potential concern in the surface soil or dust by incidental ingestion. Therefore, exposure via this route was quantitatively evaluated.

Three potential food chain transport exposure modes were also considered as possible exposure pathways. The food chain transport modes considered included, exposure to humans from consumption of fish, deer and rabbit.

DERMAL CONTACT Dermal contact via exposure to the sediment and the surface water in the three site ponds and the unnamed stream is also possible during recreational use. The unnamed stream is very shallow, and during the summer Ponds 1 and 2 tend to be dry and the level in Pond 3 is relatively low. Also, no waders have been observed in the stream or ponds. Therefore, exposure to stream sediment and/or surface water would be infrequent. Although contact is considered to occur infrequently, the risks associated with dermal contact with the stream sediment and surface water were evaluated. The potential does exist for contamination to extend to the Oswego River, but based on the low levels detected in the samples collected furthest downstream of the Drum Disposal Area and the dilution factors associated with the River, the risk is considered to be very low (lower than that associated with contact with ponds and streams). Therefore, it was not quantitatively evaluated.

Contaminants were detected in the surface soil in the Drum Disposal Area. A soil cover was placed over the most contaminated and accessible areas. Since direct contact with the remaining contaminated surface soil is possible, this route of exposure was quantitatively evaluated.

As discussed in the ingestion subsection, future use of ground water is possible, therefore, dermal contact with ground water during bathing was evaluated.

INHALATION Inorganics are the major contaminants of concern in the Drum Disposal Area. Other than the common laboratory contaminants, only low levels of volatile organics were detected in the ground water. Therefore, inhalation hazards associated with present land use were not considered to be of concern and were not evaluated.

As discussed in previous subsections, no known residential wells are located directly downgradient of the Drum Disposal Area. However, since ground water is used in the area, future use of ground water was considered. Therefore, since volatile organics are present in the ground water, possible future use of ground water may result in volatilization of organics during showering, therefore, this pathway was evaluated.

Upon review of the initial submission of this report, the NYSDEC and NYSDOH requested that inhalation of lead in surface soils by trespassers such as cyclists be considered. Although the potential for exposure via this pathway is possible, it was not quantitatively evaluated. Since health risks associated with incidental ingestion of soil were identified in the initial submission of this report, remediation of this area is already planned.

4.2 ESTIMATION OF CONTAMINANT INTAKES

Ten human exposure pathways were selected to be quantitatively evaluated in this risk assessment.

Chronic daily intake (CDIs) for each of the indicator parameters for both carcinogenic and noncarcinogenic effects are shown on Table 4-2. The CDIs are grouped by pathway. The equations and variable values used to calculate the CDIs are shown in Appendix F. For carcinogenic effects, it is assumed that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime. Therefore, it is critical that the full exposure period be considered to develop a lifetime average daily intake. For noncarcinogenic effects, intakes are calculated by averaging the intake over the period of exposure.

To calculate intakes, the USEPA recommends that the greatest exposure that may be reasonably expected to occur at a site be used in the risk assessment. For example the upper confidence limit (i.e., the 95 percent upper confidence limit) on the arithmetic average be used as the representative concentration of contaminants. Alternatively, for a screening level approach, the USEPA recommends using the maximum levels. The latter approach was used in this risk assessment. The equations and variables used in the calculation of the intakes are shown in Appendix F. Standard assumptions regarding exposure frequency and duration as outlined in USEPA guidance are used. Additional assumptions used are outlined below:

GENERAL

- The risk assessment assumes steady-state concentration because the information needed to estimate non-steady state conditions (such as source depletion rate) is not readily available. This is an element of uncertainty that may have caused an overestimation of exposures.

DERMAL CONTACT

- Based on the climate of the area, the outdoor contact with surface water, sediment and soil is limited to the spring, summer and autumn months. Therefore, 247 days was used to represent the annual exposure period.

- The exposure duration used for dermal contact with surface water and sediment was 2.6 hours/day (national average for swimming). This value is extremely conservative. It is unlikely that exposure time to surface water and sediment would be this high. Therefore, the intakes presented will be overestimated.

- The exposure duration used for contact with surface soil was 4 hours. This is also extremely conservative.

- In the skin absorption calculations for contact with contaminated ground water or surface water, the permeability constant for water is used as a default value to estimate the absorbed dose from skin contact. This approach may underestimate dermal permeability for some organics and overestimate the permeability of metals.

- For the skin absorption calculations for contact with sediment and soil, literature values for absorption for each analyte if available was used. If no literature values were found, a default value of one (1) was used. Using the default value of 1 will tend to overestimate risks. The percent absorption value used in the intake calculations for each analyte evaluated is presented at the end of Appendix F.

INGESTION

- The USEPA guidance suggests that, in general, the 95 percent upper confidence limit on the arithmetic average of data be used to obtain reasonably realistic exposure scenarios. However, since the validated data base is considered to be small, the upper confidence limit on the average concentration will be high and will result in values above the maximum levels detected on site. In these cases the USEPA recommends that the screening level approach (maximum concentrations) be used to estimate exposure concentrations.

- The maximum levels detected in the ground water samples were used in the intake calculations. These maximum values detected were from samples collected from wells that do not serve as drinking water supply wells. Site wells are normally preferentially located within the contaminant 'hot spot' areas, so use of these values will lead to a deliberate overestimate of intakes.

- The evaluation of intake of metals by trespassers (hunters) due to consumption of deer and rabbit is divided into two calculations. First the uptake from plants to deer and rabbit is calculated using the analytical results of the site vegetation sampling. These results, along with bioconcentration factors

(BCFs), were used to estimate concentrations of the inorganics of concern in deer and rabbit (see Appendix E). The second step is to determine uptake by hunters due to consumption of meat (deer and/or rabbit). It is assumed that both species receive all their food from the hazardous area of the site. Since the home range for deer and rabbit is up to 1 mile and 20 acres respectively and since both species feed on a variety of vegetation, calculations for uptake from vegetation are considered to be extremely conservative.

- To estimate the intake for fishermen who consume fish caught at the site, the maximum levels detected in the fish samples (all 3 species captured) collected in the hazardous area were used. It was assumed that the diet fraction of fish collected from the site was small (less than 20%). Both assumptions are considered to be extremely conservative since only small water bodies are located on-site and because it is unlikely that a fisherman would obtain all fish from same source. In addition it should be noted that pumpkinseed is the only species that was captured that is normally consumed by humans.

- The daily intake calculations for uptake of metals to humans did not include an absorption factor. Since metals are poorly absorbed these estimates are extremely conservative.

INHALATION

- For the evaluation of inhalation exposure to organic contaminants during showering, it is first necessary to estimate airborne organic chemical concentrations in the room. This was done by assuming that all organics contained in the ground water become airborne in the shower area and are dispersed uniformly throughout an unvented room with the door closed. The equation used for this calculation is presented in Appendix F. The maximum contaminant levels in ground water were used to determine the daily intakes. The estimated airborne concentrations are then used to predict contaminant intake from inhalation. As in the ingestion scenario, use of maximum levels will over estimate the potential future risks by this exposure route.

5.0 RISK CHARACTERIZATION

The final step in the risk assessment process is risk characterization. In this step the toxicity and exposure assessments are summarized to provide quantitative estimates of the upper bound public health risks. The estimates of carcinogenic and noncarcinogenic risks are presented separately. It should be noted that the risks are upper bound risks. Extremely conservative items have been incorporated into the analysis, therefore, the risks are deliberately overestimated.

5.1 NONCARCINOGENIC RISKS

HAZARD QUOTIENTS To determine the potential for noncarcinogenic effects, the maximum CDI is compared with the reference dose (or reference concentration). The reference dose is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. The ratio of CDI to the reference dose is called a hazard quotient. The noncancer hazard quotient assumes that there is a level of exposure below which adverse health effects are unlikely. If the hazard quotient exceeds unity (1), there may be concern for potential noncancer effects. It is important to bear in mind that hazard quotients are fractions of threshold doses and not probabilities of an event.

The hazard quotients for current and future pathways of concern are presented in Tables 5-1 and 5-2, respectively.

> **CURRENT LAND USE** The hazard quotients for incidental ingestion of the surface soil, dermal contact with surface water and ingestion of deer, rabbit and fish were below one for each indicator parameter. Therefore, there is no evidence that adverse noncarcinogenic health effects would result from incidental ingestion of the maximum levels of individual analytes in the surface soil, from dermal contact with the surface water or from consumption of deer, rabbit or fish from the site. Three hazard quotients associated with dermal contact with sediment and dermal contact with soil exceeded unity. The hazard quotients along with the critical effects are shown on Table 5-1.

POSSIBLE FUTURE LAND USE The hazard quotients for those analytes evaluated for ingestion of ground water, inhalation of chemicals volatilized during showering and dermal contact during bathing were all below unity. This indicates that no adverse effects would result from exposure to individual analytes from these pathways. The hazard quotients for each analyte along with the critical effects are presented on Table 5-2.

HAZARD INDICES To assess the overall potential for noncarcinogenic effects to a mixture of chemicals, a hazard index is used. The hazard index is equal to the sum of the hazard quotients for those chemicals having similar toxicological effects. The hazard indices for both present and possible future pathways is presented in Tables 5-3 and 5-4, respectively. To determine the combined impact of each pathway, the hazard indices are summed for both trespassers who may hunt and/or fish on site and those trespassers that do not hunt or fish on-site. These total indices were presented separately since hunters/fisherman would only represent a small subpopulation of the trespassers.

CURRENT LAND USE The hazard indices for dermal contact with surface water, incidental ingestion of surface soil and ingestion of deer, rabbit and fish were below one for each of the toxicological effects. This indicates that no adverse effects would result if exposure occurred by these routes. Hazard indices for dermal contact with surface soil and sediment exceeded unity for some toxicological effects. The hazard index for dermal contact with surface soil exceeded unity for liver effects. The major constituent contributing to the hazard index was bis(2-ethylhexyl)phthalate. It should be noted that this is an extremely conservative estimate. Studies have shown that this analyte is poorly absorbed through the skin. However, no dermal absorption fraction was found in the literature and a default value of one was used. The hazard index for dermal contact with sediment were exceeded for both blood effects and reduced body and organ weight effects. The major constituents contributing to these risks were zinc and nickel respectively. The additional exposure pathways for the hunters/fisherman did not result in significant increases in the total hazard index.

POSSIBLE FUTURE LAND USE The hazard indices for exposure to ground water were below one for each of the toxicological effects. The indices along with the critical effects are shown on Table 5-4.

5.2 CARCINOGENIC RISKS

To determine the potential for carcinogenic effects, risks are estimated as the incremental probability of an individual developing cancer over a lifetime. The slope factor (SF) converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risks of an individual developing cancer. At low-level environmental concentrations the dose-response relationship is assumed to be linear. Thus, carcinogenic risk is estimated as the product of the CDI and the SF. Generally, the SF represents a 95th percentile upper confidence limit of the probability of response and is considered an "upper-bound" estimate. This means that the true risk is unlikely to exceed the estimate and is likely to be less than that predicted.

To predict the combined impact of chronic exposure to a mixture of suspect carcinogens, the risk levels, which are probabilities of an individual developing cancer, may be summed for each exposure pathway.

CURRENT LAND USE Cancer risk estimates for dermal contact with surface water, sediment, surface soil and incidental ingestion of surface soil are shown on Table 5-5. Slope factors were only available for bis(2-ethylhexyl)phthalate and arsenic. Based on the available data, the cancer risk associated with dermal contact with sediment is 1×10^{-5}, while the cancer risk associated with dermal contact with surface soil and incidental ingestion of surface soil is 3×10^{-5} and 9×10^{-8}. This indicates a possible cancer risk of 1 in 100,000 for contact with sediment, 3 in 100,000 for dermal contact with surface soil and 9 in 100,000,000 for incidental ingestion of soil.

POSSIBLE FUTURE LAND USE Cancer risk estimates for specific chemicals and combined ground water pathway risks are presented in Table 5-6. The estimated cancer risks associated with TCE are 1×10^{-10}, 4×10^{-7} and 3×10^{-5} for dermal contact, ingestion and inhalation, respectively. This indicates that the largest cancer risks to ground water exposure is associated with inhalation. The results of the analysis of the potential risks associated with all ground water pathways shows the total risk to be 3 x 10^{-5}.

5.3 ASSESSMENT OF LEAD EXPOSURE

NONCARCINOGENIC RISKS Lead exposure is typically evaluated, not by comparison with reference doses, but by considering changes in blood lead levels. Blood lead levels (PbB) are reported in micrograms of lead per deciliter of blood (ug/dl). Children represent a sensitive segment of the population with respect to lead toxicity.

The USEPA's Clean Air Scientific Advisory Committee has concluded that 10 to 15 ug/l PbB is associated with the onset of effects that "may be argued as becoming biomedically adverse" (CDC, 1988).

The USEPA originally proposed a "maximum contaminant level goal" (MCLG) for lead in drinking water based on blood lead levels thought to cause the most subtle effects in young children, and calculated an acceptable drinking water exposure assuming that 100 percent of human exposure to lead was from drinking water.

In proposing the MCLG, USEPA assumed a PbB concentration of 15 ug/dl is a level of concern. A factor of 6.25 was then used to convert from PbB to lead in drinking water, and an exposure concentration of 94 ug/l was calculated. A safety factor of 5 was used to derive an MCLG of 20 ug/l. This level, translated to a long term lead intake, is equivalent to 5.7 E-04 mg/kg-day. If a lower level of concern (10 ug/dl) is used, the intake is 3.8 E-04 mg/kg-day instead. This reference intake level may be used as a means of comparing the magnitude of chronic intake levels associated with the lead exposure from Drum Disposal Area, as below:

EXPOSURE PATHWAY	LEAD INTAKE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
<u>Present Land Use</u>			
Skin Absorption in Surface Water	3.4 x 10^{-4}	3.8 x 10^{-4}	0.89
Skin Absorption in Sediment	___	3.8 x 10^{-4}	___
Skin Absorption in Soil	___	3.8 x 10^{-4}	___

EXPOSURE PATHWAY	LEAD INTAKE (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD INDEX
Ingestion of deer	1.9×10^{-5}	3.8×10^{-4}	0.05
Ingestion of rabbit	1.7×10^{-7}	3.8×10^{-4}	4.5×10^{-4}
Ingestion of fish	8.3×10^{-5}	3.8×10^{-4}	0.22
<u>Possible Future Land Use</u> Ingestion of Ground Water	2.3×10^{-3}	3.8×10^{-4}	6.1
Skin Absorption in Ground Water During Bathing	8.0×10^{-7}	3.8×10^{-4}	0.02

As indicated, the hazard index is elevated for ingestion of lead in ground water from the site.

INGESTION OF LEAD IN SOIL Exposure to lead in soil may be examined with respect to increased PbB levels. The USEPA has estimated an increase of 0.6 to 6.8 ug/dl PbB in children for each 1,000 part per million (ppm) increase in soil lead (USEPA, 1986). The following table shows the maximum concentration of lead found in the uncovered surface soil at the Columbia Mills Site, resultant blood lead levels and the percent of the total PbB based on USEPA threshold levels as established by the USEPA Clean Air Scientific Advisory Committee.

MAXIMUM SURFACE SOIL LEAD CONCENTRATION (ppm)	RESULTANT PbB LEVELS (ug/dl)	PERCENT OF PbB THRESHOLD LEVEL (10 ug/dl)
5,000	3-34	30-340

As indicated above, exposure to lead in on-site soils would potentially represent a significant hazard to children.

A recent study to derive a permissible "safe" soil lead level concluded that 600 ppm of lead in soil would contribute no more than 5 ug/dl PbB in children under 12 years of age and hence would be protective of health (Madhaven, 1989). The maximum level of lead detected in the surface soil at the Columbia Mills site is over eight times this value.

CARCINOGENIC RISKS The USEPA has classified lead as a probable human carcinogen because some lead compounds cause tumors in experimental animals, and has assigned zero as the current MCLG for lead. Despite these actions, the USEPA recommends that quantitative estimates of the carcinogenic potency of lead not be used for the purposes of risk assessment.

5.4 ASSESSMENT OF DIOXIN AND FURAN EXPOSURE

All of the PCDDs and PCDFs encountered at Columbia Mills were of the non-2,3,7,8- configuration. The only exceptions are OCDD and OCDF which have all positions substituted with chlorines, including 2,3,7,8. These are assigned a TEF value of 0.001, indicating minimal toxicity relative to 2,3,7,8-TCDD. The TEQs for the Drum Disposal Area soil are therefore 0.62, 3.2 and 0.355 parts per trillion, respectively, as indicated below:

Parameter	TEF	Soil - 1		Soil - 2		Soil - 3	
		ppt	ppt x TEF	ppt	ppt x TEF	ppt	ppt x TEF
OCDD	0.001	510	0.51	2100	2.1	330	0.33
OCDF	0.001	110	0.11	1100	1.1	25	0.025
	TEQ ->		0.62		3.2		0.355

Recent studies have identified trace (parts per trillion) concentrations of PCDDs and PCDFs in soils throughout the world, with OCDD generally being a major component of the mixture. In many cases, there is no source attributable to these low levels, which may be a function of the increased combustion of wood, waste and fossil fuel in recent decades, and atmospheric dispersion of combustion-derived particles. A compilation of current soils data from the U.S., Canada, Great Britain, Denmark, Italy, Austria and Switzerland indicated mean concentrations and standard deviations for TEQs in soils as follows: 0.4 ppt TEQ (+/- 0.6 ppt) for rural soils; 11.3 ppt TEQ (+/- 21.8 ppt) for urban soils; and 40.8 ppt TEQ (+/- 33.1 ppt) for industrial soils (Birmingham, 1990). Within this context, the Columbia Mills Drum Disposal Area soil results are typical of rural - urban soils. These parts-per-trillion values can be evaluated in the context of a proposed health-protective 1 part per billion (1,000 parts per trillion) TEQ multimedia soil guideline (JCCSHEO, 1989). The Columbia Mills TEQ values are less than 1/300 of this guideline.

6.0 SUMMARY

The human health evaluation provides a screening level approach to measuring the risks associated with direct contact with the Drum Disposal Area "hot spots" (surface water, sediment and surface soil), hunting and fishing on-site and possible future use of the ground water. The maximum concentrations detected in each media were selected for analysis. The following potential routes of exposure were or will be assessed.

Site Risks

1. Dermal contact with surface water.
2. Dermal contact with sediment.
3. Dermal contact with surface soil.
4. Incidental ingestion of surface soil.
5. Consumption of fish.
6. Consumption of deer/rabbit.

Future Risks

7. Exposure to contaminants in drinking water.
8. Skin contact with contaminants during bathing.
9. Inhalation of contaminants which may volatilize during showering.

The magnitude of the cancer risks and concancer hazard indices was estimated and may be related to Superfund site remediation goals [noncancer hazard index of 1.0 and the termination criteria (cancer risk of 10^{-6})].

Carcinogenic Risks

The cancer risks which were quantified were above the Superfund site remediation goals for three pathways. The pathways and the major contributors to the risks are summarized in the following table.

PATHWAY	MAJOR CONTRIBUTOR TO RISK
Dermal contact with sediment.	Arsenic
Dermal contact with surface soil.	Bis(2-ethylhexyl)phthalate
Inhalation of volatile organics during showering.	Trichlorethene

Non-Carcinogenic Risks

The noncancer hazard indices were in excess of the site remediation goals (hazard index of 1.0) for four pathways. The pathways included dermal contact with sediment, dermal contact with surface soil, incidental ingestion of surface soil and ingestion of ground water. The major contributors to the noncancer risks are indicated in the table presented below.

PATHWAY	MAJOR CONTRIBUTOR TO RISK
Dermal contact with sediment.	Nickel and Zinc
Dermal contact with surface soil.	Bis(2-ethylhexyl)phthalate
Incidental ingestion of surface soil.	Lead
Ingestion of ground water.	Lead

REFERENCES

1. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Arsenic. Final. U.S. Public Health Service, Atlanta, GA.

2. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Cadmium. Final. ATSDR/TP-88108. U.S. Public Health Service, Atlanta, GA.

3. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Chromium. Final. U.S. Public Health Service, Atlanta, GA.

4. Agency for Toxic Substances and Disease Registry, 1990. Toxicological Profile for Copper. Draft. U.S. Public Health Service, Atlanta, GA.

5. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Cyanide. U.S. Public Health Service, Atlanta, GA.

6. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Di(2-ethylhexyl)phthalate. Final. ATSDR-TP-88/15. U.S. Public Health Service, Atlanta, GA.

7. Agency for Toxic Substances and Disease Registry, 1990. Toxicological Profile for Lead. Final. U.S. Public Health Service, Atlanta, GA.

8. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Nickel. Final. U.S. Public Health Service, Atlanta, GA.

9. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Phenol. U.S. Public Health Service, Atlanta, GA.

10. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. Draft. U.S. Public Health Service, Atlanta, GA.

11. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for 2,3,7,8-Tetrachlorodibenzo-p-Dioxin. ATSDR/TP-88/23. U.S. Public Health Service, Atlanta, Georgia.

12. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Toluene. Draft. U.S. Public Health Service, Atlanta, GA.

13. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Trichloroethene. Final ATSDR/TP-88/24. U.S. Public Health Service, Atlanta, GA.

14. Agency for Toxic Substances and Disease Registry, 1989. Toxicological Profile for Zinc. Final. U.S. Public Health Service, Atlanta, GA.

15. Angle, C.R., A. Marcus, I.H. Cheng and M.S. McIntire, 1984. Omaha Childhood Blood Lead and Environment Lead: A Linear Total Exposure Model. Environmental Research (35):160-170.

16. Birmingham, B., 1990. Analysis of PCDD and PCDF Patterns in Soil Samples: Use in the Estimation of the Risk of Exposure. Chemosphere, Vol. 20, pp 807-814.

17. Centers for Disease Control, 1988. Childhood Lead Poisoning - United States: Report to the Congress by the Agency for Toxic Substances and Disease Registry. Leads from the Morbidity and Mortality Weekly Report (MMWR). J. American Medical Association. 260 (11): 1523-1533.

18. Clement Associates, Inc. 1985. Chemical, Physical and Biological Properties of Compounds Present at Hazardous Waste Sites. Prepared for U.S. Environmental Protection Agency. Clement Associates, Inc., Arlington, VA.

19. Cleyton, G.D., and F.E. Clayton. Patty's Industrial Hygiene and Toxicology. Third Revised Edition, Volume A: Toxicology. New York, John Wiley & Sons, 1981.

20. Feldman, R.J. and Maibach, H.I., Absorption of some organic compounds through the skin in men, J. Invest. Derm. 54: 399, 1976.

21. Howard, P.H., ed. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. I, Michigan: Lewis Publishers, 1989.

22. Howard, P.H., ed. Handbook of Environmental Fate and Exposure Data For Organic Chemicals, Vol. II, Michigan: Lewis Publishers, 1989.

23. Joint Consultative Committee of Senior Health and Environment Officials (Canada), 1989. Accepted Interim Apportionment of Exposure and Guidelines for Polychlorinated Dibenzo-p-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF), as cited in Birmingham, 1990.

24. Lang, E.P. and Kunze, F.M., The penetration of lead through the skin J. Ind. Hyg. Tox. 30: 256, 1948.

25. Madhavan, S., K.D. Rosenman, T. Shehata, 1989. Lead in Soil: Recommended Maximum Permissible Levels. Environmental Research. (49):136-142.

26. New York State Atlas of Community Water System Sources.

27. New York State Drinking Water Regulations, State Sanitary Code, Part 5.

28. New York State Water Classifications and Quality Standards, 6 NYCRR Parts 701, 702 and 703.

29. OSHA, Industrial Exposure and Control Technologies for OSHA Regulated Hazardous Substances, Volume 1, US Department of Labor, Washington, D.C., March 1989.

30. U.S. Department of Health and Human Services, 1989. Fifth Annual Report on Carcinogens.

31. USEPA, Drinking Water Regulations, 40 CFR 141.

32. USEPA, Exposure Factors Handbook, 1989.

33. USEPA, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA/540/6-89/004, October 1988.

34. USEPA, Health Effects Assessment Summary Tables. Fourth Quarter FY: 1990, September 1990.

35. USEPA, Integrated Risk Information System (IRIS), 1991.

36. USEPA, 1989. Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDS and CDFs) and 1989 Update. EPA/625/3-89/016. Risk Assessment Forum, Washington, D.C.

37. USEPA, Quality Criteria for Water, as updated, EPA-440/5-86-001, May 1987.

38. USEPA, Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual. Part A. December 1989.

39. USEPA, Risk Assessment Guidance for Superfund. Volume I, Human Health Evaluation Manual. Supplemental Guidance. "Standard Default Exposure Factors". Interim Final. March 1991.

40. Walhberg J.E., Percutaneous absorption of radioactive strontium chloride Sr-89 (89 Sr Cl_2). A comparison with 11 other metal compounds. Arch. Derm. 97 336, 1968.

41. World Health Organization, 1987. PCDD and PCDF Emissions from Incinerators for Municipal Sewage Sludge and Solid Waste - Evaluation of Human Exposure. Regional Office for Europe, Copenhagen, DN.

TABLES

MALCOLM
PIRNIE

TABLE 1-1

FINAL INDICATOR CHEMICAL SELECTION LIST

	Ground Water	Sediment	Surface Water	Surface Soil	Vegetation	Fish Tissue
Toluene	X					
Trichloroethene	X					
Bis(2-ethylhexyl)phthalate		X		X		
Phenol		X		X		
PAHs						
cPAHs	X	X				
Phenanthrene	X	X		X		
Fluoranthene	X	X		X		
Pyrene	X	X		X		
Dioxins/Furans				X		
Antimony		X				
Arsenic		X				
Cadmium		X	X	X	X	X
Chromium		X	X	X	X	X
Copper		X	X			X
Lead	X	X	X	X	X	X
Nickel		X	X	X	X	X
Manganese	X	X				
Zinc	X	X	X	X	X	X
Cyanide	X	X				

Note: cPAHs refers to Carcinogenic PAHs.

TABLE 2-1
TOXICITY VALUES:POTENTIAL NONCARCINOGENIC EFFECTS

Chemical	RfD (mg/kg/day) [sub chronic]	Confidence Level	Critical Effect	RfD Source	Uncertainty & Modifying Factors
Oral Route					
Trichloroethene	Under review	--	--	IRIS	--
Toluene	2E-01 [2E-00]	Medium	Changes in liver & kidney weights	IRIS [HEA]	UF=1000,MF=1 [UF=100,MF=1]
Bis(2-ethylhexyl)phthalate	2E-02 [2E-02]	Medium	Increased relative liver weight	IRIS [HEA]	UF=1000,MF=1 [UF=100,MF=1]
Phenol	6E-01 [6E-01]	Low	Reduced fetal body weight	IRIS & HEA [HEA]	UF=100,MF=1 [UF=100,MF=1]
PAHs					
cPAHs	--	--	--	IRIS & HEA	--
Fluoranthene	4E-02 [4E-01]	Low	Nephropathy, liver weight changes and hematological changes	IRIS & HEA [HEA]	UF=3000,MF=1 [UF=3000,MF=1]
Phenanthrene	--	--	--	IRIS & HEA	--
Pyrene	3E-02 [3E-01]	Low	Renal effects	IRIS & HEA [HEA]	UF=3000,MF=1 [UF=300,MF=1]
Antimony	4E-04 [4E-04]	Low	Reduced lifespan, altered blood chemistries (blood glucose & cholesterol)	IRIS [HEA]	UF=1000,MF=1 [UF=1000,MF=1]
Arsenic	1E-03 [1E-03]	--	Keratosis and hyperpigmentation	HEA [HEA]	UF=1,MF=1 [UF=1,MF=1]
Cadmium	5E-04(water) 1E-03(food) [Not determined]	High	Renal damage [Not Applicable]	IRIS & HEA [HEA]	UF=10, MF=1 [Not Applicable]
Chromium					
Chromium III	1E+00 [1E+01]	--	Hepatotoxicity	HEA [HEA]	UF=1000,MF=1 [UF=100,MF=1]
Chromium VI	5E-03 [2E-02]	Low	Not defined	IRIS & HEA [HEA]	UF=500,MF=1 [UF=100,MF=1]
Copper	3.7E-02* [3.7E-02]*	--	Local GI irritation	HEA [HEA]	Not Applicable [Not Applicable]
Nickel	2E-02 [2E-02]	--	Reduced body & organ weight	HEA [HEA]	UF=100,MF=3 [UF=100,MF=3]
Manganese	1E-01 [1E-01]	Medium	CNS effects [No effect]	IRIS [HEA]	UF=1,MF=1 [UF=100,MF=1]
Lead	--	--	--	IRIS & HEA	--
Zinc	2E-01 [2E-02]	--	Anemia	HEA [HEA]	UF=10,MF=1 [UF=10,MF=1]
Cyanide	2E-02 [2E-02]	Medium	Weight loss,thyroid & myelin degeneration	IRIS & HEA [HEA]	UF=100,MF=5 [UF=100,MF=5]

TABLE 2–1
TOXICITY VALUES:POTENTIAL NONCARCINOGENIC EFFECTS

Chemical	RfC (mg/kg/day) [sub chronic]	Confidence Level	Critical Effect	RfC Source	Uncertainty & Modifying Factors
Inhalation Route					
Trichloroethene	Under review	--	--	IRIS	--
Toluene	2E+00	--	CNS effects,eyes and nose irritation	HEA	UF=100,MF=1

NOTE:
-- = No data available
All information in [ ] refers to subchronic RfDs
RfD - Oral reference dose
RfC - Inhaltion reference concentration
RfD is expressed as administerd dose in drinking water, with an assumed absorption fraction of 1.0
Uncertainty adjustments - for extrapolation from H,A,S and L
  H=Variation in human sensitivity
  A=Animal to human extrapolation
  S=Extrapolation from subchronic to chronic NOAEL
  L=Extrapolation from LOAEL to NOAEL
cPAHs refers to carcinogenic PAHs
* - Based on current drinking water standard (1.3 mg/l). Documentation concluded toxicity data were inadequate for calculation of an RfD for Copper.

TABLE 2-2
TOXICITY VALUES:POTENTIAL CARCINOGENIC EFFECTS

CHEMICAL	Slope Factor (SF) (mg/kg/day)-1	Weight-of-Evidence Classification	Type of Cancer	SF Basis/ SF Source
Oral Route				
Trichloroethene	1.1E-2	B2	Liver	/HEA
Toluene	--	D	--	/IRIS
Bis(2-ethylhexyl)phthalate	1.4E-02	B2	Liver	/IRIS
Phenol	--	D	--	/IRIS
PAHs				
Benzo(a)pyrene	--	B2	Stomach & lung	/HEA & IRIS
Fluoranthene	--	D	--	/IRIS
Phenanthrene	--	D	--	/IRIS
Pyrene	--	D	--	/IRIS
Antimony	--	--	--	/IRIS
Arsenic	2.0E+00*	A	Skin	Water/IRIS
Cadmium	--	**	--	/HEA & IRIS
Chromium				
Chromium III	--	--	--	/HEA
Chromium VI	--	**	--	/HEA & IRIS
Copper	--	D	--	/IRIS
Lead	--	B2	--	/IRIS
Manganese	--	D	--	/IRIS
Nickel	--	**	--	/HEA & IRIS
Zinc	--	D	--	/IRIS
Cyanide	--	D	--	/IRIS
Inhalation Route				
Trichloroethene	1.7E-2	B2	Lung	/HEA
Toluene	--	D	--	/IRIS

NOTE:
Slope factor based on administered dose in drinking water and assumed absorption factor of 1.0
-- = No data
IRIS: Intergrated Risk Information System (USEPA, 1991)
HEA: USEPA, Fourth Quarter 1990
A = Human carcinogen
B2 = Probable human carcinogen
C = Possible human carcinogen
D = Not classifiable as to human carcinogenicity
* = Based on a unit risk factor of 5E-5(ug/l)-1.
** = Carcinognic by inhalation route, inadequate evidence by oral route.

TABLE 4-1

POTENTIAL EXPOSURE ROUTES

DRUM DISPOSAL AREA

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM AND EXPOSURE POINT	PATHWAY SELECTED FOR QUANTITATIVE EVALUATION	REASON FOR SELECTION OR EXCLUSION
CURRENT LAND USE Trespassers	Direct contact with surface water (ponds, stream).	Yes	Contact with surface water is possible.
	Ingestion of surface water (ponds, stream).	No	Surface water is not used as a drinking or irrigation source. The intermittent stream is too shallow for swimming. During the summer Ponds 1 and 2 are dry and Pond 3 is also very low.
	Direct contact with sediment in ponds and stream.	Yes	Contact with sediment is possible.
	Direct contact with surface soil.	Yes	Contact with surface soil is possible.
	Ingestion of surface soil.	Yes	Accidental ingestion of dust is possible.
	Exposure to humans from consumption of fish.	Yes	Fishing in on-site ponds is possible.
	Exposure to humans from consumption of rabbits and deer.	Yes	Hunting on-site is possible.
FUTURE LAND USE Residents	Ingestion of ground water from wells downgradient of site.	Yes	Although, no wells downgradient of the site appear to be affected by the Drum Disposal Area, ground water is currently used in the area. Therefore, future use of ground water as a drinking water source was considered.
	Inhalation of chemicals volatilized from ground water during showering.	Yes	Some of the chemicals of potential concern in ground water at the site area volatile and ground water may (in the future) be used by local residents.
	Direct contact of chemicals in ground water while bathing.	Yes	Downgradient ground water may be used by residents in the future.

TABLE 4-2
CHRONIC DAILY INTAKES

POPULATION	EXPOSURE PATHWAY	CHEMICAL	CHRONIC DAILY INTAKE (mg/kg/day)	
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS
Trespassers	Skin absorption of chemicals from contact with surface water	Cadmium	2.2E-05	NA
		Chromium	9.8E-07	NA
		Copper	3.9E-05	NA
		Lead	3.4E-04	2.5E-05
		Nickel	3.4E-06	NA
		Zinc	9.8E-03	NA
	Skin absorption of chemicals from contact with sediment	Phenol	8.4E-05	NA
		Bis(2-ethylhexyl)phthalate	7.5E-05	5.3E-06
		cPAHs	2.3E-06	1.6E-07
		Fluoranthene	3.5E-06	NA
		Phenanthrene	3.0E-06	NA
		Pyrene	3.2E-06	NA
		Antimony	1.6E-04	NA
		Arsenic	6.7E-05	4.8E-06
		Cadmium	2.7E-04	NA
		Chromium	6.1E-04	NA
		Copper	7.9E-04	NA
		Lead	0.0E+00	0.0E+00
		Nickel	3.9E-04	NA
		Manganese	3.0E-02	NA
		Zinc	3.6E-02	NA
		Cyanide	2.6E-03	NA
	Skin absorption of chemicals from contact with surface soil	Phenol	3.0E-04	NA
		Bis(2-ethylhexyl)phthalate	2.8E-02	2.0E-03
		Fluoranthene	2.8E-05	NA
		Phenanthrene	7.1E-06	NA
		Pyrene	6.3E-05	NA
		Cadmium	9.4E-05	NA
		Chromium	1.7E-02	NA
		Lead	0.0E+00	0.0E+00
		Nickel	2.1E-04	NA
		Zinc	4.5E-04	NA
	Ingestion of surface soil	Phenol	9.4E-07	NA
		Bis(2-ethylhexyl)phthalate	8.8E-05	6.3E-06
		Fluoranthene	1.3E-06	NA
		Phenanthrene	3.1E-07	NA
		Pyrene	2.8E-06	NA
		Cadmium	9.7E-06	NA
		Chromium	1.3E-03	NA
		Lead	1.6E-03	1.1E-04
		Nickel	2.2E-05	NA
		Zinc	2.8E-05	NA

TABLE 4-2
CHRONIC DAILY INTAKES

POPULATION	EXPOSURE PATHWAY	CHEMICAL	CHRONIC DAILY INTAKE (mg/kg/day)	
			NONCARCINOGENIC EFFECTS	CARCINOGENIC EFFECTS
Trespassers	Ingestion of deer	Cadmium	2.7E-06	NA
		Chromium	2.0E-04	NA
		Lead	4.4E-05	1.9E-05
		Nickel	3.8E-05	NA
		Zinc	3.1E-02	NA
	Ingestion of rabbit	Cadmium	8.7E-09	NA
		Chromium	3.1E-05	NA
		Lead	3.9E-07	1.7E-07
		Nickel	2.9E-06	NA
		Zinc	7.3E-04	NA
	Ingestion of fish	Cadmium	7.1E-05	NA
		Chromium	1.9E-04	NA
		Copper	2.4E-04	NA
		Lead	1.9E-04	8.3E-05
		Nickel	3.6E-04	NA
		Zinc	8.6E-03	NA
Residents	Ingestion of ground water that has migrated from the site	Toluene	1.1E-04	NA
		Trichloroethene	8.6E-05	3.7E-05
		cPAHs	2.8E-04	1.2E-04
		Fluoranthene	8.6E-05	NA
		Phenanthrene	5.7E-05	NA
		Pyrene	8.6E-05	NA
		Lead	2.3E-03	9.8E-04
		Manganese	3.5E-02	NA
		Zinc	1.8E-02	NA
		Cyanide	4.1E-03	NA
	Inhalation of chemicals that have volatilized from ground water during showering	Toluene	4.6E-05	NA
		Trichloroethene	3.4E-05	1.5E-05
	Skin absorption of chemicals from ground water during bathing	Toluene	4.0E-08	NA
		Trichloroethene	3.0E-08	1.3E-08
		cPAHs	9.9E-08	4.2E-08
		Fluoranthene	3.0E-08	NA
		Phenanthrene	2.0E-08	NA
		Pyrene	3.0E-08	NA
		Lead	8.0E-07	3.4E-07
		Manganese	1.2E-05	NA
		Zinc	6.1E-06	NA
		Cyanide	1.4E-06	NA

cPAHs refers to carcinogenic PAHs

NA - Not applicable

TABLE 5–1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from contact with surface water							
Cadmium	2.2E-05	NO	Not determined	Not applicable	HEA	Not applicable	--
Chromium							
Chromium III	9.8E-07	NO	1E+01	Hepatotoxicity	HEA	UF=100 MF=1	9.8E-08
Chromium VI	9.8E-07	NO	2E-02	Not defined	HEA	UF=100 MF=1	4.9E-05
Copper	3.9E-05	NO	4E-02	Local GI irritation	HEA	Not applicable	1.1E-03
Lead	3.4E-04	NO	--	--	IRIS & HEA	--	--
	See Section 5.3 for quantitative evaluation of lead						
Nickel	3.4E-06	NO	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.7E-04
Zinc	9.8E-03	NO	2E-02	Anemia	HEA	UF=10 MF=1	4.9E-01

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from contact with sediment							
Phenol	8.4E-05	NO	6E-01	Reduced fetal body weight	HEA	UF=100 MF=1	1.4E-04
Bis(2-ethylhexyl)phthalate	7.5E-05	NO	2E-02	Increased relative liver weight	HEA	UF=1000 MF=1	3.7E-03
PAHs							
cPAHs as (Benzo(a)pyrene)	2.3E-06	YES	--	--	IRIS & HEA	--	--
Fluoranthene	3.5E-06	YES	4E-01	Nephropathy, liver weight changes & hemotological changes	HEA	UF=3000 MF=1	8.8E-06
Phenanthrene	3.0E-06	YES	--	--	IRIS & HEA	--	--
Pyrene	3.2E-06	YES	3E-01	Renal effects	HEA	UF=300 MF=1	1.1E-05
Antimony	1.6E-04	YES	4E-04	Reduced lifespan, altered blood chemistries (blood glucose & cholesterol)	HEA	UF=1000 MF=1	3.9E-01
Arsenic	6.7E-05	YES	1E-03	Keratosis and hyperpigmentation	HEA	UF=1 MF=1	6.7E-02
Cadmium	2.7E-04	YES	Not determined	Not applicable	HEA	Not applicable	--

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from contact with sediment (continued).							
Chromium							
Chromium III	6.1E-04	YES	1E+01	Hepatotoxicity	HEA	UF=100 MF=1	6.1E-05
Chromium VI	6.1E-04	YES	2E-02	Not defined	HEA	UF=100 MF=1	3.0E-02
Copper	7.9E-04	YES	4E-02	Local GI irritation	HEA	Not applicable	2.1E-02
Lead	0.0E+00	YES	--	--	HEA	--	--
Manganese	3.9E-04	YES	1E-01	No effect	HEA	UF=100 MF=1	3.9E-03
Nickel	3.0E-02	YES	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.5
Zinc	3.6E-02	YES	2E-02	Anemia	HEA	UF=10 MF=1	1.8
Cyanide	2.6E-03	YES	2E-02	Weight loss, thyroid & Myelin degeneration	HEA	UF=100 MF=5	1.3E-01

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from contact with surface soil.							
Phenol	3.0E-04	NO	6E-01	Reduced fetal body weight	HEA	UF=100 MF=1	5.1E-04
Bis(2-ethylhexyl)phthalate	2.8E-02	NO	2E-02	Increased relative liver weight	HEA	UF=1000 MF=1	1.4
Fluoranthene	2.8E-05	YES	4E-01	Nephropathy, liver weight changes & hemotological changes	HEA	UF=3000 MF=1	7.0E-05
Phenanthrene	7.1E-06	YES	--	--	IRIS & HEA	--	--
Pyrene	6.3E-05	YES	3E-01	Renal effects	HEA	UF=300 MF=1	2.1E-04
Cadmium	9.4E-05	YES	Not determined	Not applicable	HEA	Not applicable	--
Chromium							
Chromium III	1.7E-02	YES	1E+01	Hepatotoxicity	HEA	UF=100 MF=1	1.7E-03
Chromium VI	1.7E-02	YES	2E-02	Not defined	HEA	UF=100 MF=1	8.4E-01
Lead	0.0E+00	YES	--	--	IRIS & HEA	--	--
		See Section 5.3 for quantitative evaluation of lead					
Nickel	2.1E-04	YES	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.0E-02

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from contact with surface soil (continued).							
Zinc	4.5E-04	YES	2E-02	Anemia	HEA	UF=10 MF=1	2.3E-02
Exposure Pathway: Incidental ingestion of surface soil							
Phenol	9.4E-07	NO	6E-01	Reduced fetal body weight	HEA	UF=100 MF=1	1.6E-06
Bis(2-ethylhexyl)phthalate	8.8E-05	NO	2E-02	Increased relative liver weight	HEA	UF=1000 MF=1	4.4E-03
Fluoranthene	1.3E-06	NO	4E-01	Nephropathy, liver weight changes & hemotological changes	HEA	UF=3000 MF=1	3.2E-06
Phenanthrene	3.1E-07	NO	--	--	IRIS & HEA	--	--
Pyrene	2.8E-06	NO	3E-01	Renal effects	HEA	UF=300 MF=1	9.3E-06
Cadmium	9.7E-06	NO	Not determined	Not applicable	HEA	Not applicable	
Chromium							
Chromium III	1.3E-03	NO	1E+01	Hepatotoxicity	HEA	UF=100 MF=1	1.3E-04
Chromium VI	1.3E-03	NO	2E-02	Not defined	HEA	UF=100 MF=1	6.5E-02

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Incidental ingestion of surface soil (continued).							
Lead	1.6E-03	NO	--	--	IRIS & HEA	--	--
		See Section 5.3 for quantitative evaluation of lead					
Nickel	2.2E-05	NO	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.1E-03
Zinc	2.8E-05	NO	2E-02	Anemia	HEA	UF=10 MF=1	1.4E-03
Exposure Pathway: Ingestion of deer							
Cadmium	2.7E-06	NO	1E-03	Renal damage	IRIS & HEA	UF=10 MF=1	2.7E-03
Chromium							
Chromium III	2.0E-04	NO	1E+00	Hepatotoxicity	HEA	UF=1000 MF=1	2.0E-04
Chromium VI	2.0E-04	NO	5E-03	Not defined	IRIS & HEA	UF=500 MF=1	4.0E-02
Lead	4.4E-05	NO	--	--	IRIS & HEA	--	--
		See Section 5.3 for quantitative evaluation of lead					
Nickel	3.8E-05	NO	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.9E-03
Zinc	3.1E-02	NO	2E-01	Anemia	HEA	UF=10 MF=1	1.5E-01

TABLE 5–1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Ingestion of rabbit							
Cadmium	8.7E-09	NO	1E-03	Renal damage	IRIS & HEA	UF=10 MF=1	8.7E-06
Chromium							
Chromium III	3.1E-05	NO	1E+00	Hepatotoxicity	HEA	UF=1000 MF=1	3.1E-05
Chromium VI	3.1E-05	NO	5E-03	Not defined	IRIS & HEA	UF=500 MF=1	6.2E-03
Lead	3.9E-07	NO	--	--	IRIS & HEA	--	--
		See Section 5.3 for quantitative evaluation of lead					
Nickel	2.9E-06	NO	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.5E-04
Zinc	7.3E-04	NO	2E-01	Anemia	HEA	UF=10 MF=1	3.6E-03
Exposure Pathway: Ingestion of fish							
Cadmium	7.1E-05	NO	1E-03	Renal damage	IRIS & HEA	UF=10 MF=1	7.1E-02
Chromium							
Chromium III	1.9E-04	NO	1E+00	Hepatotoxicity	HEA	UF=1000 MF=1	1.9E-04
Chromium VI	1.9E-04	NO	5E-03	Not defined	IRIS & HEA	UF=500 MF=1	3.8E-02
Copper	2.4E-04	NO	4E-02	Local GI irritation	HEA	Not applicable	6.5E-03

TABLE 5-1
CURRENT LAND USE
SUBCHRONIC & CHRONIC HAZARD QUOTIENTS
EXPOSURE TO SURFACE WATER, SEDIMENT & SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Subchronic or Chronic RfD (mg/kg/day)	Critical Effect	RfD Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Ingestion of fish (continued).							
Lead	1.9E-04	NO	--	--	IRIS & HEA	--	--
		See Section 5.3 for quantitative evaluation of lead					
Nickel	3.6E-04	NO	2E-02	Reduced body & organ weight	HEA	UF=100 MF=3	1.8E-02
Zinc	8.6E-03	NO	2E-01	Anemia	HEA	UF=10 MF=1	4.3E-02

NOTE:
-- =No data
HEA: USEPA, Fourth Quarter 1990
IRIS: Integrated Risk Information System (USEPA, 1991)
cPAHs =Refers to the carcinogenic PAHs
Shaded areas indicate hazard quotients greater than 1

TABLE 5-2
POSSIBLE FUTURE RISKS
CHRONIC HAZARD QUOTIENTS
GROUND WATER EXPOSURES

Chemical	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Chronic RfD/RfC (mg/kg/day)	Confidence Level	Critical Effect	RfD/RfC Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Ingestion of contaminated ground water								
Toluene	1.1E-04	NO	2E-01	Medium	Changes in liver & kidney weights	IRIS	UF=1000 MF=1	6E-04
Trichloroethene	8.6E-05	NO	Under review	--	--	IRIS	--	--
PAHs								
cPAHs	2.8E-04	NO	--	--	--	IRIS & HEA	--	--
Fluoranthene	8.6E-05	NO	4E-02	Low	Nephropathy,liver weight changes & hematological changes	IRIS & HEA	UF=3000 MF=1	2E-03
Phenanthrene	5.7E-05	NO	--	--	--	IRIS & HEA	--	--
Pyrene	8.6E-05	No	3E-02	Low	Renal effects	IRIS & HEA	UF=3000 MF=1	3E-03
Lead	2.3E-03	NO	--	--	--	IRIS & HEA	--	--
Manganese	3.5E-02	NO	1E-01	Medium	CNS effects	IRIS	UF=1 MF=1	4E-01
Zinc	1.8E-02	NO	2E-01	--	Anemia	HEA	UF=10 MF=1	9E-02
Cyanide	4.1E-03	NO	2E-02	Medium	Weight loss, thyroid & myelin degeneration	IRIS & HEA	UF=100 MF=5	2E-01

TABLE 5–2
POSSIBLE FUTURE RISKS
CHRONIC HAZARD QUOTIENTS
GROUND WATER EXPOSURES

Chemical	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Chronic RfD/RfC (mg/kg/day)	Confidence Level	Critical Effect	RfD/RfC Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Inhalation of chemicals that volatilized during showering								
Toluene	4.6E-05	NO	2E+00	--	CNS effects,eyes and nose irritation	HEA	UF=100 MF=1	2E-05
Trichloroethene	3.4E-05	NO	Under review	--	--	IRIS	--	--
Exposure Pathway: Absorption of chemicals from ground water during bathing								
Toluene	4.0E-08	NO	2E-01	Medium	Changes in liver & kidney weights	IRIS	UF=1000 MF=1	2E-07
Trichloroethene	3.0E-08	NO	Under review	--	--	IRIS	--	--
PAHs								
cPAHs	9.9E-08	NO	--	--	--	IRIS & HEA	--	--
Fluoranthene	3.0E-08	NO	4E-02	Low	Nephropathy,liver weight changes & hematological changes	IRIS & HEA	UF=3000 MF=1	7E-07
Phenanthrene	2.0E-08	NO	--	--	--	IRIS & HEA	--	--
Pyrene	3.0E-08	NO	3E-02	Low	Renal effects	IRIS & HEA	UF=3000 MF=1	1E-06

TABLE 5-2
POSSIBLE FUTURE RISKS
CHRONIC HAZARD QUOTIENTS
GROUND WATER EXPOSURES

Chemical	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	Chronic RfD/RfC (mg/kg/day)	Confidence Level	Critical Effect	RfD/RfC Source	Uncertainty & Modifying Factors	Hazard Quotient
Exposure Pathway: Absorption of chemicals from ground water during bathing (continued)								
Lead	8.0E-07	NO	--	--	--	IRIS & HEA	--	--
Manganese	1.2E-05	NO	1E-01	Medium	CNS effects	IRIS	UF=1 MF=1	1E-04
Zinc	6.1E-06	NO	2E-01	--	Anemia	HEA	UF=10 MF=1	3E-05
Cyanide	1.4E-06	NO	2E-02	Medium	Weight loss, thyroid & myelin degeneration	IRIS & HEA	UF=100 MF=5	7E-05

NOTE:
--=No data available
Shaded areas indicate hazard quotients greater than 1

TABLE 5–3
SUBCHRONIC HAZARD INDICES
EXPOSURE TO SURFACE WATER, SEDIMENT, AND SURFACE SOIL AND INGESTION OF DEER, RABBIT, AND FISH

TOXICOLOGICAL EFFECT	HAZARD INDEX*									ANALYTES CONTRIBUTING TO HAZARD INDEX
	DERMAL CONTACT SURFACE WATER	DERMAL CONTACT SEDIMENT	DERMAL CONTACT SURFACE SOIL	INGESTION SURFACE SOIL	NON–HUNTERS TOTAL FOR ALL 4 PATHWAYS+	INGESTION DEER	INGESTION RABITT	INGESTION FISH	HUNTERS TOTAL FOR ALL 7 PATHWAYS	
Liver Effects	9.8E–08	3.9E–03	1.4	0.028	1.4	2.0E–04	3.1E–05	1.9E–04	1.4	Dermal – Surface water: Chromium Dermal – Sediment: Bis(2–ethylhexyl)phthalate, chromium,fluoranthene Dermal – Surface Soil: Bis(2–ethylhexyl)phthalate, chromium,fluoranthene Ingestion – Surface Soil: Bis(2–ethylhexyl)phthalate, chromium,fluoroanthene Ingestion – Deer: Chromium Ingestion – Rabbit: Chromium Ingestion – Fish: Chromium
GI Irritation	1.1E–05	0.021	—	—	0.021	—	—	6.5E–03	0.028	Dermal – Surface water: Copper Dermal – Sediment: Copper Ingestion – Fish: Copper
Reduced body & Organ Weight	1.7E–04	1.8	0.01	6.5E–03	1.8	1.9E–03	1.5E–04	1.8E–02	1.8	Dermal – Surface water: Nickel Dermal – Sediment: Nickel,cyanide Dermal – Surface Soil: Nickel Ingestion – Surface Soil: Nickel Ingestion – Deer: Nickel Ingestion – Rabbit: Nickel Ingestion – Fish: Nickel
Blood Effects	0.049	2.2	0.023	8.4E–03	2.3	1.5E–01	3.6E–03	4.3E–02	2.5	Dermal – Surface water: Zinc Dermal – Sediment: Fluoranthene, antimony, zinc Dermal – Surface Soil: Fluoranthene, zinc Ingestion – Surface Soil: Fluoranthene, zinc Ingestion – Deer: Zinc Ingestion – Rabbit: Zinc Ingestion – Fish: Zinc
Developmental Effects	—	1.4E–04	5.1E–04	9.4E–06	6.6E–04	—	—	—	6.6E–04	Dermal – Sediment: Phenol Dermal – Surface Soil: Phenol Ingestion – Surface Soil: Phenol
Kidney Effects	—	1.1E–05	2.1E–04	5.6E–05	2.8E–04	2.7E–03	8.7E–06	7.1E–02	0.07	Dermal – Sediment: Pyrene Dermal – Surface Soil: Pyrene Ingestion – Surface Soil: Pyrene Ingestion – Deer: Cadmium Ingestion – Rabbit: Cadmium Ingestion – Fish: Cadmium
Skin Effects	—	6.7E–02	—	—	6.7E–02	—	—	—	6.7E–02	Dermal – Sediment: Arsenic
Reduced Lifespan	—	3.9E–01	—	—	3.9E–01	—	—	—	3.9E–01	Dermal – Sediment: Antimony
Thyroid & Myelin Degeneration	—	1.3E–01	—	—	1.3E–01	—	—	—	1.3E–01	Dermal – Sediment: Cyanide

* Hazard Index = Sum of hazard quotients for analytes which may cause similar toxicological effects

Shaded areas indicate hazard indicies of concern

\+ = Non–hunting/fishing hazard index includes only 4 pathways

TABLE 5–4
CHRONIC HAZARD INDICES
POSSIBLE FUTURE RISKS
EXPOSURE TO GROUNDWATER

TOXICOLOGICAL EFFECT	HAZARD INDEX*				ANALYTES CONTRIBUTING TO HAZARD INDEX	
	INGESTION	INHALATION	DERMAL CONTACT	TOTAL FOR ALL THREE PATHWAYS		
Liver Effects	2.6E-03	--	9E-07	2.6E-03	Ingestion: Dermal Contact:	Toluene, fluoranthene Toluene, fluoranthene
Kidney Effects	3.6E-03	-	1.2E-06	3.6E-03	Ingestion: Dermal Contact:	Toluene, pyrene Toluene, pyrene
Blood Effects	9.2E-03	-	6E-04	9.2E-03	Ingestion: Dermal Contact:	Fluoranthene, zinc Fluoranthene, zinc
CNS Effects	0.4	2E-05	1E-04	0.4	Ingestion: Inhalation: Dermal Contact:	Manganese Toluene Manganese
Weight Loss, Thyroid & Myelin Degeneration	0.2	-	7E-05	0.2	Ingestion: Dermal Contact:	Cyanide Cyanide
Eyes and Throat Irritations	-	2E-05	-	2E-05	Inhalation:	Toluene

* Hazard Index = Sum of hazard quotients for analytes which may cause similar toxicological effects
Shaded areas indicate hazard indicies of concern

TABLE 5–5
CURRENT LAND USE
TOXICITY VALUES:POTENTIAL CARCINOGENIC EFFECTS
EXPOSURE TO LEACHATE AND SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	SF(a) (mg/kg/day)–1	Weight–of–Evidence Classification	Type of Cancer	SF Basis/ SF Source	Chemical Specific Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Absorption of chemicals from contact with surface water									
Lead	2.5E–05	NO	—	B2	—	/IRIS & HEA	—		
Exposure Pathway: Absorption of chemicals from contact with sediment									
Bis(2–ethylhexyl)phthalate	5.3E–06	NO	1.4E–02	B2	Liver	/IRIS	7E–08		
cPAHs	1.6E–07	YES	—	B2	—	/IRIS & HEA	—		
Arsenic	4.8E–06	YES	2.0E+00	A	Skin	Water/IRIS	1E–05		
Lead	0.0E+00	YES	—	B2	—	/IRIS & HEA	—		
								1E–05	
Exposure Pathway: Absorption of chemicals from contact with surface soil									
Bis(2–ethylhexyl)phthalate	2.0E–03	NO	1.4E–02	B2	Liver	/IRIS	3E–05		
Lead	0.0E+00	YES	—	B2	—	/IRIS & HEA	—		
								3E–05	
Exposure Pathway: Ingestion of surface soil									
Bis(2–ethylhexyl)phthalate	6.3E–06	NO	1.4E–02	B2	Liver	/IRIS	9E–08		
Lead	0.0E+00	YES	—	B2	—	/IRIS & HEA	—		
								9E–08	
									4E–05*
Exposure Pathway: Ingestion of deer									
Lead	1.9E–05	NO	—	B2	—	/IRIS & HEA	—		
Exposure Pathway: Ingestion of rabbit									
Lead	1.7E–07	NO	—	B2	—	/IRIS & HEA	—		

TABLE 5-5
CURRENT LAND USE
TOXICITY VALUES:POTENTIAL CARCINOGENIC EFFECTS
EXPOSURE TO LEACHATE AND SURFACE SOIL & INGESTION OF DEER, RABBIT & FISH

CHEMICAL	Maximum CDI (mg/kg/day)	CDI Adjusted for Absorption	SF(a) (mg/kg/day)-1	Weight-of-Evidence Classification	Type of Cancer	SF Basis/ SF Source	Chemical Specific Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Ingestion of fish									
Lead	8.3E-05	NO	—	B2	—	/IRIS & HEA	—		
									4E-05**

NOTE:

Only those analytes which have a slope factor or are classified as an A or B2 carcinogen are included in this table

cPAHs - Refers to carcinogenic PAHs. The maximum CDI is based on the sum of the carcinogenic PAHs.

— =No data available

IRIS: Intergrated Risk Information System (USEPA, 1991)

HEA = USEPA, Fourth Quarter 1990

A = Human carcinogen

B2 = Probable human carcinogen

* - Refers to risk for tresspassers who do not hunt or fish on-site.

** - Refers to risk for tresspassers who do hunt or fish on-site.

TABLE 5–6
POSSIBLE FUTURE RISKS
TOXICITY VALUES:POTENTIAL CARCINOGENIC EFFECTS
EXPOSURE TO GROUND WATER

Chemical	Maximum CDI (mg/kg/day)	CDI Adjusted for absorption	SF(a) (mg/kg/day)–1	Weight–of–Evidence Classification	Type of Cancer	SF Basis/ SF Source	Chemical Specific Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Ingestion of contaminated ground water									
Trichloroethene	3.7E–05	No	1.1E–02	B2	Liver	/HEA	4E–07		
cPAHs	1.2E–04	No	—	B2	Stomach & Lung	/IRIS & HEA	—		
Lead	9.8E–04	No	—	B2	—	/IRIS	—		
								4E–07	
Exposure Pathway: Inhalation of chemicals volatilized during showering									
Trichloroethene	1.5E–03	No	1.7E–02	B2	Lung	/HEA	3E–05		
								3E–05	
Exposure Pathway: Absorption of chemicals from ground water during bathing									
Trichloroethene	1.3E–08	No	1.1E–02	B2	Liver	/HEA	1E–10		
cPAHs	4.2E–08	No	—	B2	Stomach & Lung	/IRIS & HEA	—		
Lead	3.4E–07	No	ND	B2	—	/IRIS	—		
								1E–10	
									3E–05

NOTE:

Only those analytes which have a slope factor or are classified as an A or B2 carcino an A or B2 carcinogen are included in this table.

IRIS: Intergrated Risk Information System (USEPA, 1991)

HEA = USEPA, Fourth Quarter 1990.

— = No data available

A = Human carcinogen

B2 = Probable human carcinogen

FIGURES

MALCOLM
PIRNIE

APPENDICES

MALCOLM
PIRNIE

APPENDIX A

DATA TABLES - GROUNDWATER

MALCOLM PIRNIE

MALCOLM PIRNIE

COLUMBIA MILLS GROUND WATER
DRUM DISPOSAL AREA
FREQUENCY OF DETECTION
- Validated Data -

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS (ug/l)	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)			
				USEPA MCL	NYSDEC MCL	NYSDEC GA-S	NYSDEC GA-G
<u>VOLATILE ORGANICS</u>							
Trichloroethene	1/3	1	3	5	5	5	
Toluene	1/3	1	3J-4*		5	5	50
<u>SEMIVOLATILES</u>							
Phenanthrene	1/3	10-11	2J		50		50
Fluoranthene	1/3	10-11	3J		50		50
Pyrene	1/3	10-11	3J		50		50
Benzo(a)anthracene	1/3	10-11	2J		50		0.002
Chrysene	1/3	10-11	2J		50		0.002
Benzo(b)fluoranthene	1/3	10-11	1J		50		0.002
Benzo(k)fluoranthene	1/3	10-11	0.9J		50		0.002
Benzo(a)pyrene	1/3	10-11	1J		50	ND	
di-n-Butylphthalate	2/3	10-11	2B		50	50	
<u>INORGANICS (TOTAL)</u>							
Aluminum	2/3	84.0	111-147				
Antimony	1/3	22.0	24.8B*				3
Chromium	2/3	2.0	3.0B-6.0B	50	50	50	
Copper	3/3		6.0-10.4*		1000	200	
Iron	3/3		5160J-27900J*		300	300	
Lead	1/3	3.0	80.0J	50	50	25	
Magnesium	3/3		11400J-17700J*				35000
Manganese	3/3		133J-1240J*		300	300	
Zinc	3/3		30.5B-614J*		5000	300	
Cyanide	1/3	10.0	143			100	

Notes:

Samples obtained from B-7D, B-10S and B-10D February 1990. Water was purged from wells one day before sampling to allow water in wells to sit overnight to reduce sample turbidity for metals analysis.

*Additional QA/QC sample (duplicate) included in range of detected concentrations.

SCGs-Standards, Criteria and Guidelines.

J-Indicates an estimated value.

B-This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).

ND-Non detectable

COLUMBIA MILLS GROUND WATER
DRUM DISPOSAL AREA
FREQUENCY OF DETECTION

- Non Validated Data -

CHEMICAL		FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS (ug/l)	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)			
					USEPA MCL	NYSDEC MCL	NYSDEC GA-S	NYSDEC GA-G
VOLATILE ORGANICS								
Methylene Chloride		5/12	1-5	1J-2.6B		5	5	50
Acetone		3/3		2JB-51		50		
1,1-Dichloroethylene		1/12	1-5	TR<1	7	5	5	0.07
Chloroform		2/12	1-5	6-7	100+	100+	100	
Methyl ethyl ketone		1/5	10	18		50		
Toluene		2/12	1-5	2J-4		5	5	50
SEMIVOLATILES								
Bis(2-ethylhexyl)phthalate		2/2	10	1J-4J		50	50	
INORGANICS								
Aluminum	- soluble	0/2	200	ND				
	- total	1/2	200	7220				
Antimony	- soluble	0/2	60.0	ND				
	- total	1/2	60.0	74.0				3
Barium	- soluble	1/2	200	238	1000(T)	1000(T)	1000(T)	
Cadmium	- soluble	0/5	5-10	ND				
	- total	2/6	5	110-120	10	10	10	
Calcium	- soluble	2/2	5000	51600-56300				
Chromium	- soluble	0/5	10-50	ND				
	- total	3/6	10-50	176-900	50	50	50	
Copper	- soluble	0/5	10-25.0	ND				
	- total	4/6	20-25.0	30-2500		1000	200	
Iron	- soluble	2/2	100	284-512				
	- total	2/2	100	17000-65000		300	300	
Lead	- soluble	0/5	5-100	ND				
	- total	3/6	3.0-300	2760-58000	50	50	25	
Magnesium	- soluble	2/2	5000	7110-15900				
	- total	2/2	5000	11500-11800				35000
Manganese	- soluble	2/2	15.0	116-2310				
	- total	2/2	15.0	91.6-4550		300	300	
Nickel	- soluble	3/5	30-40	40-120				
	- total	3/4	30	40-14000				
Sodium	- soluble	2/2	5000	6230-12900			20000(T)	
Zinc	- soluble	5/5	20.0	54-270				
	- total	6/6	5-20.0	39-22000		5000	300	
Cyanide		2/4	10.0-100	153-218			100	

Notes:
Samples obtained from B-7S October 1985; B-7S/B-7D April, August, October 1987 and April 1988; B-10D April 1990 and B-10S/B-10D October 1990.
SCGs-Standards, Criteria and Guidelines.
J-Indicates an estimated value.
B-This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).
ND-Indicates compound was analyzed but not detected.
TR-Trace amount detected.
+Limit for total trihalomethanes.
(T)-SCG for total Barium or Sodium.

APPENDIX B

DATA TABLES - SEDIMENT

MALCOLM PIRNIE

MALCOLM PIRNIE

COLUMBIA MILLS SEDIMENT
INTERMITTENT STREAM ORIGINATING IN DRUM DISPOSAL AREA
SUMMARY OF DETECTIONS
- Validated Data -

Sample ID	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10	Criteria*	Limit of Tolerance**
Inorganics (mg/kg)										
Aluminum	4900J	10300J	6180J	8040J	6880J	8690J	9870J	12400J		
Antimony	13.5B	31.4B	24.2B	16.2B	7.0U	7.2U	6.6U	5.4U		
Arsenic	1.5J	22.0J	6.6J	7.4J	3.3J	0.80J	0.81J	3.5J	5(4.0-5.5)	33
Cadmium	1.6B	88.8	25.4	23.4	10.1	2.2B	1.5B	0.66U	0.8(0.6-1.0)	10
Chromium	25.8J	151J	37.8J	46.6J	18.5J	13.1J	15.1J	18.6J	26(22-31)	111
Copper	49.3J	156J	48.6J	59.4J	22.1J	13.1B	13.4B	14.3B	19(15-25)	114
Iron	8800J	45500J	17100J	18000J	9200J	7690J	8470J	18200J	24,000 (20,000-30,000)	40,000
Lead	26.9	31.1	10.3	15.5	1.7	9.4	8.9	5.3	27(23-31)	250
Magnesium	971J	2650J	1380J	1800J	1610J	1670J	2010J	2470J		
Manganese	176J	6030J	3350J	1240J	1500J	561J	562J	4780J	428(400-457)	1100
Zinc	540J	7230J	2690J	2640J	1210J	593J	608J	282J	85(65-110)	800
Cyanide	10.0U	10.0U	10.0	26.0	10.0U	10.0U	10.0U	10.0U		

Notes: All samples collected November 1989. Results arranged based on sample locations, from upstream (SED 3) to downstream (SED-10).

U Indicates constituent was analyzed for but not detected.

J Indicates an estimated value.

B This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).

* Source: NYSDEC Sediment Criteria Guidance Document - December 1989. Values in parenthesis are "no-effect" and "lowest-effect" levels, respectively.

** Source: NYSDEC Sediment Criteria Guidance Document. Concentration which would be detrimental to the majority of species, potentially eliminating most.

COLUMBIA MILLS SEDIMENT
DRUM DISPOSAL AREA – PONDS
FREQUENCY OF DETECTION

– Non Validated Data –

POND 1

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (mg/kg)	Criteria* (mg/kg)	Limit of Tolerence** (mg/kg)
<u>INORGANICS</u>				
Cadmium	13/13	0.35–6.6	0.8(0.6–1.0)	10
Chromium	13/13	2.6–110	26(22–31)	111
Copper	13/13	5.7–180	19(15–25)	114
Lead	12/13	1.7–480	27(23–31)	250
Nickel	13/13	2.0–130	22(15–31)	40
Silver	2/13	0.3–4.0		
Zinc	13/13	41–2300	85(65–110)	800

POND 2

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (mg/kg)	Criteria* (mg/kg)	Limit of Tolerence** (mg/kg)
<u>INORGANICS</u>				
Cadmium	4/4	1.0–9.2	0.8(0.6–1.0)	10
Chromium	4/4	20–62	26(22–31)	111
Copper	4/4	13–590	19(15–25)	114
Lead	4/4	120–3000	27(23–31)	250
Nickel	4/4	2.7–42	22(15–31)	40
Zinc	4/4	94–7800	85(65–110)	800

POND 3

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (mg/kg)	Criteria* (mg/kg)	Limit of Tolerence** (mg/kg)
<u>INORGANICS</u>				
Cadmium	6/6	0.63–8.4	0.8(0.6–1.0)	10
Chromium	6/6	13–200	26(22–31)	111
Copper	6/6	9.2–160	19(15–25)	114
Lead	6/6	58–13,000	27(23–31)	250
Nickel	6/6	4.6–60	22(15–31)	40
Silver	1/6	0.3		
Zinc	6/6	100–3200	85(65–110)	800

Notes:

* Values in parenthesis are "no effect" and "lowest effect" levels, respectively. Source NYSDEC, Division of Fish and Wildlife document – Sediment Criteria – December 1989

** Concentration which would be detrimental to the majority of species, potentially eliminating most. Source: NYSDEC, Division of Fish and Wildlife document – Sediment Criteria – December 1989

COLUMBIA MILLS SEDIMENT
INTERMITTENT STREAM ORIGINATING IN DRUM DISPOSAL AREA
SUMMARY OF DETECTIONS
- Non Validated Data -

								ORGANICS CRITERIA*			METALS CRITERIA	
SAMPLE ID DATE COLLECTED	SED-3 04/11/88	SED3-MS 04/11/88	R 04/28/87	R 08/19/87	S 04/28/87	S 08/19/87	SED-2 04/11/88	AQUATIC TOXICITY BASIS	HUMAN HEALTH RESIDUE BASIS	WILDLIFE RESIDUE BASIS	CRITERIA**	LIMIT OF TOLERANCE***
VOLATILE ORGANICS (ug/kg)												
Toluene	24U	110%	20U		20U		4J					
Methylene Chloride	110B	150B	100U		100U		45B					
Acetone	41JB	43JB					17JB					
SEMIVOLATILES (ug/kg)												
Phenol	2000U						830J	18				
4-Chloro-3-methylphenol	2000U						490J					
Phenanthrene	2000U						430J	4170+				
Fluoranthene	2000U						500J					
Pyrene	400J						460J					
Chrysene	2000U						320J		39			
bis(2-Ethylhexyl)phthalate	710J						740J	3591				
TICS												
Carboxylic acid	2400J						3400J					
Hexanedioic acid							4200J					
PESTICIDES (ug/kg)												
4,4'-DDE	40J						13J	1500	0 3	30/25+		
4,4'-DDD	43J						6 4J	1500	0 3	30/25+		
INORGANICS (mg/kg)												
Aluminum	6130						4920					
Barium	166U						87 9					
Cadmium	23 2		2 1	3 1	14	38	1 8U				0 8(0 6-1 0)	10
Calcium	4620						3730					
Chromium	18 4		42	45	15	28	23 5				26(22-31)	111
Copper	181		70	53	30	29	63 3				19(15-25)	114
Iron	12300						6830				24,000(20,000-30 000)	40 000
Lead	61 5		250	180	73	47	606				27(23-31)	250
Manganese	408						192				428(400-457)	1100
Nickel	33 1U		8 6	14	14	52	21 5				22(15-31)	40
Selenium	4 7						2 1					
Zinc	2000		37	540	33	1900	662				85(65-110)	800

NOTES
Sample results arranged based on sample locations from upstream (SED-3) to downstream (SED-2)
No data indicates compound was not analyzed
MS-Matrix Spike
U-Indicates compound was analyzed but not detected
J-Indicates an estimated quantity
B-This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s)
%Indicates percent recovery for MS sample
TICs-Tentatively identified compounds
*Source: NYSDEC Sediment Criteria Guidance Document - December 1989 Criteria based on sediment organic carbon content of 3%
**Source: NYSDEC Sediment Criteria Guidance Document Values in parenthesis are "no-effect" and "lowest-effect" levels, respectively
***Source: NYSDEC Sediment Criteria Guidance Document Concentration which would be detrimental to the majority of species, potentially eliminating most
+-EPA proposed interim sediment criteria

APPENDIX C

DATA TABLES – SURFACE WATER

MALCOLM PIRNIE

COLUMBIA MILLS SURFACE WATER
DRUM DISPOSAL AREA–PONDS
FREQUENCY OF DETECTION
– Non Validated Data –

POND 1

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)		
			USEPA ACUTE CRITERIA	USEPA CHRONIC CRITERIA	NYSDEC CLASS D STANDARD
VOLATILE ORGANICS					
Methylene Chloride	3/3	1.0 – 2.4			
INORGANICS					
Cadmium	5/7	0.06 – 46	3.9	1.1	3.92
Calcium	3/3	35000 – 59000			
Chromium	3/7	0.11 – 2.0	1700	210	1737
Chromium(+6)	3/4	0.009 – 0.010	16	11	16
Copper	6/7	0.10 – 80	18	12	17.7
Iron	3/3	40 – 15000		1000	300
Lead	4/7	0.6 – 270	82	3.2	82.6
Magnesium	3/3	4300 – 5600			
Manganese	3/3	290 – 2500			
Nickel	3/7	2 – 7	1400	160	1844
Sodium	3/3	6500 – 12000			
Zinc	7/7	10 – 2100	120	110	321

POND 2

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)		
			USEPA ACUTE CRITERIA	USEPA CHRONIC CRITERIA	NYSDEC CLASS D STANDARD
INORGANICS					
Cadmium	2/4	5 – 7	3.9	1.1	3.92
Calcium	2/2	38000 – 39000			
Copper	1/2	70	18	12	17.7
Iron	2/2	1100 – 2700		1000	300
Magnesium	2/2	3700 – 4500			
Manganese	2/2	70 – 190			
Sodium	2/2	4100 – 5300			
Zinc	4/4	40 – 270	120	110	321

COLUMBIA MILLS SURFACE WATER
DRUM DISPOSAL AREA–PONDS
FREQUENCY OF DETECTION
– Non Validated Data –

POND 3

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)		
			USEPA ACUTE CRITERIA	USEPA CHRONIC CRITERIA	NYSDEC CLASS D STANDARD
VOLATILE ORGANICS					
Methylene Chloride	2/2	3.0B–4.5B			
INORGANICS					
Cadmium	1/9	25	3.9	1.1	3.92
Calcium	3/3	31000 – 37000			
Copper	4/9	0.01 – 80	18	12	17.7
Iron	3/3	220 – 1100		1000	300
Lead	4/9	0.08 – 700	82	3.2	82.6
Magnesium	3/3	3800 – 4000			
Manganese	3/3	30 – 110			
Nickel	2/9	0.01 – 0.02	1400	160	1844
Sodium	3/3	6400 – 7400			
Zinc	9/9	0.04 – 20000	120	110	321

UPGRADIENT OF POND 1
(JUNE 1991 SAMPLE SW7)

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)		
			USEPA ACUTE CRITERIA	USEPA CHRONIC CRITERIA	NYSDEC CLASS D STANDARD
INORGANICS					
Calcium	1/1	28000			
Copper	1/1	50	18	12	17.7
Iron	1/1	980		1000	300
Magnesium	1/1	4100			
Manganese	1/1	280			
Sodium	1/1	14000			
Zinc	1/1	73	120	110	321

Note:SCGs – Standards, Criteria and Guidelines
B = Also found in blank: value shown corrected for concentration in blank.
Hardness dependent criteria based on surface water hardness of 100 mg/l. All criteria are hardness dependent except for Chromium(+6) and Iron.

COLUMBIA MILLS SURFACE WATER
INTERMITTENT STREAM ORIGINATING IN DRUM DISPOSAL AREA
FREQUENCY OF DETECTION

– Non Validated Data –

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS (ug/l)	RANGE OF DETECTED CONCENTRATION (ug/l)	SCGs (ug/l)		
				USEPA ACUTE CRITERIA	USEPA CHRONIC CRITERIA	NYSDEC CLASS D STANDARD
VOLATILE ORGANICS						
1,1,1-Trichloroethane	2/2	1	1 TR-1			
Chloroform	2/2	1	2	28,900*	1,240*	
INORGANICS						
Zinc	2/2	10	110-350	120+	110+	321+

Note: SCGs – Standards, Criteria and Guidelines
TR = Trace amount
* Insufficient data to develop criteria. Value presented is the lowest observed effect level.
\+ Hardness dependent criteria based on surface water hardness of 100 mg/l.

APPENDIX D

DATA TABLES – SURFACE SOIL

MALCOLM PIRNIE

COLUMBIA MILLS EXPOSED SURFACE SOIL/FILL
DRUM DISPOSAL AREA
FREQUENCY OF DETECTION

- Non Validated Data -

AREA BETWEEN PONDS

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS	RANGE OF DETECTED CONCENTRATION*	BACKGROUND CONCENTRATION***
SEMIVOLATILES (ug/kg)				
Phenol	0/1	1000	ND	390U–490U
Acenaphthylene	1/1	1000	1000	390U–490U
Phenanthrene	0/1	1000	ND	390U–490U
Dibutyl phthalate	1/1		8000	2600B–4000B
Fluoranthene	0/1	1000	ND	390U–490U
Pyrene	0/1	1000	ND	390U–490U
Bis(2–ethylhexyl)phthalate	1/1		17000	390U–2500B
PCBS (ug/kg)				
Aroclor 1254	1/1	100	300	170U–210U
INORGANICS (mg/kg)				
Cadmium	1/1		31	0.69U–0.66
Chromium	1/1		4200	8.5–8.6
Cobalt	1/1		20	4.1B–5.8B
Copper	NA		NA	8.5B–25.2J
Lead	1/1		5000	8.6J–15.9J+
Nickel	1/1		69	7.6–10.5
Silver	NA		NA	0.53UL–0.64UL
Zinc	NA		NA	33.9J–45.5J

ALONG CREEK & EAST OF POND 1

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS	RANGE OF DETECTED CONCENTRATION**	BACKGROUND CONCENTRATION***
SEMIVOLATILES (ug/kg)				
Phenol	1/1	1000	3000	390U–490U
Acenaphthylene	0/1	1000	ND	390U–490U
Phenanthrene	1/1	1000	1000	390U–490U
Dibutyl phthalate	1/1		18000	2600B–4000B
Fluoranthene	1/1	1000	4000	390U–490U
Pyrene	1/1	1000	9000	390U–490U
Bis(2–ethylhexyl)phthalate	1/1		280000	390U–2500B
PCBS (ug/kg)				
Aroclor 1254	0/1	100	ND	170U–210U
INORGANICS (mg/kg)				
Cadmium	1/1		0.3	0.69U–0.66
Chromium	1/1		12	8.5–8.6
Cobalt	NA		NA	4.1B–5.8B
Copper	1/1		18	8.5B–25.2J
Lead	3/3		100–130	8.6J–15.9J+
Nickel	1/1		8	7.6–10.5
Silver	1/1		0.3	0.53UL–0.64UL
Zinc	1/1		78	33.9J–45.5J

NOTES:

*As detected in samples obtained May 1984 (8) and April 1988 (CB1).

**As detected in samples obtained August 1985(B) and April 1988 (CB2, L1, L2).

***Concentrations detected in two background surface soil samples obtained November 1989. Data is validated. Additional QA/QC samples (MS, MSD) included in range of concentrations for semivolatiles and PCBs.

+Concentrations of lead in twelve surface soil samples obtained at locations outside the Drum Disposal Area in April 1988 ranged from 8.9 ppm – 53 ppm (average = 26.5 ppm). Data was not validated.

U–Indicates compound was analyzed but not detected.

L–Indicates sample quantitation limit is an estimated quantity.

J–Indicates an estimated value.

B–This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).

NA–Indicates compound was not analyzed.

ND–Indicates compound was analyzed but not detected.

MALCOLM PIRNIE

COLUMBIA MILLS SURFACE SOIL
DOWNGRADIENT AND ADJACENT TO DRUM DISPOSAL AREA
FREQUENCY OF DETECTION

- Non Validated Data -

CHEMICAL	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS*	RANGE OF DETECTED CONCENTRATION*	BACKGROUND CONCENTRATION**
VOLATILE ORGANICS (ug/kg)				
Methylene Chloride	3/3		28B–41B	32B–71B
Acetone	3/3		8JB–21B	13UL–70B
Toluene	2/3	7	2J–7	6U–7UL
SEMIVOLATILES (ug/kg)				
Phenanthrene	1/3	500	94J	390U–490U
Fluoranthene	2/3	500	150J	390U–490U
Pyrene	2/3	500	140J–180J	390U–490U
Bis(2–ethylhexyl)phthalate	3/3		100J–1100	390U–2500B
TICs				
Carboxylic acid	1/3	–	710	–
PESTICIDES (ug/kg)				
4,4'–DDE	2/3	100–110	3.8J–12J	2.8J(17U)–18J
4,4'–DDT	1/3	100–110	16J	21U
INORGANICS (mg/kg)				
Aluminum	3/3	42.8–49.1	6310–11600	8800J–9880J
Arsenic	2/3	1.9–2.8	2.6–2.7	2.8J–3.3J
Barium	3/3	42.8–49.1	50.8–167	34.2J–80.8J
Chromium, total	3/3	2.1–2.5	9.2–11.5	8.5–8.6
Copper	3/3	5.4–6.1	9.2–16.6	8.5B–25.2J
Iron	3/3	21.4–24.6	12800–14600	11900J–12100J
Lead	3/3	7.0–12.7	12.9–73.6	8.6J–15.9J+
Magnesium	2/3	1070–1230	1270–1730	1180J–2350J
Manganese	3/3	3.2–3.7	169–333	178–313
Nickel	1/3	8.6–9.8	11.4	7.6–10.5
Vanadium	3/3	10.7–12.3	11.6–18.0	15.5–19.2
Zinc	3/3	4.3–4.9	41.3–89.6	33.9J–45.5J

NOTES:

*As detected in samples S1, S2 and S3 obtained April 1988. Additional QA/QC samples (MS, MSD) included in ranges of quantitation limits and detected concentrations of semivolatiles and pesticides.

**Concentrations detected in two background surface soil samples obtained November 1989. Data is validated. Additional QA/QC samples (MS, MSD, reprep) included in range of concentrations for volatile and semivolatile organics and pesticides.

+Concentrations of lead in twelve surface soil samples obtained at locations outside the Drum Disposal Area in April 1988 ranged from 8.9 ppm – 53 ppm (average = 26.5 ppm). Data was not validated.

TIC – Tentatively identified compound.

U – Indicates compound was analyzed but not detected.

L – Indicates sample quantitation limit is an estimated quantity.

J – Indicates an estimated value.

B – This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).

COLUMBIA MILLS SURFACE SOIL/FILL
DRUM DISPOSAL AREA
SUMMARY OF DETECTIONS - DIOXINS & FURANS

– Validated Data –

CHEMICAL	SOIL-1 (ng/g)	SOIL-2 (ng/g)	SOIL-3 (ng/g)
POLYCHLORINATED DIBENZO-P-DIOXINS			
TCDD	0.13	0.22	ND 0.05UL
PeCDD	ND 0.05	0.22	ND 0.05UL
HxCDD	ND 0.025	0.43	ND 0.05UL
HpCDD	0.07	1.1	ND 0.05UL
OCDD	0.51	2.1J	0.33B
POLYCHLORINATED DIBENZOFURANS			
2,3,7,8-TCDF	0.10	0.60	ND 0.05UL
TCDF	0.12	1.6	ND 0.05UL
PeCDF	ND 0.05	2.1	ND 0.05UL
HxCDF	ND 0.05	1.0	ND 0.05UL
HpCDF	ND 0.1	7.1	ND 0.05UL
OCDF	0.11	1.1J	ND 0.05UL

NOTES:

Samples obtained November 1989.

ND – Indicates compound was analyzed but not detected.

UL – Indicates compound was analyzed but not detected. The sample quantitation limit is an estimated quantity.

J – Indicates an estimated value.

B – This result is qualitatively suspect since this analyte was detected in field and/or laboratory blank(s) at a similar level(s).

APPENDIX E

ANALYTICAL RESULTS
PLANT & TISSUE SAMPLES

[redacted]

APPENDIX E
COLUMBIA MILLS
ANALYTICAL RESULTS
PLANT & FISH TISSUE SAMPLES

TES Sample Number	Species	Individual/ Composite	Location	# Indiv.	Avg. Wt. / Indiv.	Total Sample Wt.	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
1	Sumac	C	Hazardous	N/A	N/A	32.6	1.11	8.32	5.86	1.57	36.2	76.9
2	Sumac	C	Control	N/A	N/A	55.8	0.211	1.82	4.08	0.33	4.64	24.3
3	Red Raspberry	C	Hazardous	N/A	N/A	81.9	0.037	12.47	3.92	1.23	3.34	16.9
3 DUPE							0.026	13.12	3.82	1.01	3.13	18.7
4	Red Raspberry	C	Control	N/A	N/A	66.6	<0.0012	6.04	4.63	0.03	2.02	14.9
5	Mudminnow	C	Hazardous	5	2.6 g	13	0.0019	1.40	3.18	0.56	1.11	115
6	Mudminnow	C	Hazardous	6	2.1 g	12.5	<0.0011	2.54	2.59	0.51	2.57	91.1
7	Mudminnow	C	Control	5	2.9 g	11.8	0.078	1.45	3.82	0.50	4.86	89.0
8	Mudminnow	C	Control	4	2.6 g	10.4	0.013	1.71	16.32	0.16	5.65	79.8
9	Creek Chub	C	Hazardous	7	1.9 g	13.3	0.11	0.46	1.61	0.56	1.63	62.5
10	Creek Chub	C	Hazardous	6	2.1 g	12.4	0.051	0.35	1.92	0.42	0.96	49.0
11	Creek Chub	C	Hazardous	6	2.2 g	13.2	0.073	1.07	2.07	0.64	1.03	77.7
12	Creek Chub	C	Hazardous	13	1.0 g	13.1	0.94	2.16	2.80	0.63	1.58	47.3
13	Creek Chub	C	Control	18	1.9 g	34.3	0.52	0.87	2.69	0.43	0.68	65.2
14	Creek Chub	C	Control	51	1.8 g	91.7	0.63	1.13	3.04	0.91	1.11	60.6
14 DUPE							0.66	0.86	2.88	0.76	1.07	65.6
15	Creek Chub	C	Control	24	1.8 g	43.3	0.12	0.89	7.98	0.49	0.72	63.9
16	Creek Chub	C	Control	18	2.1 g	38.6	0.15	0.38	1.71	0.34	0.47	62.6
17	Pumpkinseed	C	Hazardous	4	3.3 g	13.2	0.003	0.56	1.62	4.75	0.59	63.1
18	Pumpkinseed	C	Hazardous	2	6.3 g	12.5	0.022	0.74	1.27	0.90	1.00	68.8
19	Pumpkinseed	C	Hazardous	2	7.0 g	13.9	0.003	0.20	0.79	1.16	0.53	44.5

TES – Terrestrial Environmental Services

▨ – Shaded value used in intake calculations.

APPENDIX E
ESTIMATED CONCENTRATIONS OF INORGANIC ANALYTES IN DEER

ANALYTE	CONCENTRATION OF ANALYTE IN SUMAC (mg/kg)	BCF	CONCENTRATION OF ANALYTE IN DEER (mg/kg)
Cd	1.11	0.006	0.0067
Cr	8.32	0.06	0.499
Ni	1.57	0.06	0.094
Pb	36.2	0.003	0.109
Zn	76.9	1.00	76.9

NOTE: BCF - Bioconcentration Factor, from Baes, et al,1987
Concentration in deer = Concentration in sumac x BCF

APPENDIX E
ESTIMATED CONCENTRATIONS OF INORGANIC ANALYTES IN RABBIT

ANALYTE	CONCENTRATION OF ANALYTE IN RED RASPBERRY (mg/kg)	BCF	CONCENTRATION OF ANALYTE IN RABBIT (mg/kg)
Cd	0.037	0.006	2.2×10^{-4}
Cr	13.12	0.06	0.79
Ni	1.23	0.06	0.074
Pb	3.34	0.003	0.01
Zn	18.7	1.00	18.7

NOTE: BCF - Bioconcentration Factor, from Baes, et al, 1987
Concentration in rabbit = Concentration in sumac x BCF

APPENDIX F

EXPOSURE CONCENTRATIONS
EXPOSURE EQUATIONS
DERMAL ABSORPTION FRACTIONS

EXPOSURE CONCENTRATIONS USED IN THE RISK ASSESSMENT

	GROUND WATER ug/l	SEDIMENT ug/kg	SURFACE WATER ug/l	SURFACE SOIL ug/kg	SUMAC ug/kg	RED RASBERRY ug/kg	FISH ug/kg
Toluene	4						
Trichloroethene	3						
Bis(2-ethylhexyl)phthalate		(740)		(280,000)			
Phenol		(830)		(3,000)			
PAHs							
cPAHs	9.9	(320)					
Fluoranthene	3	(500)		(4,000)			
Phenanthrene	2	(430)		(1,000)			
Pyrene	3	(460)		(9,000)			
Dioxins and Furans				*			
Antimony	24.8	31,400					
Arsenic		22,000					
Cadmium		88,800	(46)	(31,000)	(1,110)	(37)	(940)
Chromium		151,000	(2)	(4,200,000)	(8,320)	(13,120)	(2,540)
Copper		156,000	(80)				(3,180)
Lead	80	31,100	(700)	(5,000,000)	(36,200)	(3,340)	(2,570)
Manganese	1,240	6,030,000					
Nickel		130,000	(7)	(69,000)	(1,570)	(1,230)	(4,750)
Zinc	614	7,230,000	(20,000)	(89,600)	(76,900)	(18,700)	(115,000)
Cyanide	143	26,000					

Note: cPAHs refer to carcinogenic PAHs (sum of 8 PAHs)
Exposure levels presented above are maximum concentrations detected

( ) – Values in parenthesis indicate non-validated data, no validated data for that parameter exists

* – See section 5.4

RESIDENTIAL EXPOSURE: INGESTION OF CHEMICALS IN DRINKING WATER

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
IR = Ingestion Rate (liters/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Average Time (period over which exposure is averaged -- days)

Variable Values:

CW: Site-specific measured value

IR: 2 liters/day (adult, 90th percentile; EPA 1989)

EF: Daily (365 days/year)

ED: 30 years (national upper-bound time (90th percentile) at one residence; EPA 1989)

BW: 70 kg (adult, average; EPA 1989)

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

RESIDENTIAL EXPOSURE:
DERMAL CONTACT WITH CHEMICALS IN GROUND WATER

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Chemical-Specific Dermal Permeability Constant (cm/hr)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Volumetric Conversion Factor for Water (1 liter/1000 cm^3)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CW: Site-specific measured value

SA: 1.94 m^2 (50th percentile total body surface area, adult male, EPA 1989)

PC: 8.4E-04 cm/hr for permeability of water is used

ET: 0.3 hours/day

EF: 52 days/year

ED: 30 years (national upper-bound time (90th percentile) at one residence; EPA 1989)

CF: 1 liter/1000 cm^3

BW: 70 kg (adult, average; EPA 1989)

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

RESIDENTIAL EXPOSURE: CALCULATION OF VAPOR PHASE CONCENTRATION

Equation:

$$CA\ (mg/m^3) = CW \times WV \times 1/RV$$

Where:

CA = Chemical Concentration in Air (mg/m^3)
CW = Chemical Concentration in Water (mg/liter)
WV = Volume of Water (liters)
RV = Room Volume (m^3)

Variable Values:

CA: Site-specific measured Value

WV: 200 liters (EPA, 1989)

RV: 30 m^3 (EPA, 1989)

RESIDENTIAL EXPOSURE:
INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CA = Chemical Concentration in Air (mg/m^3)
IR = Inhalation Rate (m^3/day)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Average Time (period over which exposure is averaged -- days)

Variable Values:

CA: Site-specific measured value

IR: 0.6 m^3/hour (14.4 m^3/day) -- showering (all age groups; EPA 1989)

ET: 12 minutes/day (0.2 hours/day) -- showering (90th percentile; EPA 1989)

EF: 365 days/year

ED: 30 years (national upper-bound time (90th percentile) at one residence; EPA 1989)

BW: 70 kg (adult, average; EPA 1989)

AT: Pathway - specific period of exposure for non-carcinogenic effects (i.e. ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

TRESPASSER EXPOSURE:
DERMAL CONTACT WITH CHEMICALS IN SURFACE WATER

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Chemical-Specific Dermal Permeability Constant (cm/hr)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Volumetric Conversion Factor for Water (1 liter/1000 cm^3)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CW:	Site-specific measured value
SA:	1.16 m^2 (50th percentile total body surface area, age 9-12; USEPA, 1989).
PC:	8.4×10^{-4} cm/hr for permeability of water is used.
ET:	2.6 hours/day (national average for swimming; EPA 1989)
EF:	247 days/year (see text)
ED:	For children exposure duration of 5 years
CF:	1 liter/1000 cm^3
BW:	36 kg (child, average; USEPA 1989)
AT:	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

TRESPASSER EXPOSURE:
DERMAL CONTACT WITH CHEMICALS IN SURFACE SOIL AND SEDIMENT

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CS:	Site-specific measured Value
CF:	10^{-6} kg/mg
SA:	1.16 m^2 (50th percentile total body surface area, age 9-12)
AF:	2.77 mg/cm^2 - Kaolin Clay (for hands; USEPA)
ABS:	Chemical - specific value (see table that follows)
EF:	247 days - Contact time - 4 hours (see text)
ED:	For children exposure duration of 5 years
BW:	36 kg (child, average; USEPA 1989)
AT:	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year), and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

TRESPASSER EXPOSURE: INGESTION OF CHEMICALS IN SOIL

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
At = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CS:	Site-specific measured value.
IR:	100 mg/day (age groups greater than 6 years old; EPA 1989).
CF:	10^{-6} kg/mg.
EF:	247 days/year - contact time - 4 hours (see text).
ED:	For children exposure duration of 5 years.
BW:	36 kg (child, average; USEPA 1989).
AT:	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

TRESPASSER EXPOSURE:
INGESTION OF DEER AND RABBIT

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CT \times IR \times EF \times ED}{BW \times AT}$$

Where:

CT = Contaminant Concentration in Tissue (mg/kg)
IR = Ingestion Rate (kg/meal)
EF = Exposure Frequency (meals/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CT: Calculated from vegetation concentrations. (See Appendix E)

IR: 0.200 kg/meal (USEPA, 1991).

EF: 52 meals/year (Assume consumption of venison - once/week)
5 meals/year (Assume consumption of rabbit - 5 times/year)

ED: 30 years (90th percentile, national upper-bound time at one residence, USEPA 1989).

BW: 70 kg (adult, average: EPA 1989).

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year), and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

TRESPASSER EXPOSURE:
INGESTION OF FISH FROM THE SITE

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CF \times IR \times FI \times EF \times ED}{BW \times AT}$$

Where:

CF = Contaminant Concentration in Fish (mg/kg)
IR = Ingestion Rate (kg/meal)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (meals/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Variable Values:

CF: Maximum concentration detected in fish samples collected on-site.

IR: 0.200 kg/meal (USEPA, 1991).

FI: 0.2 (USEPA, 1991)

EF: 48 meals/year (USEPA 1989).

ED: 30 years (90th percentile, national upper-bound time at one residence, USEPA 1989).

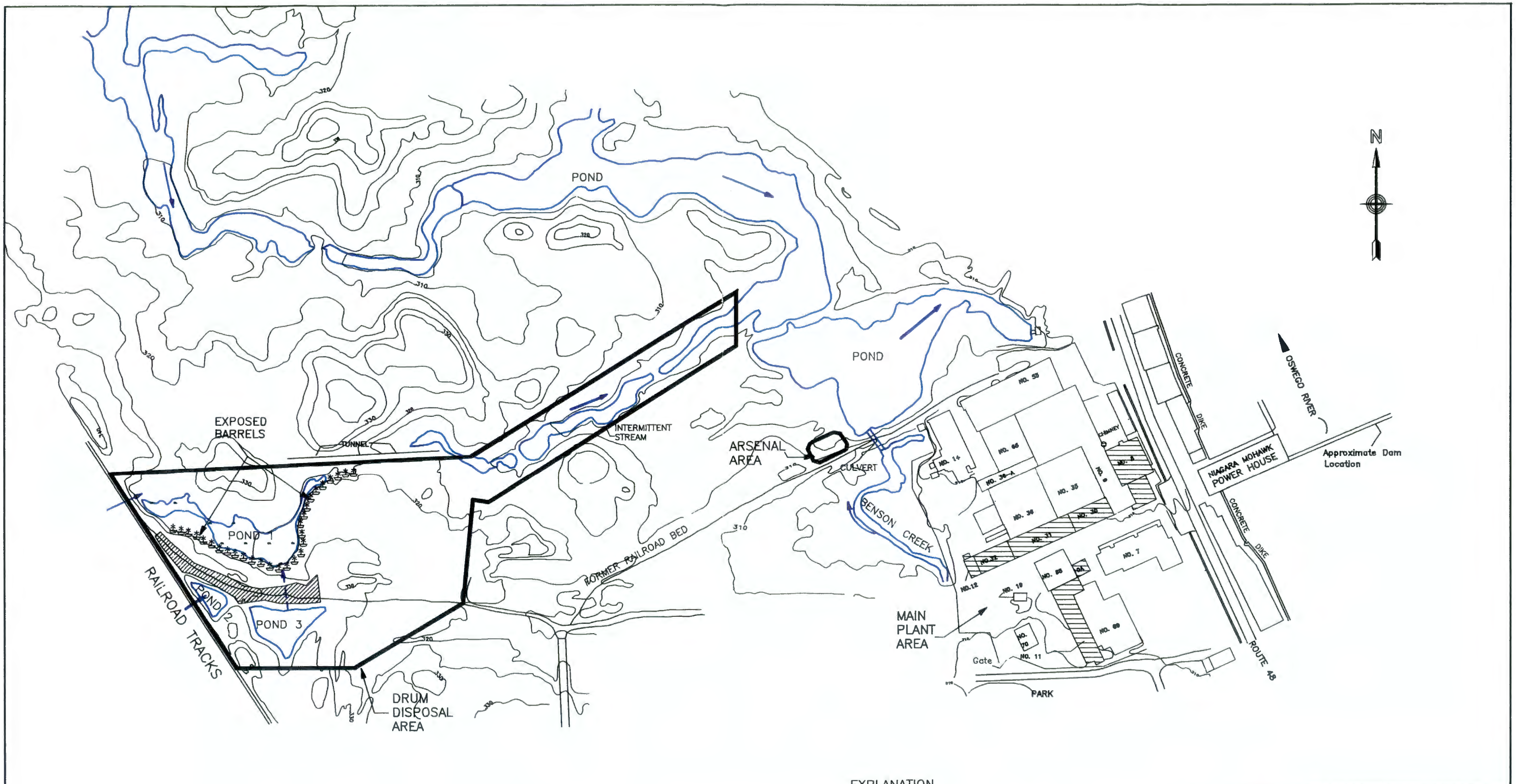
BW: 70 kg (adult, average: EPA 1989).

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year) and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

DERMAL ABSORPTION FRACTIONS

ANALYTE	DERMAL ABSORPTION FACTOR	SOURCE
Phenol	1	Used default value of 1. No absorption fraction found in the literature.
Bis(2-ethylhexyl)phthalate	1	Used default value of 1. No absorption fraction found in the literature.
Cyanide	1	Used default value of 1. No absorption fraction found in the literature.
PAHs	0.07	Feldmen and Maiback, 1970
Antimony	0.05	*
Arsenic	0.03	Skog and Wahlberg, 1964
Cadmium	0.03	Skog and Wahlberg, 1964
Chromium	0.04	Wahlberg, 1968
Copper	0.05	*
Lead	0	Lang Kunze, 1948
Nickel	0.03	Skog and Wahlberg, 1964
Manganese	0.05	*
Zinc	0.05	Skog and Wahlberg, 1964.

* Assumed to be equal to the highest value for a metal (Mercury). Skog and Wahlberg, 1964.



EXPLANATION

- SURFACE WATER FLOW DIRECTION
- SUBSURFACE WATER FLOW DIRECTION
- AREA COVERED WITH SOIL JUNE 1988

0 feet 250

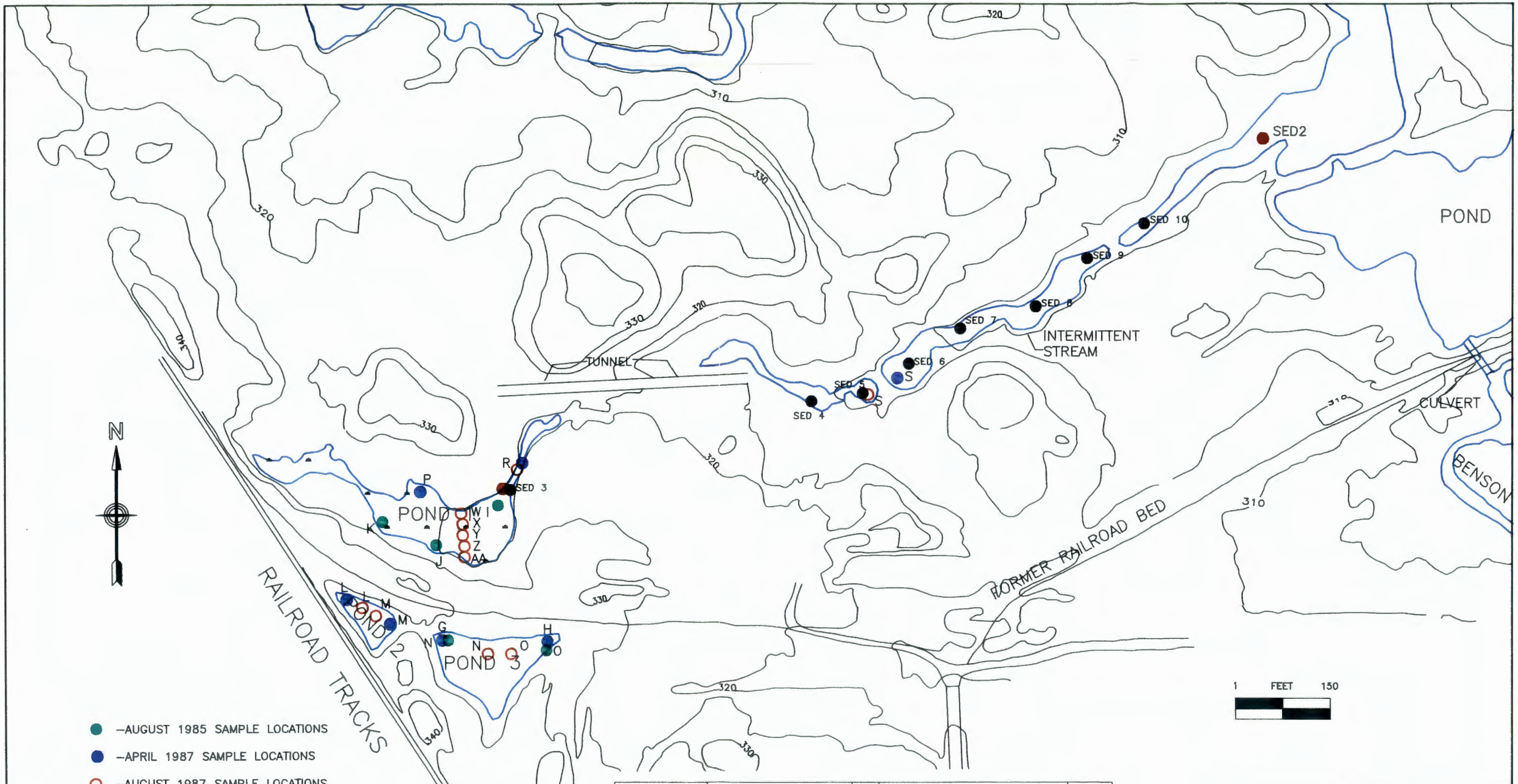
COLUMBIA MILLS

SITE LOCATION MAP

MALCOLM PIRNIE

Date
APRIL 1991

Figure No.
1



TABLE/DESCRIPTION (SEE APPENDIX B)	SAMPLE LOCATIONS	DATE	ANALYSES	VALIDATED DATA
SEDIMENT				
Ponds 1, 2 and 3	G, H, I, J, K	08/85	USEPA 624; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	L, M, N, O, P	04/87	Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	L, M, N, O, W, X, X1, X2, Y, Z, Z1, Z2, AA	08/87	Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
Intermittent Stream	SED - 3, 4, 5, 6, 7, 8, 9, 10	11/89	Inorganics*	YES
Intermittent Stream	R, S	04/87	USEPA 601/602; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	R, S	08/87	Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	SED 2, SED 3	04/88	TCL Parameters (+TICs)	NO

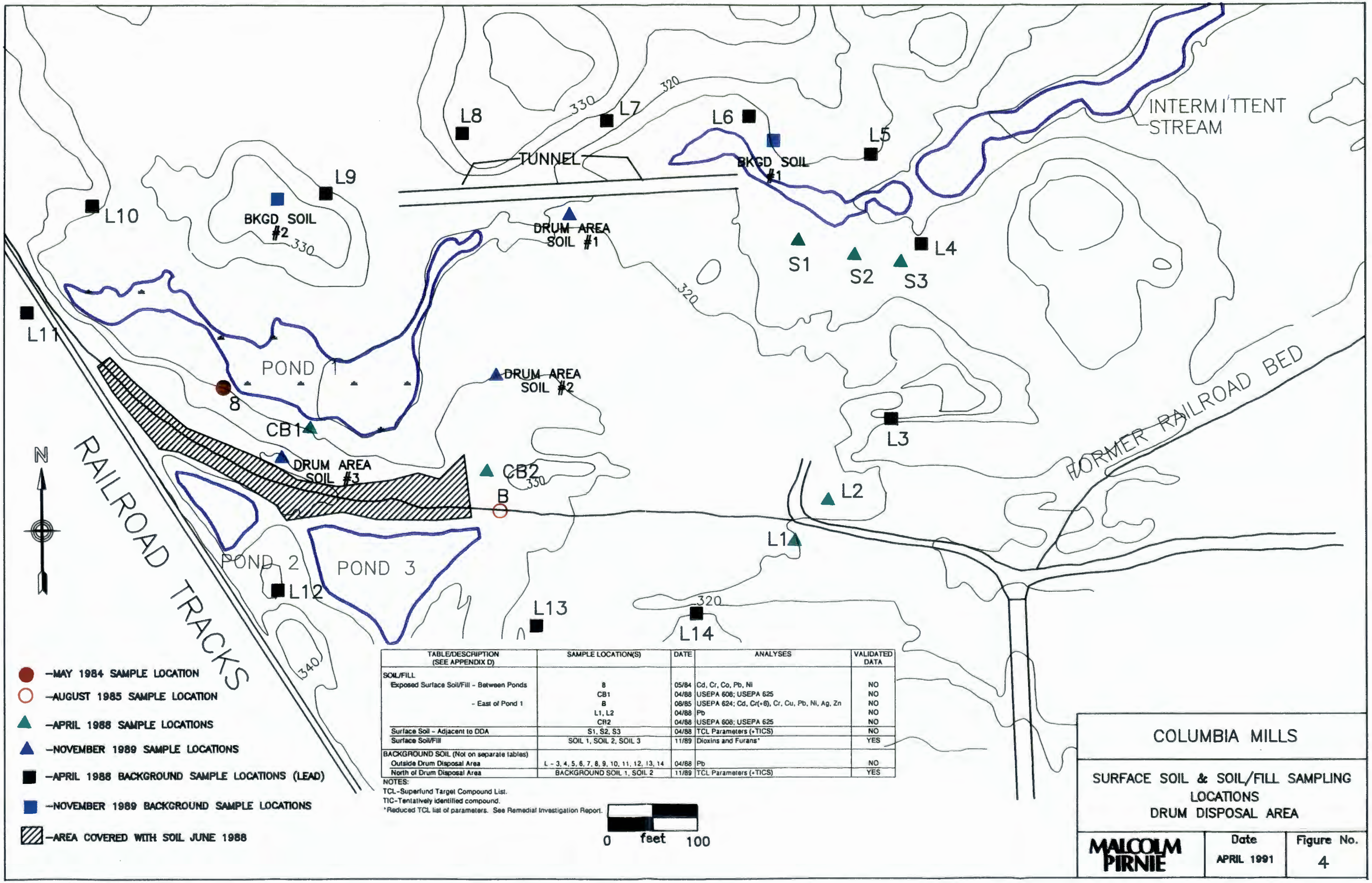
NOTES:
TCL-Superfund Target Compound List
TIC-Tentatively identified compound.
*Reduced TCL list-of parameters. See Remdial Investigation Report.

COLUMBIA MILLS

SEDIMENT SAMPLING
LOCATIONS
DRUM DISPOSAL AREA

MALCOLM PIRNIE

Date	Figure No.
APRIL 1991	3



● –MAY 1984 SAMPLE LOCATION
○ –AUGUST 1985 SAMPLE LOCATION
▲ –APRIL 1988 SAMPLE LOCATIONS
▲ –NOVEMBER 1989 SAMPLE LOCATIONS
■ –APRIL 1988 BACKGROUND SAMPLE LOCATIONS (LEAD)
■ –NOVEMBER 1989 BACKGROUND SAMPLE LOCATIONS
▨ –AREA COVERED WITH SOIL JUNE 1988

TABLE/DESCRIPTION (SEE APPENDIX D)	SAMPLE LOCATION(S)	DATE	ANALYSES	VALIDATED DATA
SOIL/FILL				
Exposed Surface Soil/Fill - Between Ponds	8	05/84	Cd, Cr, Co, Pb, Ni	NO
	CB1	04/88	USEPA 608; USEPA 625	NO
- East of Pond 1	B	08/85	USEPA 624; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	L1, L2	04/88	Pb	NO
	CB2	04/88	USEPA 608; USEPA 625	NO
Surface Soil - Adjacent to DDA	S1, S2, S3	04/88	TCL Parameters (+TICS)	NO
Surface Soil/Fill	SOIL 1, SOIL 2, SOIL 3	11/89	Dioxins and Furans*	YES
BACKGROUND SOIL (Not on separate tables)				
Outside Drum Disposal Area	L - 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	04/88	Pb	NO
North of Drum Disposal Area	BACKGROUND SOIL 1, SOIL 2	11/89	TCL Parameters (+TICS)	YES

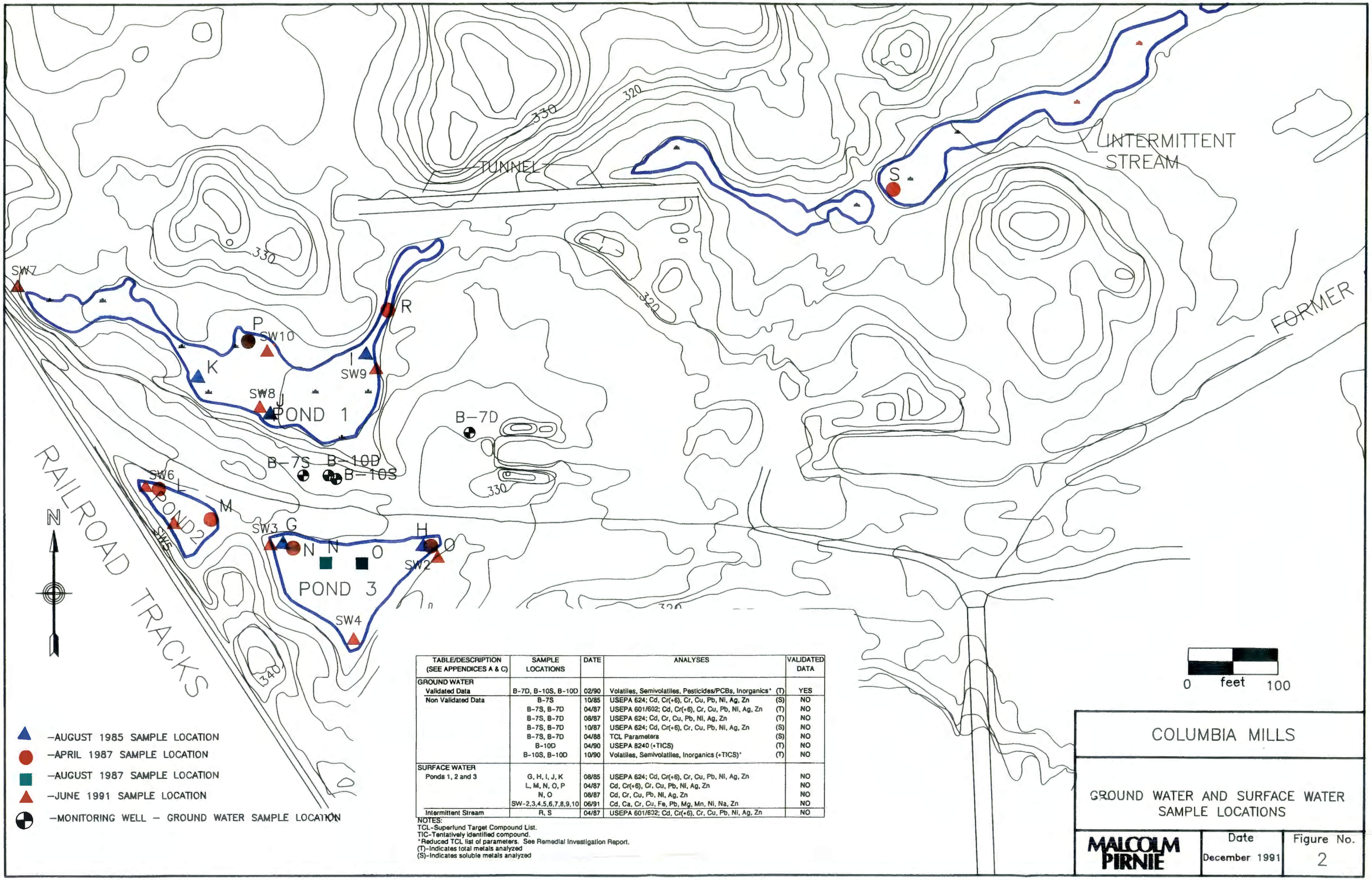
NOTES:
TCL-Superfund Target Compound List.
TIC-Tentatively identified compound.
*Reduced TCL list of parameters. See Remedial Investigation Report.

COLUMBIA MILLS

SURFACE SOIL & SOIL/FILL SAMPLING
LOCATIONS
DRUM DISPOSAL AREA

MALCOLM PIRNIE

Date	Figure No.
APRIL 1991	4



▲ –AUGUST 1985 SAMPLE LOCATION
● –APRIL 1987 SAMPLE LOCATION
■ –AUGUST 1987 SAMPLE LOCATION
▲ –JUNE 1991 SAMPLE LOCATION
◐ –MONITORING WELL – GROUND WATER SAMPLE LOCATION

TABLE/DESCRIPTION (SEE APPENDICES A & C)	SAMPLE LOCATIONS	DATE	ANALYSES	VALIDATED DATA
GROUND WATER				
Validated Data	B-7D, B-10S, B-10D	02/90	Volatiles, Semivolatiles, Pesticides/PCBs, Inorganics* (T)	YES
Non Validated Data	B-7S	10/85	USEPA 624; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn (S)	NO
	B-7S, B-7D	04/87	USEPA 601/602; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn (T)	NO
	B-7S, B-7D	08/87	USEPA 624; Cd, Cr, Cu, Pb, Ni, Ag, Zn (T)	NO
	B-7S, B-7D	10/87	USEPA 624; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn (S)	NO
	B-7S, B-7D	04/88	TCL Parameters (S)	NO
	B-10D	04/90	USEPA 8240 (+TICS) (T)	NO
	B-10S, B-10D	10/90	Volatiles, Semivolatiles, Inorganics (+TICS)* (T)	NO
SURFACE WATER				
Ponds 1, 2 and 3	G, H, I, J, K	08/85	USEPA 624; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	L, M, N, O, P	04/87	Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO
	N, O	08/87	Cd, Cr, Cu, Pb, Ni, Ag, Zn	NO
	SW-2,3,4,5,6,7,8,9,10	06/91	Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Ni, Na, Zn	NO
Intermittent Stream	R, S	04/87	USEPA 601/602; Cd, Cr(+6), Cr, Cu, Pb, Ni, Ag, Zn	NO

NOTES:
TCL-Superfund Target Compound List.
TIC-Tentatively identified compound.
*Reduced TCL list of parameters. See Remedial Investigation Report.
(T)-Indicates total metals analyzed
(S)-Indicates soluble metals analyzed

COLUMBIA MILLS

GROUND WATER AND SURFACE WATER
SAMPLE LOCATIONS

MALCOLM PIRNIE

Date
December 1991

Figure No.
2