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Woodward-Clyde Consultants

Engineering & sciences applied to the earth & its environment

March 18, 1992
88C2076-4V

VIA: FEDERAL EXPRESS

Mr. Randy Sturgeon
Enforcement Project Manager
U.S. Environmental Protection Agency
Region 3, 841 Chestnut Street
Philadelphia, Pennsylvania 19107

Re: Risk Assessment, Du Pont - Newport Site
Transmittal of Final Human Health Evaluation

Dear Mr. Sturgeon:

On behalf of Du Pont, Woodward-Clyde Consultants (WCC) is pleased to submit to the USEPA six copies of the Final Human Health Evaluation for the Risk Assessment at the Du Pont - Newport Site. This Final Human Health Evaluation, which describes potential human health risks associated with the Site, is Volume 1 of the two-volume Risk Assessment. Volume 2, which will be submitted under separate cover to the EPA at a later date, is the Environmental Evaluation, which describes potential ecological risks.

Please be aware that some comments outlined in your December 2, 1991 letter to J. Karmazyn of Du Pont were not addressed in the Human Health Evaluation, but are resolved below:

Comment 8

The chemicals of concern were developed using screening procedures consistent with RAGS. As documented in Section 2 and Appendix B of the report, the chemicals identified in Comment 8 are not considered significant potential risk contributors based upon concentration/toxicity screening. Their inclusion would be inconsistent with the screening procedure used, and would require reworking calculations with no material change in results.

Comment 12

No action is required by this comment. However, it should be noted that our approach of providing average or mid-range values is consistent with pending EPA Risk Assessment Guidance (see Superfund Report, January 15, 1992).

[illegible] • Fax 215 834 [illegible]

Mr. Randy Sturgeon
U.S. Environmental Protection Agency
March 18, 1992

Comment 15

The permeability constant value of 1E-4 was specified in the March 11, 1991 letter to EPA (Appendix A). However, the value of 8E-4 in the December 2, 1991 letter from EPA is more appropriate, and the report was revised to incorporate this value.

Comment 17

The RfD for arsenic was revised in risk calculations to reflect the updated value in IRIS. A conservative slope factor of 1.7E-2$(mg/kg/day)^{-1}$ was used for TCE, in accordance with the Region III comments. However, it should be noted that the value of 6E-3 derived from the unit risk for an inhaled TCE dose is appropriate based upon the Risk Assessment Guidance for Superfund (RAGS).

Please do not hesitate to call Mr. Roger Gresh at WCC or Mr. Joel Karmazyn at Du Pont if you have any questions.

Very truly yours,

James F. Roetzer, Ph.D.
Senior Associate Engineer

Roger T. Gresh, P.G.
Project Manager

encl.

cc: K. Kalbacher, DNREC (5)
S. Sury, CIBA-GEIGY
G. Wise, CIBA-GEIGY
B. Butler, Du Pont
J. Karmazyn, Du Pont
M. Nicholson, Du Pont
C. Trmal, Du Pont
A. Hirsch, WCC

RISK ASSESSMENT
HUMAN HEALTH EVALUATION
DU PONT-NEWPORT SITE
NEWPORT, DELAWARE

Submitted to:

U.S. Environmental Protection Agency
Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

On behalf of:

E.I. du Pont de Nemours & Company, Inc.
Du Pont Chemicals
BOD 918-14
1007 Market Street
Wilmington, Delaware 19898

Prepared by:

Woodward-Clyde Consultants
5120 Butler Pike
Plymouth Meeting, PA 19462
(215) 825-3000
March 18, 1992

Project No. 88C2076-4V

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EXECUTIVE SUMMARY

As part of the Remedial Investigation/Feasibility Study (RI/FS) process for the Du Pont-Newport Site, Woodward-Clyde Consultants (WCC) conducted a Human Health Evaluation in accordance with the EPA's Risk Assessment Guidance documents (RAGS), including "Risk Assessment Guidance For Superfund, Volume I: Human Health Evaluation Manual" (USEPA, 1989). The objective of this Human Health Evaluation is to define the risks and hazards which may be associated with the Du Pont-Newport Site (Site). This assessment 1) examines the current levels of chemicals at the Site study area, 2) portrays potential current and future exposure scenarios to these chemicals by human populations, and 3) estimates the carcinogenic risks and non-carcinogenic hazards associated with these potential exposures.

The Du Pont-Newport Site study area includes: an operations area (consisting of the Du Pont-Holly Run Plant area and the CIBA-GEIGY Newport Plant area); two inactive landfills (designated as the North and South Disposal sites); the associated wetlands; the associated segment of the Christina River; the potentially impacted groundwater; and a small recreational area (Ballpark) adjacent to and directly northwest of the Site.

Data collected during the three phases of the RI were evaluated for suitability in the risk assessment process. Based upon screening procedures defined in EPA guidance, twenty-three (23) chemicals of potential concern to human health via a variety of potential exposure routes were identified for soils, surface water and groundwater seeps within the Site study area. These same chemicals of concern were used to evaluate a potential groundwater exposure route.

In addition, potential exposure to lead was considered as a separate case, since EPA has not determined an acceptable level of intake for lead. Lead found in soils and groundwater at the Site was evaluated by comparison to an action level for lead in surface soils and potential drinking water in the Site study area, agreed to by Du Pont and the EPA Region III. Potential lead exposure via ingestion of fish taken from the

Christina River was evaluated by analysis of fish tissue, which indicated lead concentrations were below method detection limit in the fish.

Exposures to chemicals were considered for Site maintenance and construction workers and for local residents who may trespass at the Site or play in areas adjacent to the Site study area. Estimated risks were calculated for current and future land use for both an "average" exposure, based upon moderately conservative assumptions, and a "Reasonable Maximum Exposure" (RME) which represents a grouping of very conservative assumptions. The risks associated with the average exposure and RME were calculated for eleven different populations of potentially exposed humans for various exposure scenarios developed for the Site. Risks were also summed for each of the eleven populations. These risks for each exposure scenario and the cumulative risks for each population were compared to risk levels considered acceptable by the EPA as provided in the 1990 National Contingency Plan (NCP, 1990) and the April 22, 1991 EPA OSWER Directive 9355.0-30. The 1990 NCP provided a guideline for an acceptable excess lifetime cancer risk range of 10^{-4} to 10^{-6}. Furthermore, the more recent EPA guidance (OSWER Directive 9355.0-30) indicates that, "Where the cumulative carcinogenic site risk to an individual based on RME for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient (index) is less than 1, (remedial) action generally is not warranted...". Comparisons to these guidelines were made for carcinogenic risks and non-carcinogenic hazards.

Carcinogenic Risks

For average carcinogenic risks, all cumulative excess lifetime cancer risks associated with current land use at the Newport Site were estimated to be below 10^{-6}. For the RME assumptions, which are very conservative and, thus, may greatly over-estimate risks, all estimated excess lifetime cumulative carcinogenic risks were at or below 1.4×10^{-5}. These values are well within the acceptable risk range of the EPA's guidelines.

Cumulative excess lifetime carcinogenic risks were below 10^{-6} for hypothetical future construction scenarios under average conditions, and at or below 1.1×10^{-5} under RME assumptions. These results suggest that no unacceptable cancer risk is associated with potential construction activities at the Newport Site.

Groundwater in the Old Airport Road area does not represent a future potential community water supply due to the low yield of the Potomac Formation in this area. The Columbia Formation at the Newport Site, along with other Quaternary deposits, is not typically used as a potable water supply due to the indigenous high dissolved mineral content (WCC, 1988; WCC, 1989; WCC, 1991b).

Current monitoring data do not indicate that wells at Old Airport Road have been impacted by the Newport Site study area. To evaluate this future hypothetical scenario of ingestion of groundwater, EPA directed Du Pont to use wells in the vicinity of MW-19 as representative of the Potomac and Columbia Formation aquifers. Potential carcinogenic risks for average and RME scenarios for the potential pathway of Site chemicals were 5.7×10^{-7} and 4.6×10^{-5}, respectively for Potomac Formation groundwater and 2.1×10^{-5} and 3.9×10^{-4}, respectively for Columbia Formation or Shallow Zone groundwater. These risks are generally well within the EPA's acceptable risk range, with the exception of the RME scenario for Columbia groundwater which is above the 10^{-4} guidance value. These estimates are considered very conservative because it was assumed, at the direction of EPA, that ingestion of groundwater from monitoring wells at the site would occur.

With the exception of potential future ingestion of Columbia Formation groundwater, all estimated cumulative carcinogenic risks were below or well within the EPA's acceptable risk range of 10^{-4} to 10^{-6} for both current and future land use scenarios.

Non-carcinogenic Hazards

For non-carcinogenic hazards, all cumulative chronic hazard indices (HI) under average and RME case conditions were below the acceptable level of 1.0 for current land use, suggesting there is no potential for unacceptable non-carcinogenic hazards.

For potential future construction activities, total subchronic non-carcinogenic hazard indices are below 1.0 for average conditions, but slightly above 1.0 for RME assumptions (HI = 2.5) at the CIBA-GEIGY Plant area. This finding was associated primarily with incidental ingestion of soil particulates.

Cumulative hazard indices for the hypothetical ingestion of Columbia Formation groundwater at Old Airport Road exceeded one for both average and RME cases. Cobalt was the major contributor to these calculated hazards. The cumulative hazard index for hypothetical residential ingestion of groundwater from the Potomac Formation was also above 1.0 for RME assumptions. Cobalt was also a primary contributor to this risk.

The potential risk associated with cobalt is considered greatly overestimated due to the Reference Dose (RfD). EPA Region III directed Du Pont to utilize an RfD for cobalt, which is based on a single study of cobalt exposure to heavy beer drinkers, and is intended to protect sensitive subpopulations. EPA Environmental Criteria and Assessment Office (ECAO) in Cincinnati recommends use of an RfD ten times lower than the valve recommended by Region III. Therefore, EPA Region III believes that the required RfD (0.0001 mg/kg/day) is an intermediate position. The calculated hazard indices are also considered to be very conservative because of EPA direction to assume ingestion of on-site groundwater for this scenario. The installation of pub water supply wells along Old Airport Road is unlikely. Monitoring of existing priv potable wells in the Old Airport Road area has not detected evidence of significant site-related contamination.

Lead

An action level of 1000 ppm for lead in all surface soils was proposed by Du Pont, based upon previous EPA Records of Decision (ROD), by letter to the EPA Region III dated July 10, 1991. Subsequent discussions between Du Pont and the EPA Region III resulted in an agreement for using an action level of 500 ppm for lead in surface soils in areas where exposure to children or adolescents is considered likely. Likewise, Du Pont and the EPA Region III agreed to use an action level of 1000 ppm for lead in surface soils in areas where only industrial exposure is anticipated. Hazard quotients were calculated for lead in soils and groundwater based on EPA direction concerning the action levels for lead in soils and the drinking water. Hazard quotients for lead above ten were estimated for exposure to CIBA-GEIGY Plant soils and ingestion of Columbia Formation groundwater. Hazard quotients for lead above one were estimated for exposure to North Disposal site and South Disposal site soils and ingest

of Potomac Formation groundwater. Methods for eliminating or controlling exposure to lead in surface soils and groundwater above the action level will be evaluated in the Feasibility Study for the Site.

A variety of "edible" fish species representing different trophic levels were collected from the Christina River in the Site vicinity and near the upstream reference station. Fillets (edible portions) were analyzed for lead content to address lead exposure to humans via ingestion. In all samples from the Christina River, the lead concentration was below the method detection limit. Utilizing one-half the detection limit for the lead analyses, the available lead concentrations in fish fillet tissues were used to evaluate the potential increase in blood lead levels of children based on the EPA LEAD.4 biokinetic model. The calculated increase in blood lead level was insignificant compared to the advisory range for blood lead levels. These results eliminated concerns for potential lead risks in fish from the Site study area and obviate need for any further action regarding lead in fish at the Site.

Uncertainty

In this risk assessment, as in any risk assessment conducted with the current state of knowledge, there is considerable uncertainty associated with chemical concentrations and movement, chemical toxicity, and quantification of exposure and risk. In order to offset these uncertainties, EPA guidance generally requires use of conservative assumptions. The net effect of these assumptions is that this risk assessment is much more likely to overestimate risk than to underestimate risk. In interpreting the quantitative risk estimates presented in this report, it should be recognized that the risk estimates presented herein may overestimate actual risks by one or more orders of magnitude.

1.0
INTRODUCTION

1.1 SCOPE AND OBJECTIVES

As part of the Remedial Investigation/Feasibility Study (RI/FS) process for the Du Pont-Newport Site, Woodward-Clyde Consultants (WCC) conducted, on behalf of Du Pont, a Human Health Evaluation and an Environmental Evaluation in accordance with the EPA's Risk Assessment Guidance documents (RAGS). The Newport Site assessment is provided in two separate volumes. Volume I, herein, is the Human Health Evaluation which addresses the potential human health risks associated with the Du Pont-Newport Site. Volume II, presented under separate cover, is the Environmental Evaluation which addresses the extent of the potential environmental/ecological impacts and is a companion document.

The objective of this Human Health Evaluation was to define the potential risks which may be associated with the chemicals detected at the Du Pont-Newport Site study area. This assessment (1) examined the current levels of chemicals at the Site study area, (2) portrayed current and future exposure scenarios, and (3) estimated the potential carcinogenic risks and non-carcinogenic hazards associated with these exposures. Throughout this report, calculations or mention of carcinogenic risks refers to potential excess lifetime cancer risks.

The Human Health Evaluation also addressed exposures to chemicals associated with historic operations and their potential impacts on the surrounding areas. Chemicals historically used at the on-site manufacturing facilities as well as those chemicals previously discarded in the on-site disposal areas (landfills) and found to be present in the surface soil, surface water and/or groundwater were evaluated on the basis of analytical data from three phases of remedial investigation. The following Site-related activities and events were included in this assessment:

- Potential exposures associated with current and potential future Site-related construction and maintenance activities

- Current and potential future recreational activities at locations near the Site
- Current and potential future trespass activities, and
- Potential future nearby residential development

On February 20, 1991, a meeting was held between representatives of Du Pont, EPA Region III, and WCC personnel to define requirements for the Newport Site risk assessment. This meeting led to a series of agreements concerning assumptions for exposure scenarios and input parameters to be used in the Human Health Evaluation. Key assumptions and parameters agreed to at the meeting included:

- Receptor groups to be considered
- Exposure durations, frequencies and times for various exposure scenarios
- Soil ingestion rates
- Airborne soil particulate concentrations
- Soil to skin adherence factors
- Dermal permeability constants, and
- Body areas exposed in dermal contact scenarios

The March 11, 1991 WCC letter to the EPA documenting the agreements reached at this meeting is included as Appendix A. Section 4 of this report discusses in detail the incorporation of these agreements, subsequent agreements reached between Du Pont and the EPA, and other exposure factors consistent with EPA guidance into the exposure calculations used in this Human Health Evaluation for the potentially exposed receptor populations.

A draft of this report dated October 14, 1991 was submitted to EPA. This report incorporates comments on the draft report documented in letters from R. Sturgeon of EPA to J. Karmazyn of Du Pont, dated December 2, 1991 and February 11, 1992, a letter from J. Karmazyn to R. Sturgeon dated January 2, 1992, and several teleconferences between Du Pont and EPA personnel.

1.2 SITE BACKGROUND

The Du Pont-Newport Site study area (Figure 1-1) includes: an operations area (consisting of the Du Pont-Holly Run Plant area and the CIBA-GEIGY Newport Plant area); two inactive landfills (designated as the North and South Disposal sites); the associated wetlands; the associated segment of the Christina River; the potentially impacted groundwater; and a small recreational area (Ballpark) adjacent to and directly northwest of the Site.

Except in the landfill areas and the operating plant areas, the portion of the Site study area adjacent to the riverbank is mostly comprised of wetlands. The extent of these wetlands is related to the tidal nature of the Christina River at this location.

Plant Operations

Historically, the Newport Plant, located at James and Water Streets, in Newport, Delaware, has been primarily a pigment manufacturing facility. The facility was originally owned and operated (from 1902 to 1929) by Henrik J. Krebs for the manufacture of Lithophone, a white inorganic pigment made by blending zinc sulfide and barium sulfate. In 1929, Du Pont purchased the plant and continued to manufacture Lithophone and other materials. The production of Lithophone ceased in 1952.

Copper phthalocyanine (CPC), a blue, green and yellow pigment, was manufactured at the Site from approximately 1948 to 1984. The production of Quinacridone (QA), a red organic pigment, started at the Site during 1958 and continues today under the ownership of CIBA-GEIGY.

Other historical Du Pont operations at the plant included the production of: titanium metal, manufactured at the plant from approximately 1948 to 1969; thoria dispersed modified nickel, 1961 to 1966; high purity silicon, from approximately 1942 to 1958; "Ti Pure" finishing operations which yielded a TiO_2 white pigment made from TiO_2 slurry received from the Edgemoor Plant; and other new pigment products such as "Afflair"

flake pigments (mica coated with titanium oxide) that were manufactured at the pilot plant on a demonstration scale.

The facilities related to the above pigment operations at the Newport Plant were sold to CIBA-GEIGY in 1984. Only QA production continues today under CIBA-GEIGY ownership. In addition, Du Pont has produced chromium dioxide (powder) at the Newport Site since 1966, and until 1983 manufactured magnetic recording tape. The original chromium dioxide plant facilities and all the magnetic tape operations buildings were included in the sale of the Newport Plant in 1984. New facilities were constructed for the chromium dioxide powder production in 1979 and were retained by Du Pont as the Holly Run Plant, when the remainder of the operations area was sold in 1984.

Predominant materials associated with these manufacturing processes included barium, zinc, cadmium, lead, mercury, chromium, arsenic, and tetrachloroethene (PCE). Various wastes disposed on-site were associated with these materials, as well as production of specialty metals including thoriated nickel, a low level radioactive material. Since on-s[illegible] radiation levels are within background levels, the thoriated wastes are not considered [illegible] issue of concern at the Newport Site and, therefore, will not be addressed further in this report. For additional information regarding the disposal of thoriated wastes, see the WCC Data Sufficiency Supplement report for the Du Pont-Newport Site, issued to the EPA on November 8, 1989 (WCC, 1989b).

About 75 percent of the Holly Run and CIBA-GEIGY Plant areas are covered with buildings, concrete, or macadam. The ground surface in this operations area generally slopes to the east from an elevation high of approximately 29 feet above mean sea level in the eastern end of the Holly Run Plant area to a low of approximately 10 feet at James Street.

Since the early 1900's, the land use at the Site has been limited to industrial activities. In parts of the non-wetlands area of the Site north of the river, industrial operations were preceded by agriculture, as supported by historic aerial photographs, and present day remnants of an orchard adjacent to the North Disposal site.

Power plant facilities utilizing fossil fuels have existed during the entire period of manufacturing operations along the railroad tracks in the vicinity of the present day Building 204. The polynuclear aromatic hydrocarbons (PAHs) detected in this area of the site during the RI are probably associated with the historic power plant activities at the Site, rather than historic pigment manufacturing operations.

The North and South Disposal Sites

Throughout the period from 1902 to 1953, certain wastes from the facility operations were disposed of in the two unlined landfills adjacent to the Christina River. In 1953, the South Disposal site was closed but the North Disposal site remained active until 1974. Historically, different types of wastes were deposited in the two sites at different times (WCC, 1988). Prior studies have detected various chemicals in the subsurface soils and fill material of both the North and South Disposal sites.

The North Disposal site is a seven-acre inactive landfill bounded by the Holly Run and CIBA-GEIGY Plant areas, the Christina River and north wetlands area (see Figure 1-2). The North Disposal site is primarily covered with maintained grass and rimmed with pine trees and other heavy vegetation. A drainageway surrounds the northern and western edge of the landfill and empties into the Christina River. Except in areas sloping toward the drainageway, the surface elevation for most of the North Disposal site is approximately 20 to 25 feet above mean sea level and at least 10 feet above the shallow water table. Based on records of disposal history, materials known or believed to have been deposited at the North Disposal site include plant debris such as off-grade imitation marble counters, empty steel drums, metal alloys, liquid wastes and pigment muds (WCC, 1988). After disposal ceased in 1974, the North Disposal site was capped with about two feet of clayey soil and vegetated.

The South Disposal site constitutes 15 acres of a 45-acre tract of land owned by Du Pont on the south side of the Christina River. The elevated northern one-third of the tract is the inactive landfill labeled the South Disposal site, which is covered with moderate to heavy vegetation. Wastes were disposed of in the South landfill (south of the river) from approximately 1902 to 1953. Materials deposited in the South Disposal site consisted primarily of nearly insoluble residues of zinc and barium ores from Lithophone

production, which were pumped as a slurry to the landfill through a pipeline under the Christina River. In 1973, the State of Delaware Department of Highways deposited about 130,000 cubic yards of variable soils from highway construction over the South Disposal site, covering it to an average depth of about three feet (WCC, 1988).

The previous landfilling operations resulted in grade elevations ranging from a high of approximately 16 feet above mean sea level in the northern portion of the landfill to approximately 4 feet in the wetlands area immediately south of the landfilled area. The South Disposal site exhibits a gentle grade, north to south, with a steepening slope near the southern edge of the filled area and a northwestern slope along the riverbank itself. An existing dike traverses the center of the tract in an east-west direction, curving in a northerly direction at the eastern and western boundaries of the landfill. This dike has steep side slopes and an approximately 25-foot wide crest with a typical elevation of about 12 to 13 feet above mean sea level. A breach exists in the dike near its southwestern corner. A triangular wedge of wetlands and a small surface water pond exists between the dike and the South Disposal site.

The remaining southern portion of the 45-acre tract (approximately 40 percent) is fresh water emergent lowlands which have been designated by the U.S. Fish and Wildlife Service (USF&WS) as "wetlands." Historically, a series of ditches were cut through this wetlands area with drainage the river primarily to the east as evidenced by aerial photographs from the 1930's and 1940's. The water from the ditch system currently flows northwest to the Christina River via a tide gate located just west of the northern property boundary with the Christina River. The tide gate is designed to allow surface water to flow from these wetlands at low tide, but to prevent inflow of river water when the tide level rises by a sealing flap valve on the outflow side of the tide gate pipe. Historic aerial photography demonstrates that drainage of these southern wetlands used to be eastward, rather than northwestward. This change in drainage direction was apparently caused by rechannelization of the river and filling operations associated with the construction of state Route 141 adjacent to the Site.

The Christina River

The width of the Christina River between the North and South Disposal sites ranges from approximately 160 to 330 feet. The tidal influence of the Delaware River extends past the Du Pont-Newport Site to approximately 15 miles upstream from the confluence of the Christina and Delaware Rivers. According to the National Oceanic and Atmospheric Administration (NOAA), the mean tidal range of the Christina River at Wilmington, approximately five miles downstream of the Newport Site, is 5.7 feet. This agrees with the daily tidal fluctuations observed to occur over an average of 5 to 6 feet by WCC during one month of continuous tidal monitoring from June to July 1987.

The substrate of the Christina River in the Newport area is variable. The sediments range from silts and muds in depositional areas, to predominantly sands in erosional areas, with areas adjacent to the Newport Site underlain by rubble, rip-rap and various types of urban refuse. In general, subsurface sediments (below 6-12 inches) are composed of stiff, grey clay.

Intermittent areas of groundwater seepage into the river have been identified in some segments of the intertidal zone on the north bank of the Christina River between the mouth of the North Disposal site drainageway and about 200 feet west (upstream) of the James Street bridge where a bulkhead begins and extends to the bridge.

Surrounding Area

The City of Newport is to the north of the Site and is mainly commercial and residential. There is a railroad line used by Amtrak Rail that runs east-west along the northern border of the Site. The area to the east of the Site between the railroad tracks and the Christina River is mixed commercial, industrial, and residential; this area also includes some wetlands. The area to the east and southeast of the Site (to the south of the Christina River) is owned by the State of Delaware and comprises right-of-way zones for the restricted access highway interchange and wetlands. The area to the southwest of the Site (south of the Christina River) consists of commercial, industrial, and residential zones. The area to the west and southwest of the Site (north of the Christina River) is currently owned by Du Pont. This area includes the former site of the Kopper's

Company wood-preserving operations and potential wetlands. A resident in the area along Old Airport Road, south of the Site, was considered as a receptor for a hypothetical future groundwater ingestion scenario, using representative on-site wells to evaluate concentrations of chemical constituents for the Site study area. A small Du Pont-owned area north of the CIBA-GEIGY Plant area which is used recreationally by the City as a ballpark (the Ballpark), was also considered in this assessment.

A review of aerial photography dating back to 1937 for the area of the Newport Site suggests that the current location of the Ballpark coincides with the recreational area that existed during much of the historical Lithophone operations era. Conversion of the Ballpark into a parking lot coincided approximately with the termination of Lithophone operations at the plant in the early 1950s. By 1961, fill material was placed over the gravel parking lot, and by 1968 the Ballpark was in use again for recreational activities.

As Du Pont discussed verbally with the EPA on January 8, 1991, pedestrian (employee) "tracking" may have resulted in transport of various fill materials from the plant to the Ballpark and parking lot during the period of Lithophone operations. In addition, Du Pont believes fill material from the plant may have been used to occasionally groom the infield area of the baseball diamond at home plate, first base, and third base. The parking lot was returned to a recreational area by 1961. By the early 1970s, the high speed rail became operational and a fence was erected along the Du Pont side of the railroad tracks. These events precluded any further crossing of the tracks from the plant area. Thus, no additional tracking is likely to have occurred after that point in time.

Additional details concerning land use in the Site vicinity are presented in Section 3.2.

1.3 PREVIOUS SITE INVESTIGATIONS

Previous remedial investigations at the Newport Site have been discussed in the following reports:

Proposed RI/FS Work Plan (Phase I)	July 20, 1987

Work Plan, Remedial Investigation/Feasibility Study, Du Pont-Newport Site, Volumes I, II, III	July 28, 1988
Wetlands Investigation Du Pont-Newport Site	March 23, 1989
Data Sufficiency Memorandum-Remedial Investigation, Phase II, Du Pont-Newport Site	April 27, 1989
Data Sufficiency Supplement, Remedial Investigation, Phase II, Du Pont-Newport Site	November 1989
Phase III Wetlands Investigation, Technical Data Summary Report, Du Pont-Newport Site	January 1990
Draft Human Health and Environmental Assessment Operable Unit 1, Du Pont-Newport Site, Newport, Delaware	June 8, 1990
Final Phase III Remedial Investigation Feasibility Study Work Plan	February 5, 1991
Phase III Remedial Investigation Data Sufficiency Report, Du Pont-Newport Site	May 17, 1991

The following subsections briefly summarize the results of media studies conducted to date at the Site. Additional details concerning sampling and analytical methods, and detailed discussions of results are presented in the above-referenced reports.

Surface Soil

The assessment of surface soils at the Site was conducted with several sets of data collected over the four-year period of Phases I, II and III of the RI. During this period, approximately 345 soil samples were taken at various depths and geographic locations, both on-site and off-site. Approximately 100 of these samples consisted of near surface soils (samples taken within 4.5 feet of the surface) and the balance were deeper sub-surface soils. Specific locations of the test borings and surface samples from areas other than the Ballpark are presented in Figure 1-2. Specific locations of surface soil samples taken from the Ballpark are presented in Figure 1-3.

Because soils impacted by historical Site operations may have been covered by clean fill in some areas, and because potential future construction activities may uncover current subsurface soils in some areas, soil samples collected up to and including a depth of 4.5 feet were used in the assessment as representative of conditions to which receptors may be exposed. Analyses performed on the soil samples included Target Compound List (TCL) volatile organics, TCL semi-volatile organics, pesticides, polychlorinated biph- (PCBs), Target Analyte List (TAL) metals and parameters on the Hazardous Subst- List (HSL).

Surface Water

In order to assess the surface waters at the Newport Site for a potential adverse human health effect, data were used from a total of 27 surface water samples. These samples were selected from areas that were identified as potential exposure points and were obtained from both on-site and off-site locations in the immediate vicinity of the Site during the wetlands investigation (WCC, 1988 and 1989a). Analyses performed on th- water samples included TCL volatile organics, TCL semi-volatile organics, pesticid-, PCBs and total and dissolved TAL metals.

The locations of wetlands investigation sampling stations (which included sediment and surface water sample collection) are presented in Figures 1-4 and 1-5.

Groundwater

Four water-bearing zones have been previously identified at the Site (from shallow to deep): the Fill/Other Quaternary zone; the Columbia Formation zone; the Intermediate zone; and the Deep zone. The Fill/Other Quaternary zone and Columbia Formation zones are relatively shallow unconfined water-bearing zones and are not used for public water supply in the area of Newport, Delaware. The Delaware Department of Natural Resources and Environmental Control (DNREC) considers these shallow unconfined zones equivalent to EPA Class III groundwaters. The EPA Region III Office of Groundwater Management has reevaluated and reclassified the Columbia Formation at the Newport Site as a Class II-A aquifer. Initially EPA direction during workshops Du Pont on February 20, 1991 and October 1, 1991 was not to include ingestion of

groundwater from the Columbia Formation in this Human Health Evaluation. However, in EPA's letter to Du Pont, dated February 11, 1992, Du Pont was instructed to utilize analytical results from wells MW-8, MW-9, MW-19A and MW-26A as representative of constituent concentrations in the Columbia Formation for this risk assessment.

The intermediate and deep water-bearing zones are in the Potomac Formation, which underlies the Columbia Formation. The Potomac Formation is used for public water supply at a distance of over one mile to the south of the Site, but not in the Newport area. The low yield of the Potomac Formation in the vicinity of the Site is considered to preclude the potential future installation of public water supply wells. There are private residential wells located on Old Airport Road south of the Site. A house-to-house inventory of private well usage along this road was conducted by WCC to determine well depths and screened intervals. Based on the information provided by the residents, these wells along Old Airport Road are screened in various shallow to deep zones (WCC, 1988 and 1989).

Groundwater in the intermediate zone at the Site is generally moving toward the southeast across the Site. A vectorial component of the Potomac Formation groundwater flow could potentially reach the residential wells south of the Site along Old Airport Road. In contrast, shallow zone (Fill and Columbia Formation) groundwater generally flows from the Site toward the Christina River and the wetlands rather than toward Old Airport Road and, therefore, is not likely to reach the Old Airport Road receptors. However, under EPA direction, both intermediate and deep groundwater (Potomac Formation) and shallow groundwater (Columbia Formation) were used in evaluating potential future groundwater exposure. The location of the Potomac Formation wells and Columbia Formation wells from which groundwater quality data were used for this risk assessment, as directed by EPA, are presented in Figure 1-6.

Groundwater samples from monitoring wells installed during Phase III were analyzed for TCL volatile organics, TCL semi-volatile organics, pesticides, PCBs, and total and dissolved TAL metals. Samples collected from wells installed prior to Phase III were analyzed for TCL volatile organics and total and dissolved TAL metals. Groundwater samples from the private wells off-site (along Old Airport Road) that were analyzed for

TCL volatile organics and total and dissolved TAL metals showed that there is currently no impact on groundwater chemistry at those well locations from the Site.

Groundwater seepage samples were collected during the Phase III RI from 12 points along the north bank of the Christina River adjacent to the North Disposal site and the CIBA-GEIGY Plant area. These samples were analyzed for TCL volatile organics, TCL semi-volatile organics, and total and dissolved TAL metals. Sampling locations are shown on Figure 1-6. These results were used in evaluating potential exposures to recreational users along the river.

1.4 SCOPE OF RISK ASSESSMENT

This Human Health Evaluation for the Du Pont-Newport Site follows guidance provided by the EPA for performing risk assessments at Superfund sites. This guidance provided a framework for performing and presenting the assessment and is comprised of several steps discussed in Section 1.5. This risk assessment used site-specific data and professional judgement as required to evaluate the potential human health risks associated with the source areas at the Site study area.

The primary objective of this baseline risk assessment was to evaluate the potential human health risks associated with existing or baseline conditions. Health risks were evaluated for baseline conditions, defined as the present conditions at the Site, and for exposures related to potential on-site and nearby off-site future human activities. Both average and reasonable maximum exposure (RME) scenarios were addressed in this risk assessment. This assessment does not identify clean-up levels or evaluate remedial alternatives. The results of this assessment may be used in later stages of the overall Site remediation planning as part of the Feasibility Study.

The approach used to evaluate potential health risks associated with baseline conditions follows EPA guidance for human health risk assessment. Specifically, this human health risk assessment is consistent with guidance and data provided in the following EPA references:

- "Superfund Exposure Assessment Manual" (USEPA, 1988)

- "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual" (USEPA, 1989)
- "Exposure Factors Handbook" (USEPA, 1990)
- Integrated Risk Information System (USEPA-IRIS)
- OSWER Directive 9355.0-30 (OSWER, April 22, 1991)
- 1990 National Oil and Hazardous Substances Contingency Plan (NCP, 1990)

1.5 ORGANIZATION OF RISK ASSESSMENT

1.5.1 Data Evaluation

"Data Evaluation", Section 2, describes the process by which the data gathered during the Site investigations were evaluated and organized into a form appropriate to conduct a risk assessment. The objective of this step was to identify the chemicals of concern for human health evaluation. These chemicals are Site-related and have data of adequate quality for use in the quantitative risk assessment.

1.5.2 Site Characteristics

"Site Characteristics", Section 3, discusses the exposure setting for the Du Pont-Newport Site study area. Specific items included in this chapter are the geological setting, soil type/vegetation, climate, meteorology, groundwater hydrology, land use and area demographics.

1.5.3 Exposure Assessment

"Exposure Assessment", Section 4, describes the human receptor populations that may potentially be exposed to Site-related chemicals of potential concern, the pathways by which exposures may occur, and the potential magnitudes, frequencies and durations of these exposures.

1.5.4 Toxicity Assessment

"Toxicity Assessment", Section 5, discusses the evidence regarding the potential for a substance to cause adverse effects in exposed human populations, and where possible, to estimate the relationship between extent of exposure and extent of toxic response. Chemical-specific toxicity values, i.e., reference doses for non-carcinogenic effects and slope factors for carcinogenic effects, are presented in this section.

1.5.5 Risk Characterization

"Risk Characterization", Section 6, integrates the information presented in the previous section of the risk assessment to estimate quantitatively the baseline carcinogenic and non-carcinogenic human health risks. The major uncertainties and limitations associated with the risk assessment process and assumptions are presented as Section 7 of this report.

2.0
DATA EVALUATION

The data evaluation objective was to identify the chemicals of concern for each media. The chemical data must be Site-related and of sufficient quality for use in the quantitative baseline risk assessment. The chemicals of concern were identified from the entire list of chemicals detected at the Site study area on the basis of: concentrations in each medium, toxicity, background concentrations, and frequency of detection. Those chemicals that potentially accounted for greater than one percent of the total risk were identified as chemicals of concern for the Human Health Evaluation. The selection of chemicals of concern for the quantitative risk assessment was based on the evaluation criteria recommended in EPA's "Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual" (USEPA, 1989).

Samples of surface soil, sub-surface soil, sediment, surface water, groundwater, groundwater seepage, and biota were collected for chemical analysis. Soil, sediment, and surface water quality data used in the Human Health Evaluation included data collected during all three phases of the Remedial Investigation. Groundwater quality data used in this evaluation were limited to Phase III data, which represents the most recent and comprehensive groundwater quality data. Some of the collection data were not appropriate for calculating the health risks for the potential Site-related human receptors, due to the absence of human exposure pathways. For example, sub-surface soils (greater than 4.5-foot depths) and surface water sediments were not evaluated due to incomplete exposure pathways. The remaining data were compiled by area and media of concern and are summarized in Tables 2-1 through 2-10. A summary of the soil and water samples used for each source area for the exposure assessment (Section 4) is presented in Table 2-13.

The remainder of this section presents the evaluation criteria utilized in the identification of acceptable data for quantitative risk assessment purposes and in the selection of the chemicals of concern at the Du Pont-Newport Site study area.

2.1 DATA QUALITY

Quality of analytical data was evaluated through a data validation process and ongoing project quality assurance programs. The following section summarizes procedures used in evaluating the chemical data set used in this risk assessment.

2.1.1 Detection Limits

The detection limit is the lowest amount of a chemical that can be "seen" above normal, random noise of an analytical instrument or method (USEPA, 1989). When a given chemical was not detected (ND) above the detection limit in any sample in a given medium and area, it was not included in the quantitative risk assessment. When a chemical was detected in some of the samples for a given medium and exposure point, one-half the detection limit was substituted for the non-detect value in order to conservatively quantify potential average and 95 percent upper confidence limit concentrations.

2.1.2 Data Validation, Data Qualification and Rejection

Analytical data reported by the laboratories were subjected to additional quality assurance through the WCC data validation process reported in the following documents:

- Quality Assurance/Quality Control Audit. Phase I-RI, Du Pont-Newport Site, Newport, Delaware (November, 1988)
- Quality Assurance/Quality Control Audit. Aquatic Biological Investigation, Du Pont-Newport Site, Newport, Delaware (December, 1988)
- Quality Assurance/Quality Control Audit. Wetlands Investigation, Du Pont-Newport Site, Newport, Delaware (January, 1989)
- Quality Assurance/Quality Control Audit. Phase II RI Data, Du Pont-Newport Site, Newport, Delaware (February, 1989)

- Quality Assurance/Quality Control Audit. Phase III Wetlands Investigation, Du Pont-Newport Site, Newport, Delaware (January, 1990)

- Quality Assurance/Quality Control Audit. Phase III RI Data, Appendix F of the Remedial Investigation Report (May, 1991).

During data validation, some sample results were rejected as being of unacceptable quality for use in decision making based upon the EPA Contract Laboratory Program (CLP) guidance. Rejected data were not used in this risk assessment. Other data, although not rejected, may be subject to certain limitations or qualifications. These qualifications are identified by a flag or code attached to the data, as discussed below. Qualified data, as well as data accepted without qualification, were used in the risk assessment.

Qualifier codes, as defined in the EPA CLP, are described below, along with a brief discussion of how qualified data were handled in this risk assessment.

J Indicates the compound was present at a level less than the CLP-required quantitation limit or otherwise denotes an estimated value. This qualifier indicates uncertainty in the reported concentration of the chemical but not in the identification. Data qualified as estimated were included in the quantitative risk assessment by assuming that the estimated concentration was the actual concentration.

B For organic chemicals, this indicates the constituent was found in the associated laboratory and field blank sample as well as in the Site sample. Blank samples provide a measure of contamination that has been introduced into a sample either (1) in the field while the samples were being collected or transported to the laboratory or (2) in the laboratory during sample preparation or analysis. Typically, "B" qualified data include certain organic chemicals commonly used in the laboratory that may be introduced into a sample from laboratory cross-contamination or from field sampling equipment and does not originate from the Site study area. Organic chemicals considered to be potential laboratory contaminants by the EPA

include acetone, 2-butanone, methylene chloride, toluene, and phthalate esters. These potential blank contaminants were not automatically eliminated from the data sets used in this risk assessment. Data validation reports were reviewed and values determined to be laboratory artifacts were transformed to not detected at the value originally reported, in accordance with EPA data validation guidelines. Those not identified as artifacts in a given sample were included in the data set used to evaluate potential health risk.

E Indicates the reported concentration exceeds the calibration range of the analytical instrumentation. This qualifier indicates uncertainty in the reported concentration of the chemical but not the identification. For CLP analyses, these data were considered acceptable and were used in the risk assessment.

D Indicates the compound was identified in an analysis at a secondary dilution factor. No uncertainty is associated with the identity or concentration of these constituents. These data were included in the quantitative risk assessment.

N For organic analyses, indicates presumptive evidence that the organic compound was present and denotes an estimated value for tentatively identified compounds (TICs). Both the identity and the concentration of TICs are uncertain. These data were not included in the quantitative risk assessment. For inorganic chemical analyses, N indicates the spiked sample recovery was not within control limits. This qualifier indicates uncertainty in the reported concentration but not in constituent identification. Therefore, these data were included in the quantitative risk assessment.

2.2 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs are organic constituents detected in the sample but not present on the Target Compound List (TCL). When the number of TICs reported is low compared to the TCL constituents detected, TICs are not generally included in a quantitative risk assessment. However, when historical or other site information indicates that certain TICs are

potentially present at a site, the TICs should be evaluated. Previous RI reports have not identified TICs as compounds of concern for the Newport Site. Therefore, TICs were not considered in this risk assessment.

2.3 CHEMICALS OF CONCERN

2.3.1 Site Soils, Surface Waters and Groundwater Seeps

Tables 2-1 to 2-7 present summaries of chemical data reported for soils and surface water for each exposure point at the Site study area. Table 2-8 reports chemical data for groundwater seeps at the Site study area. Each table lists the number of times the chemical was detected, the total number of samples, and the minimum, maximum, mean, and 95 percent upper confidence limit on the mean (95 percent UCL) for each chemical. Chemicals detected in the soils and surface waters at the Site were screened to identify compounds of greatest concern from the perspective of human health risk. This screening procedure followed guidance given in the RAGS (EPA, 1989). The first step was a pre-screening procedure, to eliminate chemicals not considered to represent human health risks. Due to the large number of chemicals reported in these various media, additional screening was performed to focus the analysis on those chemicals of greatest potential concern. Chemicals were screened based upon comparison to background conditions, frequency of detection, and concentration-toxicity ratios to develop the list of chemicals of concern to be used in the quantitative estimation of risk. The following sections describe the results of the screening process for chemicals detected in the soils, surface waters and groundwater seeps at the Site.

2.3.1.1 Pre-Screening

Some of the chemicals analyzed for and reported in the data tables were collected as general indicators of soil and water quality, and are not related to human health risks. Parameters analyzed for, but not considered in this Human Health Evaluation, are presented on Table 2-14. These parameters are either general indicators unrelated to toxicity (e.g. total organic carbon, total suspended solids) or parameters of such low toxicity (e.g. sodium and chloride) that they are extremely unlikely to contribute to any

significant risks through environmental exposure. These parameters are not considered further in this evaluation.

2.3.1.2 Background Metals Concentrations in Soils

Background metal concentrations for soils in the vicinity of the Site were difficult to establish due to the generally disturbed nature of the soils in the area. For this reason, metals detected in soils in each area of the Site were compared to reported background soil concentrations in the U.S. This comparison used data reported by Shacklette & Boergnen (1984) and Dragun (1988). Table 2-15 presents a summary of this evaluation. Site concentrations of five metals were determined to be within the range of U.S. background concentrations: beryllium, chromium, cobalt, manganese, and nickel. However, site-specific background soil concentrations for these five metals could not be established. Therefore, it could not be determined definitively if these metals were indeed present in Site soils at true background levels. The conservative approach to this situation was to retain these five metals in the evaluation performed to determ chemicals of concern from among the list of site contaminants, i.e., none of the me were excluded from consideration based upon background concentrations.

2.3.1.3 Frequency of Detection

Chemical constituents that were detected infrequently were deleted from consideration in the risk assessment process. A detection frequency of approximately five percent or greater in each environmental medium was utilized as a criterion for the inclusion of constituents in the lists of chemicals of concern as recommended in EPA guidance. For some media, less than 20 samples were analyzed. In these cases, if a chemical was detected in only one sample in a given medium where greater than 10 samples were analyzed, it was not retained as a chemical of concern unless it was detected at high frequency in other media at the Site. In this manner, isolated occurrences, not confirmed by additional analyses, and likely non-representative of the condition of the Site study Area, were excluded from the quantitative risk analyses.

Tables 2-1 through 2-8 summarize data reported for media of concern (soils, su waters and groundwater seeps) at the Site, including frequency of detection. Table 2-10

summarizes frequency of detection for potential chemicals of concern. Based upon this information, six chemicals detected at low frequency in these media were eliminated as chemicals of concern. These are:

Beta-BHC
4-Methyl-2-pentanone
1,2-Dichloroethane
Dieldrin
Heptachlor epoxide
Xylenes

Maximum reported concentrations of each of these chemicals were below 0.05 mg/kg in soil.

2.3.1.4 Concentration-Toxicity Screen

The most important factors that determine the potential risk of a chemical to exposed populations are the concentration detected at the Site study area and the toxicity of that chemical. The objective of the concentration-toxicity screen was to identify the constituents in a particular medium that contribute most significantly to potential health risks for site-specific exposure pathways. This procedure resulted in a list of potential chemicals of concern. The concentration-toxicity screen focused the risk assessment on the most toxicologically significant chemicals present in the soils, surface waters and groundwater seeps at the Site study area.

The concentration-toxicity screen applied in this assessment followed the guidance provided in RAGS (USEPA, 1989) and allowed a chemical and medium specific chemicals of concern list to be prepared for each potential exposure point. For each chemical within each media, a risk factor was calculated by multiplying the maximum chemical concentration by a chemical-specific toxicity criterion. Risk factors were calculated separately for non-carcinogens and carcinogens and utilized either the reciprocal of the Reference Dose (RfD) or the Slope Factor (SF), respectively. An RfD for a chemical is an estimate of a daily exposure level for that chemical in the human population that is likely to be without an appreciable risk of deleterious effects during

a lifetime exposure. In the case of cobalt, an extremely conservative RfD of 0.0001 mg/kg/day was used, based upon the direction of EPA Region III. The cancer SF for a chemical is a plausible upper-bound estimate of the probability of a response per unit intake of that chemical over a lifetime. It is used to estimate the probability of an individual developing cancer as a result of a lifetime of exposure to that chemical. These toxicity criteria are discussed further in Section 5.

The chemical-specific risk factors for each medium were summed to obtain a total risk screening factor. The ratio of the individual risk factors to the total risk factor approximates the relative risk associated with each chemical in the medium. Chemicals contributing less than one percent of the total risk factor for each medium were eliminated from the list of chemicals of potential concern. Appendix B presents detailed results of the concentration-toxicity screen. Chemicals identified as potential chemicals of concern for each area are presented in Table 2-17.

Several chemicals could not be screened due to the absence of toxicity factors (RfDs, slope factors). These chemicals, identified on Table 2-18, were not evaluated quantitatively in this Human Health Evaluation. Some of the compounds identified on Table 2-18, namely PAHs and 1,3-dichlorobenzene, were not evaluated in the risk assessment. Instead, structural analogs were evaluated. For dibenzofuran, detected at low concentrations (less than 1 ppm), in 3 samples, there is insufficient data to support a quantitative assessment, and this compound was not considered further. Lead was considered as a special case, since no generally accepted RfD is available.

Lead was evaluated on the basis of an action level rather than a quantitative risk assessment. An action level of 1000 ppm for lead in surface soils, based upon previous EPA Record of Decision (RODs) for sites with lead contamination, was proposed by Du Pont by letter to EPA Region III dated July 10, 1991. Based upon subsequent discussions, Du Pont and EPA have agreed to an action level of 500 ppm for lead in surface soils where exposure to children or adolescents is likely. Likewise, Du Pont and EPA have agreed to an action level of 1000 ppm for lead in surface soils where only industrial exposure is anticipated. EPA directed Du Pont to evaluate these lead action levels by determining lead's contribution to the Hazard Index. This evaluation is discussed in Section 6.4. Methods for eliminating or controlling exposure to lead

surface soils above the action level will be evaluated in the Feasibility Study for the Site study area.

2.3.1.5 Chemicals of Concern for Soils and Surface Waters

Each of the chemicals presented on Table 2-17 was considered a chemical of concern. Chemicals were retained for quantitative assessment of risk for all media and pathways if they were identified as a concern in one or more media.

Bis(2-ethylhexyl)phthalate represents a potential laboratory and/or field artifact. However, it was retained in this assessment because it was not determined to be a blank contaminant in all samples during the data validation process.

The selected list of compounds of concern identified by the screening process retained for the quantitative risk assessment included: antimony, arsenic, barium, benzo(a)anthracene, beryllium, bis(2-ethylhexyl)phthalate, cadmium, carbon tetrachloride, 4-chloroaniline, chlorobenzene, chromium, cobalt, copper, 1,1-dichloroethene, manganese, mercury, nickel, tetrachloroethene, thallium, trichloroethene, vanadium, vinyl chloride, and zinc.

Lead is considered as a chemical of concern, but is evaluated by comparison to an action level rather than through a quantitative calculation of risk.

2.3.2 Groundwater

Tables 2-9 and 2-10 present summaries of analytical data for chemicals of concern for groundwater for the Potomac and Columbia Formations, respectively. In a letter dated February 11, 1992, EPA directed Du Pont to utilize analytical data for MW-8, MW-9, MW-19A and MW-26A to characterize the constituents in the Columbia Formation and MW-19B, MW-26BD, MW26-BS, DMU-7 and DML-7 to characterize the Potomac Formation. Potential chemicals of concern for Potomac Formation groundwater were identified based upon reported Phase III data for all Potomac Formation wells. The chemicals of concern for the Potomac wells are consistent with those identified for surface soils, surface waters and groundwater seeps (see Table 2-11 and Appendix B:

Table B-9). In order to focus the Columbia Formation data on those wells most representative of the potential exposures, data were compiled and screened for the Columbia Formation wells specified in the EPA's February 11, 1992 letter. The chemicals of concern for the Columbia wells are consistent with those identified for surface soils, surface waters and groundwater seeps (see Table 2-12 and Appendix B: Table B-10).

TABLE 2-1 - SUMMARY OF ANALYTICAL DATA FOR SOUTH DISPOSAL SITE AREA SOILS DUPONT - NEWPORT SITE

Input file for this report: a:b1.lst

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
2-Butanone	1	6	0.00857	0.01712	0.005	0.0252
Acetone	5	6	0.03337	0.06774	0.00353	0.0849
Aluminum, Total	6	6	14088.333	20802.776	4530	24100
Arsenic, Total	5	6	7.3175	12.79297	0.005	12
Barium, Total	6	6	4129	12273.818	86	19800
Benzene	1	6	0.00608	0.01015	0.0027	0.01377
Beryllium, Total	6	6	0.575	0.7903	0.29	0.84
Cadmium, Total	6	6	13.18333	36.21961	4.1	58
Calcium, Total	6	6	1483.99563	3319.37975	0.974	4790
Carbon disulfide	1	6	0.00433	0.00544	0.0027	0.005
Chromium, Total	6	6	28	36.18105	15	37
Cobalt, Total	6	6	7.15	9.91698	4.6	10
Copper, Total	6	6	63.55	197.59839	3.4	324
Di-n-Butyl Phthalate	1	3	0.2565	0.56548	0.178	0.4
Fluoranthene	1	6	0.21508	0.32406	0.165	0.426
Iron, Total	6	6	21513.334	28309.114	9580	28400
Lead, Total	5	6	291.41691	925.72488	0.0015	1520
Magnesium, Total	6	6	1485.50163	2351.2035	3.01	2250
Manganese, Total	6	6	570.83331	1229.6185	129	1820
Mercury, Total	3	6	0.08505	0.22416	0.0001	0.34
Methylene chloride	6	6	0.02042	0.04759	0.00621	0.0722
Nickel, Total	6	6	21.33333	35.85124	11	49
Potassium, Total	6	6	911	1119.75613	555	1050
Selenium, Total	1	6	1.21875	4.34451	0.0025	7.3
Silver, Total	1	6	0.57083	2.02502	0.005	3.4
Sodium, Total	4	6	65.5	102.80633	24	124
Vanadium, Total	6	6	38.33333	48.58474	19	44
Zinc, Total	6	6	530	1702.27563	43	2810

NOTES:

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening.

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

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TABLE 2-2 - SUMMARY OF ANALYTICAL DATA FOR SOUTH DISPOSAL SITE AREA SURFACE WATER DUPONT - NEWPORT SITE

Input file for this report: A2.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Alkalinity, Total	2	2	147.4	1272.62	58.8	236
Aluminum, Total	7	7	1.0125	3.09069	0.034	6.09
Arsenic, Total	2	7	0.00239	0.00409	0.001	0.005
Barium, Total	7	7	1.05671	1.35578	0.61	1.57
Beryllium, Total	1	7	0.00145	0.0024	0.00035	0.0025
Cadmium, Total	1	7	0.00257	0.00346	0.0015	0.0046
Calcium, Total	7	7	28.78571	42.6468	16.2	61.9
Chloride	2	2	40.05	50.845	39.2	40.9
Chromium, Total	1	7	0.00549	0.0096	0.002	0.0152
Cobalt, Total	3	7	0.0136	0.02359	0.0025	0.025
Copper, Total	5	7	0.00997	0.0191	0.003	0.0262
Iron, Total	9	9	13.72044	30.01047	0.904	52.8
Lead, Total	7	7	0.03563	0.07644	0.0042	0.126
Magnesium, Total	7	7	12.27714	17.54531	6.9	24.3
Manganese, Total	7	7	1.98029	3.10914	0.946	4.03
Phosphorus, Total	2	2	0.545	5.6885	0.14	0.95
Potassium, Total	7	7	3.86143	6.16149	1.06	7.32
Silica as SiO2	2	2	26.305	243.41152	9.21	43.4
Silver, Total	2	7	0.00291	0.00386	0.002	0.005
Sodium, Total	7	7	15.80286	23.52937	5.67	25.8
Sulfate	1	2	3.85	20.995	2.5	5.2
Total Suspended Solids	2	2	269.5	3450.85	19	520
Vanadium, Total	3	7	0.0043	0.00897	0.0015	0.0155
Zinc, Total	7	7	0.16599	0.28839	0.0078	0.391

NOTES

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

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TABLE 2-3 - SUMMARY OF ANALYTICAL DATA FOR
CIBA - GEIGY SOILS
DUPONT - NEWPORT SITE

Input file for this report: A4.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
1,2-Dichlorobenzene	1	19	0.20211	0.21557	0.185	0.29
1,2-Dichloroethene	1	20	0.00297	0.00323	0.001	0.004
1,4-Dichlorobenzene	1	19	0.19111	0.20664	0.081	0.26
2-Butanone	5	21	0.00502	0.00586	0.001	0.008
2-Methylnaphthalene	3	20	0.1757	0.19892	0.053	0.22
4-Chloroaniline	1	21	0.19571	0.20499	0.15	0.26
Acenaphthene	2	20	0.198	0.22316	0.045	0.36
Acetone	2	21	0.01195	0.01492	0.005	0.03
Aluminum, Total	25	25	13132.399	15516.117	2990	23000
Anthracene	3	20	0.22895	0.32612	0.054	1.1
Antimony, Total	4	24	40.07083	87.18782	3	461
Arsenic, Total	23	25	265.97	776.49331	0.75	6210
Barium, Total	25	25	8989.032	16385.404	40	85200
Benzene	1	20	0.00288	0.0032	0.001	0.004
Benzo(a)anthracene	9	20	0.3988	0.86329	0.039	4.6
Benzo(a)pyrene	6	20	0.30595	0.55977	0.05	2.6
Benzo(b)fluoranthene	11	20	0.49355	1.08411	0.04	5.8
Benzo(ghi)perylene	5	20	0.25355	0.40256	0.051	1.6
Benzo(k)fluoranthene	10	20	0.4953	1.08521	0.042	5.8
Benzoic Acid	1	20	0.86908	1.00754	0.0285	1.25
Beryllium, Total	23	25	0 0.723	0.87224	0.165	1.6
Beta-BHC	1	19	0.00818	0.01349	0.0045	0.0485
Butyl Benzyl Phthalate	2	20	0.18765	0.20648	0.053	0.26
Cadmium, Total	15	25	138.94	325.32413	0.3	1990
Calcium, Total	25	25	6574.72	0 10618.29	670	46000
Chlorobenzene	1	20	0.00547	0.01048	0.0025	0.051
Chloroform	1	20	0.00297	0.00312	0.002	0.0035
Chromium, Total	25	25	28.2012	33.73806	7.2	54.7
Chrysene	8	20	0.3394	0.63814	0.038	3
Cobalt, Total	24	25	14.0028	18.28525	2.9	42.29
Copper, Total	25	25	608.96638	1417.13875	6	9070
Di-n-Butyl Phthalate	2	20	0.1881	0.20432	0.092	0.26

TABLE 2-3 - SUMMARY OF ANALYTICAL DATA FOR CIBA - GEIGY SOILS (continued) DUPONT - NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
Dibenzo(a,h)anthracene	2	20	0.2152	0.26475	0.099	0.65
Dibenzofuran	2	20	0.19	0.2078	0.045	0.26
Fluoranthene	10	20	0.4812	0.96863	0.042	5
Fluorene	2	20	0.20485	0.24058	0.052	0.49
Heptachlor epoxide	1	19	0.00765	0.01255	0.0045	0.0485
Indeno(1,2,3-c,d)pyrene	4	20	0.26015	0.4192	0.078	1.7
Iron, Total	25	25	24396.002	29401.328	4400	56700
Lead, Total	24	25	8201.988	19814.15	0.3	127000
Magnesium, Total	25	25	3032.32	4360.178	216	15900
Manganese, Total	25	25	380.05159	548.02644	39.79	1980
Mercury, Total	11	25	0.8258	1.80916	0.02	11.3
Methylene chloride	1	21	0.0126	0.01689	0.003	0.049
Naphthalene	2	20	0.1821	0.20164	0.06	0.22
Nickel, Total	23	25	23.2008	32.7249	2	92.5
Percent Moisture	15	15	17.53	21.31	11	37
Percent Solids	22	22	81.67	84.64	60.59	92
Phenanthrene	6	21	0.37286	0.7055	0.044	3.5
Potassium, Total	18	25	1367.08	1906.51188	190	6360
Pyrene	9	20	0.4251	0.85021	0.054	4.2
Selenium, Total	2	18	1.69056	3.02762	0.23	11.6
Silver, Total	2	25	2.5234	4.85742	0.495	23.2
Sodium, Total	22	25	276.172	352.35128	30	799
Tetrachloroethene	4	21	0.00521	0.00899	0.001	0.04
Thallium Total	3	24	3.04729	7.16544	0.05	41.9
Trichloroethene	2	20	0.003	0.0032	0.002	0.004
Vanadium, Total	25	25	39.3376	46.39756	13	80.8
Zinc, Total	25	25	6262.4885	12229.722	19.6	63300
bis(2-Ethylhexyl)phthalate	12	21	0.20943	0.27945	0.036	0.66
pH	15	15	7.36	8.04	5.6	9.7

NOTES.

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t0

TABLE 2-4 - SUMMARY OF ANALYTICAL DATA FOR HOLLY RUN SOILS

Input file for this report: A5.LST

DUPONT - NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
2-Butanone	4	14	0.00643	0.00764	0.004	0.012
4-Methyl-2-pentanone	1	14	0.006	0.00657	0.005	0.009
Acetone	10	14	0.02559	0.03648	0.0035	0.086
Aluminum, Total	16	16	17485.624	24894.834	7970	67500
Arsenic, Total	14	16	8.81875	12.74093	1.2	28
Barium, Total	16	16	294.72938	586.54525	25	2270
Beryllium, Total	16	16	0.74	1.04315	0.25	2.7
Cadmium, Total	2	16	0.57875	0.65155	0.36	1
Calcium, Total	16	16	1325.75	1897.68713	432	3980
Chloroform	2	14	0.00346	0.00409	0.002	0.006
Chromium, Total	16	16	30.26813	45.19443	14.3	132
Cobalt, Total	16	16	11.09938	18.32389	3.5	57.29
Copper, Total	16	16	14.6625	21.13331	5.6	55.2
Iron, Total	16	16	22431.25	27611.382	12300	52500
Lead, Total	14	16	40.44688	63.32881	5.45	124
Magnesium, Total	16	16	2858.75	4363.511	1050	12800
Manganese, Total	16	16	217.59375	313.11834	53.6	780
Mercury, Total	2	16	0.06876	0.10084	0.0001	0.22
Methylene chloride	9	14	0.02099	0.03076	0.003	0.065
Nickel, Total	12	16	15.98375	26.12323	3.75	84.5
Percent Moisture	6	6	16.33	20.41	14	24
Percent Solids	7	7	79.11	92.39	48	89.59
Potassium, Total	13	16	1399.6875	2179.3345	431.5	6650
Selenium, Total	4	15	5.20567	7.85244	0.235	11.75
Sodium, Total	15	16	166.84063	220.53672	29.15	431
Tetrachloroethene	1	14	0.00709	0.01558	0.0025	0.0582
Trichloroethene	1	14	0.00314	0.0037	0.001	0.005
Vanadium, Total	16	16	43.09125	61.94146	21.9	172
Xylenes, Total	1	14	0.00321	0.00369	0.002	0.005
Zinc, Total	16	16	81.83563	125.72597	27.9	354
bis(2-Ethylhexyl)phthalate	6	14	0.1895	0.31064	0.048	0.89
pH	6	6	6.03	6.56	5.4	6.8

NOTES:

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t04a.xls

TABLE 2 SUMMARY OF [illegible] DATA FOR
NORTH DISPOSAL SITE AREA SOILS
DUPONT-NEWPORT SITE

Input file for this report: A6.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
2-Butanone	1	4	0.006	0.0073	0.005	0.007
4,4'-DDE	1	4	0.08291	0.32371	0.00165	0.31
Aluminum, Total	9	9	8827.889	12828.701	411	15900
Anthracene	1	8	1.64125	4.80394	0.165	11
Antimony, Total	2	9	1.80556	3.60426	0.03	6.5
Arsenic, Total	9	9	12.36667	23.97766	1.3	50
Barium, Total	9	9	2918.47775	7603.9655	6.3	18800
Benzene	1	4	0.00325	0.00525	0.002	0.005
Benzo(a)anthracene	1	8	1.99875	5.21053	0.165	11
Beryllium, Total	7	9	0.29694	0.44904	0.0025	0.6
Cadmium, Total	7	9	22.82222	60.26013	0.55	149
Calcium, Total	9	9	1169.66663	2400.38525	141	5250
Chromium, Total	8	9	20.38222	29.37953	0.44	44
Chrysene	1	8	1.75075	4.91199	0.081	11
Cobalt, Total	8	9	6.11556	9.02522	0.44	11
Copper, Total	8	9	185.71556	481.58694	0.44	1180
Di-n-Butyl Phthalate	1	8	1.63625	4.79985	0.165	11
Fluoranthene	1	8	2.14875	5.44584	0.165	11
Fluorene	1	8	1.57625	4.75409	0.165	11
Iron, Total	9	9	17843.112	26769.424	908	42100
Lead, Total	9	9	1289.6545	3955.48675	14	10500
Magnesium, Total	9	9	1216.77775	1921.56988	147	2420
Manganese, Total	9	9	179.55556	309.07766	42	535
Mercury, Total	3	9	0.84172	2.32886	0.0001	5.8
Methylene chloride	1	4	0.00632	0.01235	0.003	0.011
Nickel, Total	8	9	23.17222	52.91564	3.85	123
Percent Moisture	1	1	0	99999	15	15
Percent Solids	2	2	87.95	119.07	85.5	90.4
Phenanthrene	1	8	2.77375	6.759	0.165	11
Potassium, Total	8	9	547.55556	783.13438	226	1160
Pyrene	1	8	2.16125	5.46706	0.165	11
Selenium, Total	4	9	0.59806	1.25942	0.0025	2.5
Silver, Total	1	9	0.25333	0.5408	0.005	0.8
Sodium, Total	9	9	154.22222	321.31213	43	725
Vanadium, Total	8	9	155.38222	440.195	0.44	1140
Zinc, Total	9	9	3485.111	7708.9795	4.8	15100
pH	1	1	0	99999	6	6

NOTES: Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening.

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t05.xls

TABLE 2-6 - SUMMARY OF ANALYTICAL DATA FOR CHRISTINA RIVER WATER DUPONT - NEWPORT SITE

Input file for this report: A10.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Alkalinity, Total	2	2	70	158.9	63	77
Aluminum, Total	15	15	1.41707	1.64959	0.689	2.06
Arsenic, Total	1	15	0.00455	0.00522	0.001	0.005
Barium, Total	15	15	0.09435	0.10347	0.074	0.143
Cadmium, Total	2	15	0.00296	0.00403	0.0015	0.0096
Calcium, Total	15	15	24.84	26.00444	22.3	28.9
Chloride	2	2	69.4	141.79	63.7	75.1
Chromium, Total	13	15	0.00674	0.00835	0.002	0.012
Copper, Total	12	15	0.00694	0.00841	0.003	0.0125
Dissolved Organic Carbon	2	2	23.5	55.25	21	26
Iron, Total	17	17	2.01353	2.29753	0.71	2.84
Lead, Total	7	15	0.01448	0.02548	0.0015	0.072
Magnesium, Total	15	15	16.56	18.60173	11.3	22.6
Manganese, Total	15	15	0.23707	0.30535	0.122	0.66
Methylene chloride	9	13	0.00212	0.00257	0.00101	0.00353
Phosphorus, Total	2	2	0.12	0.247	0.11	0.13
Potassium, Total	15	15	6.69533	7.22824	5.04	8.36
Silica as SiO2	2	2	12.77	53.791	9.54	16
Sodium, Total	15	15	62.23646	81.5855	0.115	119
Sulfate	2	2	31.45	67.645	28.6	34.3
Tetrachloroethene	1	13	0.00318	0.00468	0.0025	0.0114
Total Suspended Solids	2	2	33	83.8	29	37
Vanadium, Total	11	15	0.00909	0.01367	0.0025	0.025
Zinc, Total	15	15	0.13993	0.1908	0.07	0.409
pH (Field)	1	1	0	99999	7.47	7.47

NOTES.

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t06a.xls

TABLE 2-7 - SUMMARY OF ANALYTICAL DATA FOR BALLPARK SOILS

Input file for this report: A11.LST **DUPONT - NEWPORT SITE**

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/kg)	95% UCL (1) (mg/kg)	Minimum (2) (mg/kg)	Maximum (mg/kg)
Aluminum, Total	29	29	14353.449	15489.147	8890	21000
Antimony, Total	2	29	3.58828	4.32847	0.325	11
Arsenic, Total	29	29	3.35655	3.95443	0.92	7.3
Barium, Total	29	29	1062.91038	1764.96838	44.1	10100
Beryllium, Total	29	29	1.41552	2.12036	0.37	8.9
Butyl Benzyl Phthalate	1	2	0.1575	0.76075	0.11	0.205
Cadmium, Total	8	29	3.24931	7.84707	0.445	65.8
Calcium, Total	29	29	8670.966	12584.751	608	36300
Chromium, Total	29	29	25.62759	30.32847	13	79.9
Cobalt, Total	29	29	9.11379	10.69903	4.4	20.4
Copper, Total	29	29	37.34828	60.48372	7	313
Iron, Total	29	29	18700.002	20709.846	12600	32600
Lead, Total	29	29	62.56552	109.32534	6.9	690
Magnesium, Total	29	29	4090	5175.085	1240	11100
Manganese, Total	29	29	640.93794	847.39581	67.2	2830
Mercury, Total	7	29	0.10518	0.15618	0.0001	0.72
Nickel, Total	29	29	14.96552	17.64401	7.3	35.6
Potassium, Total	29	29	1808.31038	2417.459	301	5780
Sodium, Total	28	29	195.31489	243.31153	0.132	657
Vanadium, Total	29	29	41.74483	48.5661	22.6	90.7
Zinc, Total	29	29	348.58622	735.06288	30.8	5530

NOTES:

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t07.xls

TABLE 2-8 - SUMMARY OF ANALYTICAL DATA FOR CHRISTINA RIVER/GROUNDWATER SEEPS

Input file for this report: A12.LST

DUPONT - NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
1,1-Dichloroethene	1	10	0.01695	0.03053	0.0025	0.055
1,2,4-Trichlorobenzene	1	6	0.008	0.01678	0.003	0.025
1,2-Dichlorobenzene	5	6	0.69683	1.46534	0.005	1.7
1,2-Dichloroethene	9	10	0.23745	0.42385	0.0025	0.77
1,3-Dichlorobenzene	3	6	0.00983	0.01844	0.003	0.025
1,4-Dichlorobenzene	4	6	0.06683	0.14852	0.005	0.21
2-Methylnaphthalene	1	6	0.008	0.01678	0.003	0.025
4-Chloroaniline	4	6	0.15583	0.33288	0.005	0.41
Acetone	2	10	0.0552	0.11259	0.005	0.24
Aluminum, Total	4	6	3.82875	8.40881	0.1885	10.6
Antimony, Total	1	6	0.01853	0.02761	0.015	0.0362
Arsenic, Total	4	6	0.01746	0.05118	0.0015	0.08259
Barium, Total	6	6	4.33007	13.34251	0.0554	21.8
Benzene	3	10	0.0181	0.03032	0.0025	0.049
Benzoic Acid	1	6	0.03867	0.08368	0.007	0.125
Beryllium, Total	1	6	0.0011	0.00264	0.0005	0.0041
Cadmium, Total	6	6	0.06057	0.12411	0.0109	0.151
Calcium, Total	6	6	41.45	54.91637	22.8	59.4
Carbon tetrachloride	2	10	0.0443	0.11206	0.0025	0.31
Chlorobenzene	6	10	0.54065	1.10114	0.0025	2.3
Chloroform	4	10	0.0175	0.03244	0.002	0.055
Chromium, Total	3	6	0.01423	0.03722	0.0025	0.05829
Cobalt, Total	6	6	0.08078	0.15102	0.0127	0.167
Copper, Total	6	6	0.09782	0.27101	0.0153	0.431
Dibenzofuran	1	6	0.00833	0.0169	0.005	0.025
Iron, Total	6	6	15.02767	30.62899	0.476	38.2
Lead, Total	6	6	0.29317	0.80684	0.0139	1.22
Magnesium, Total	6	6	15.13333	22.86395	9.58	28.6
Manganese, Total	6	6	4.805	8.89367	1.11	12.1
Mercury, Total	1	6	0.00027	0.00069	0.0001	0.0011
Methylene chloride	2	10	0.01785	0.03105	0.002	0.055

TABLE 2-8 - SUMMARY OF ANALYTICAL DATA FOR CHRISTINA RIVER/GROUNDWATER SEEPS (continued) DUPONT - NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Naphthalene	2	6	0.0095	0.01845	0.003	0.025
Nickel, Total	5	6	0.04598	0.07503	0.007	0.0799
Phenol	1	1	0	99.999	0.011	0.011
Potassium, Total	6	6	8.14333	10.29179	5.24	10.6
Sodium, Total	6	6	93.58334	150.49819	30.9	177
Tetrachloroethene	10	10	0.4516	1.15132	0.004	3.2
Toluene	1	10	0.0174	0.03076	0.0025	0.055
Trichloroethene	9	10	0.0434	0.072	0.004	0.13
Vanadium, Total	3	6	0.00937	0.02155	0.0025	0.0322
Vinyl chloride	4	10	0.103	0.24343	0.005	0.65
Zinc, Total	6	6	19.90333	44.47721	0.78	64.7

NOTES:

Only total metals presented where both dissolved and total metals were reported. Total metal results were used for screening.

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t08a.xls

TABLE 2-9 - SUMMARY OF ANALYTICAL DATA FOR CHEMICALS OF CONCERN FOR POTOMAC FORMATION GROUNDWATER DUPONT - NEWPORT SITE

Input file for this report: POTOM2.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95 % UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Antimony, Total	0	5	0.0150	0.0150	0.015	0.015
Arsenic, Total	0	5	0.0015	0.0015	0.0015	0.0015
Barium, Total	5	5	0.0894	0.1836	0.0375	0.231
Benzo(a)anthracene	0	2	0.0052	0.0056	0.005	0.0055
Beryllium, Total	0	5	0.0005	0.0005	0.0005	0.0005
Bis(2-Ethylhexyl)phthalate	1	2	0.0041	0.0061	0.003	0.0055
Cadmium, Total	2	5	0.0021	0.0033	0.0015	0.004
Carbon tetrachloride	0	5	0.0025	0.0025	0.0025	0.0025
4-Chloroaniline	0	2	0.0052	0.0056	0.005	0.0055
Chlorobenzene	0	5	0.0025	0.0025	0.0025	0.0025
Chromium, Total	0	5	0.0025	0.0025	0.0025	0.0025
Cobalt, Total	1	5	0.0040	0.0110	0.0025	0.0266
Copper, Total	5	5	0.0098	0.0192	0.0043	0.0285
1,1-Dichloroethene	0	5	0.0025	0.0025	0.0025	0.0025
Lead, Total	4	5	0.0086	0.0337	0.0015	0.0754
Manganese, Total	5	5	0.1331	0.3131	0.04159	0.507
Mercury, Total	0	5	0.0001	0.0001	0.0001	0.0001
Nickel, Total	1	5	0.0086	0.0133	0.007	0.0194
Tetrachloroethene	2	5	0.0032	0.0059	0.002	0.01
Thallium, Total	0	5	0.0014	0.0027	0.001	0.005
Trichloroethene	0	5	0.0025	0.0025	0.0025	0.0025
Vanadium, Total	0	5	0.0025	0.0025	0.0025	0.0025
Vinyl chloride	0	5	0.0050	0.0050	0.005	0.005
Zinc, Total	5	5	0.0580	0.1369	0.026	0.202

NOTES.

(1) Arithmetic mean and 95% UCL are based on an assumption that non-detects are equal to 1/2 the detection limit.
(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename. d002109.xls

TABLE 2-10 - SUMMARY OF ANALYTICAL DATA FOR CHEMICALS OF CONCERN FOR COLUMBIA FORMATION GROUNDWATER DUPONT - NEWPORT SITE

Input file for this report: COLUM2.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95 % UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Antimony , Total	0	4	0.0150	0.0150	0.015	0.015
Arsenic, Total	2	4	0.0041	0.0166	0.0015	0.0122
Barium, Total	4	4	0.1117	0.2627	0.0492	0.229
Benzo(a)anthracene	0	1	0.0055	--	0.0055	0.0055
Beryllium, Total	0	4	0.0005	0.0005	0.0005	0.0005
Bis(2-Ethylhexyl)phthalate	1	1	0.0130	--	0.013	0.013
Cadmium, Total	1	4	0.0031	0.0174	0.0015	0.028
Carbon tetrachloride	0	4	0.0025	0.0025	0.0025	0.0025
4-Chloroaniline	0	1	0.0055	--	0.0055	0.0055
Chlorobenzene	0	4	0.0025	0.0025	0.0025	0.0025
Chromium, Total	0	4	0.0025	0.0025	0.0025	0.0025
Cobalt, Total	3	4	0.0396	0.5408	0.0025	0.578
Copper, Total	3	4	0.0149	0.1532	0.002	0.227
1,1-Dichloroethene	0	4	0.0025	0.0025	0.0025	0.0025
Lead, Total	1	4	0.0101	0.2907	0.0015	0.627
Manganese, Total	4	4	5.1477	37.6877	0.439	20.2
Mercury, Total	0	4	0.0001	0.0001	0.0001	0.0001
Nickel, Total	2	4	0.0296	0.2442	0.007	0.283
Tetrachloroethene	3	4	0.0118	0.0465	0.0025	0.041
Thallium, Total	0	4	0.0022	0.0067	0.001	0.005
Trichloroethene	3	4	0.0107	0.0463	0.0025	0.047
Vanadium, Total	2	4	0.0045	0.0105	0.0025	0.0112
Vinyl chloride	0	4	0.0050	0.0050	0.005	0.005
Zinc, Total	4	4	1.9587	80.6768	0.0499	44.1

NOTES:
(1) Arithmetic mean and 95% UCL are based on an assumption that non-detects are equal to 1/2 the detection limit.
(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

filename: d002t10.xls

TABLE 2-11 - SUMMARY OF ALL ANALYTICAL DATA FOR POTOMAC FORMATION GROUNDWATER
DUPONT - NEWPORT SITE

Input file for this report: A13.LST

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Aluminum, Dissolved	1	37	0.073	0.0853	0.0227	0.232
Arsenic, Dissolved	1	37	0.00136	0.00145	0.001	0.0022
Barium, Dissolved	37	37	0.05894	0.08305	0.0069	0.437
Beryllium, Dissolved	1	37	0.00058	0.00075	0.0005	0.0036
Cadmium, Dissolved	9	37	0.12563	0.30463	0.0015	3.23
Calcium, Dissolved	37	37	11.15081	14.01868	3.29	43.3
Chromium, Dissolved	1	37	0.00265	0.00319	0.002	0.0121
Cobalt, Dissolved	16	37	0.01993	0.03693	0.002	0.299
Copper, Dissolved	17	37	0.01356	0.02127	0.002	0.112
Iron, Dissolved	24	37	1.75375	3.34113	0.005	26
Lead, Dissolved	5	37	0.00392	0.00764	0.0015	0.069
Magnesium, Dissolved	37	37	3.48746	4.60206	0.665	15.8
Manganese, Dissolved	36	37	0.35318	0.59053	0.0005	2.76
Nickel, Dissolved	12	37	0.02995	0.05453	0.007	0.453
Potassium, Dissolved	31	37	10.10162	19.47092	0.54	172
Selenium, Dissolved	1	37	0.00316	0.00438	0.0015	0.0135
Sodium, Dissolved	37	37	17.93946	24.31555	5.02	93.6
Zinc, Dissolved	27	37	11.23748	28.77006	0.0034	0 318
1,2-Dichloroethane	1	37	0.00266	0.00292	0.0025	0.007
1,2-Dichloroethene	2	37	0.00253	0.00269	0.001	0.005
Acetone	1	37	0.00523	0.00578	0.0035	0.014
Aluminum, Total	1	37	0.12629	0.17403	0.0421	0.771
Antimony, Total	1	37	0.03589	0.07874	0.0145	0.792
Arsenic, Total	1	27	0.00144	0.00166	0.001	0.0039
Barium, Total	37	37	0.07497	0.10344	0.0112	0.503
Benzene	1	37	0.0025	0.00262	0.001	0.004
Benzyl alcohol	2	16	0.00509	0.00562	0.002	0.006
Beryllium, Total	1	37	0.00056	0.00069	0.0005	0.0028
Butyl Benzyl Phthalate	5	16	0.00606	0.00773	0.004	0.017
Cadmium, Total	11	37	0.12422	0.26718	0.0015	2.5
Calcium, Total	37	37	10.66439	13.37703	0.0525	44.1
Carbon tetrachloride	3	37	0.0025	0.00262	0.001	0.004
Chlorobenzene	1	37	0.00253	0.00261	0.002	0.004
Chloroform	4	37	0.00262	0.0028	0.002	0.005

TABLE 2-11 - SUMMARY OF ALL ANALYTICAL DATA FOR POTOMAC FORMATION GROUNDWATER (continued) DUPONT - NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (mg/l)
Chromium, Total	2	37	0.00291	0.00384	0.002	0.0192
Cobalt, Total	19	37	0.01922	0.03327	0.002	0.239
Copper, Total	33	37	0.01986	0.02996	0.002	0.155
Dieldrin	1	16	0.00007	0.00009	0.00005	0.00026
Iron, Total	30	37	3.37463	5.61162	0.01085	30.4
Lead, Total	20	31	0.00714	0.01197	0.0015	0.0754
Magnesium, Total	37	37	3.38938	4.46906	0.654	16.1
Manganese, Total	37	37	0.31711	0.5282	0.0083	2.66
Methylene chloride	5	37	0.00376	0.00546	0.0005	0.031
Nickel, Total	12	37	0.02975	0.0497	0.007	0.356
Potassium, Total	33	37	12.84973	26.93618	1.49	259
Sodium, Total	37	37	16.6	22.10208	4.57	99.1
Tetrachloroethene	15	37	0.01184	0.02309	0.001	0.2
Trichloroethene	8	37	0.00399	0.00635	0.001	0.044
Vanadium, Total	5	37	0.00336	0.00435	0.002	0.0146
Xylenes, Total	1	37	0.00249	0.00251	0.002	0.0025
Zinc, Total	30	37	11.16152	25.82796	0.00785	262
bis(2-Ethylhexyl)phthalate	10	16	0.01191	0.01837	0.002	0.042

NOTES:
Both dissolved and total metals were reported. Total metal results were used for screening
(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit
(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set.

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TABLE 2-12 - SUMMARY OF ALL ANALYTICAL DATA FOR COLUMBIA FORMATION GROUNDWATER

input for this report: colum3.lst

DUPONT-NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (2) (mg/l)
1,1,1-Trichloroethane	1	4	0.0024	0.0027	0.0020	0.0025
1,1,2,2-Tetrachloroethane	0	4	0.0030	0.0045	0.0025	0.0025
1,1,2-Trichloroethane	0	4	0.0025	0.0025	0.0025	0.0025
1,1-Dichloroethane	0	4	0.0025	0.0025	0.0025	0.0025
1,1-Dichloroethene	0	4	0.0025	0.0025	0.0025	0.0025
1,2,4-Trichlorobenzene	0	1	0.0055	--	0.0055	0.0055
1,2-Dichlorobenzene	0	1	0.0055	--	0.0055	0.0055
1,2-Dichloroethane	0	4	0.0025	0.0025	0.0025	0.0025
1,2-Dichloroethylene, Total	4	4	0.0271	0.1028	0.0090	0.0910
1,2-Dichloropropane	0	4	0.0025	0.0025	0.0025	0.0025
1,3-Dichlorobenzene	0	1	0.0055	--	0.0055	0.0055
1,4-Dichlorobenzene	0	1	0.0055	--	0.0055	0.0055
2,4,5-Trichlorophenol	0	1	0.0280	--	0.0280	0.0280
2,4,6-Trichlorophenol	0	1	0.0055	--	0.0055	0.0055
2,4-Dichlorophenol	0	1	0.0055	--	0.0055	0.0055
2,4-Dimethylphenol	0	1	0.0055	--	0.0055	0.0055
2,4-Dinitrophenol	0	1	0.0280	--	0.0280	0.0280
2,4-Dinitrotoluene	0	1	0.0055	--	0.0055	0.0055
2,6-Dinitrotoluene	0	1	0.0055	--	0.0055	0.0055
2-Butanone	1	4	0.0058	0.0082	0.0050	0.0050
2-Chloronaphthalene	0	1	0.0055	--	0.0055	0.0055
2-Chlorophenol	0	1	0.0055	--	0.0055	0.0055
2-Hexanone	0	4	0.0050	0.0050	0.0050	0.0050
2-Methyl-4,6-dinitrophenol	0	1	0.0280	--	0.0280	0.0280
2-Methylnaphthalene	0	1	0.0055	--	0.0055	0.0055
2-Methylphenol	0	1	0.0055	--	0.0055	0.0055
2-Nitroaniline	0	1	0.0280	--	0.0280	0.0280
2-Nitrophenol	0	1	0.0055	--	0.0055	0.0055
3,3'-Dichlorobenzidine	0	1	0.0110	--	0.0110	0.0110
3-Nitroaniline	0	1	0.0280	--	0.0280	0.0280
4,4'-DDD	0	1	0.0001	--	0.0001	0.0001
4,4'-DDE	0	1	0.0001	--	0.0001	0.0001
4,4'-DDT	0	1	0.0001	--	0.0001	0.0001
4-Bromophenyl-Phenylether	0	1	0.0055	--	0.0055	0.0055
4-Chloro-3-methylphenol	0	1	0.0055	--	0.0055	0.0055
4-Chloroaniline	0	1	0.0055	--	0.0055	0.0055
4-Chlorophenyl phenyl ether	0	1	0.0055	--	0.0055	0.0055
4-Methyl-2-pentanone	0	4	0.0050	0.0050	0.0050	0.0050
4-Methylphenol	0	1	0.0055	--	0.0055	0.0055
4-Nitroaniline	0	1	0.0280	--	0.0280	0.0280
4-Nitrophenol	0	1	0.0280	--	0.0280	0.0280
Acenaphthene	0	1	0.0055	--	0.0055	0.0055
Acenaphthylene	0	1	0.0055	--	0.0055	0.0055
Acetone	0	4	0.0050	0.0050	0.0050	0.0050
Aldrin	0	1	0.0000	--	0.0000	0.0000
Alpha-BHC	0	1	0.0000	--	0.0000	0.0000
Alpha-Chlordane	0	1	0.0003	--	0.0003	0.0003
Aluminum, Dissolved	4	4	0.1373	0.1981	0.0880	0.1820
Aluminum, Total	4	4	0.3566	1.1934	0.1540	1.4900
Anthracene	0	1	0.0055	--	0.0055	0.0055
Antimony, Dissolved	0	4	0.0150	0.0150	0.0150	0.0150
Antimony, Total	0	4	0.0150	0.0150	0.0150	0.0150
Arsenic, Dissolved	2	4	0.0024	0.0063	0.0010	0.0058
Arsenic, Total	2	4	0.0041	0.0166	0.0015	0.0122
Barium, Dissolved	4	4	0.0611	0.1275	0.0298	0.0710
Barium, Total	4	4	0.1117	0.2627	0.0492	0.2290
Benzene	0	4	0.0025	0.0025	0.0025	0.0025
Benzo(a)anthracene	0	1	0.0055	--	0.0055	0.0055
Benzo(a)pyrene	0	1	0.0055	--	0.0055	0.0055
Benzo(b)fluoranthene	0	1	0.0055	--	0.0055	0.0055
Benzo(ghi)perylene	0	1	0.0055	--	0.0055	0.0055
Benzo(k)fluoranthene	0	1	0.0055	--	0.0055	0.0055
Benzoic Acid	0	1	0.0280	--	0.0280	0.0280
Benzyl alcohol	0	1	0.0055	--	0.0055	0.0055
Beryllium, Dissolved	0	4	0.0005	0.0005	0.0005	0.0005
Beryllium, Total	0	4	0.0005	0.0005	0.0005	0.0005
Beta-BHC	0	1	0.0000	--	0.0000	0.0000
bis(2-Chloroethoxy)methane	0	1	0.0055	--	0.0055	0.0055
bis(2-Chloroethyl)ether	0	1	0.0055	--	0.0055	0.0055
bis(2-Chloroisopropyl)ether	0	1	0.0055	--	0.0055	0.0055
bis(2-Ethylhexyl)phthalate	1	1	0.0130	--	0.0130	0.0130
Bromodichloromethane	0	4	0.0025	0.0025	0.0025	0.0025
Bromoform	0	4	0.0030	0.0045	0.0025	0.0025

input for this report: colum3.lst

TABLE 2-12 - SUMMARY OF ALL ANALYTICAL DATA FOR COLUMBIA FORMATION GROUNDWATER (continued)
DUPONT-NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (2) (mg/l)
Bromomethane	0	4	0.0042	0.0063	0.0025	0.0050
Butyl Benzyl Phthalate	1	1	0.0130	--	0.0130	0.0130
Cadmium, Dissolved	1	4	0.0030	0.0148	0.0015	0.0231
Cadmium, Total	1	4	0.0031	0.0174	0.0015	0.0280
Calcium, Dissolved	4	4	53.1556	106.4387	25.4000	95.3000
Calcium, Total	4	4	53.2110	110.8562	24.1000	93.5000
Carbon disulfide	0	4	0.0025	0.0025	0.0025	0.0025
Carbon tetrachloride	0	4	0.0025	0.0025	0.0025	0.0025
Chlorobenzene	0	4	0.0025	0.0025	0.0025	0.0025
Chlorodibromomethane	0	4	0.0025	0.0025	0.0025	0.0025
Chloroethane	0	4	0.0050	0.0050	0.0050	0.0050
Chloroform	1	4	0.0024	0.0027	0.0020	0.0025
Chloromethane	0	4	0.0050	0.0050	0.0050	0.0050
Chromium, Dissolved	0	4	0.0025	0.0025	0.0025	0.0025
Chromium, Total	0	4	0.0025	0.0025	0.0025	0.0025
Chrysene	0	1	0.0055	--	0.0055	0.0055
cis-1,3-Dichloropropene	0	4	0.0025	0.0025	0.0025	0.0025
Cobalt, Dissolved	3	4	0.0413	0.5697	0.0025	0.5790
Cobalt, Total	3	4	0.0396	0.5408	0.0025	0.5780
Copper, Dissolved	1	4	0.0045	0.0306	0.0020	0.0517
Copper, Total	3	4	0.0149	0.1532	0.0020	0.2270
Delta-BHC	0	1	0.0000	--	0.0000	0.0000
Di-N-Butyl Phthalate	0	1	0.0055	--	0.0055	0.0055
Di-N-Octyl Phthalate	0	1	0.0055	--	0.0055	0.0055
Dibenzo(a,h)anthracene	0	1	0.0055	--	0.0055	0.0055
Dibenzofuran	0	1	0.0055	--	0.0055	0.0055
Dieldrin	0	1	0.0001	--	0.0001	0.0001
Diethyl phthalate	0	1	0.0055	--	0.0055	0.0055
Dimethyl phthalate	0	1	0.0055	--	0.0055	0.0055
Endosulfan I	0	1	0.0000	--	0.0000	0.0000
Endosulfan II	0	1	0.0001	--	0.0001	0.0001
Endosulfan sulfate	0	1	0.0001	--	0.0001	0.0001
Endrin	0	1	0.0001	--	0.0001	0.0001
Endrin ketone	0	1	0.0001	--	0.0001	0.0001
Ethylbenzene	0	4	0.0025	0.0025	0.0025	0.0025
Fluoranthene	0	1	0.0055	--	0.0055	0.0055
Fluorene	0	1	0.0055	--	0.0055	0.0055
Gamma-Chlordane	0	1	0.0003	--	0.0003	0.0003
Heptachlor	0	1	0.0000	--	0.0000	0.0000
Heptachlor epoxide	0	1	0.0000	--	0.0000	0.0000
Hexachlorobenzene	0	1	0.0055	--	0.0055	0.0055
Hexachlorobutadiene	0	1	0.0055	--	0.0055	0.0055
Hexachlorocyclopentadiene	0	1	0.0055	--	0.0055	0.0055
Hexachloroethane	0	1	0.0055	--	0.0055	0.0055
Indeno(1,2,3-c,d)pyrene	0	1	0.0055	--	0.0055	0.0055
Iron, Dissolved	4	4	16.9928	267.0006	0.5270	64.1000
Iron, Total	4	4	26.0687	343.5058	0.9910	78.1000
Isophorone	0	1	0.0055	--	0.0055	0.0055
Lead, Dissolved	0	4	0.0022	0.0058	0.0015	0.0075
Lead, Total	1	4	0.0101	0.2907	0.0015	0.6270
Lindane	0	1	0.0000	--	0.0000	0.0000
Magnesium, Dissolved	4	4	21.5923	85.3011	4.1600	60.1000
Magnesium, Total	4	4	21.2669	87.4419	3.8700	59.1000
Manganese, Dissolved	4	4	5.1930	39.5132	0.4170	20.4000
Manganese, Total	4	4	5.1477	37.6877	0.4390	20.2000
Mercury, Dissolved	0	4	0.0001	0.0001	0.0001	0.0001
Mercury, Total	0	4	0.0001	0.0001	0.0001	0.0001
Methoxychlor	0	1	0.0003	--	0.0003	0.0003
Methylene chloride	4	4	0.0037	0.0147	0.0010	0.0120
N-Nitroso-Di-n-propylamine	0	1	0.0055	--	0.0055	0.0055
N-Nitrosodiphenylamine (1)	0	1	0.0055	--	0.0055	0.0055
Naphthalene	0	1	0.0055	--	0.0055	0.0055
Nickel, Dissolved	3	4	0.0353	0.2385	0.0070	0.2830
Nickel, Total	2	4	0.0296	0.2442	0.0070	0.2830
Nitrobenzene	0	1	0.0055	--	0.0055	0.0055
PCB-1016	0	1	0.0003	--	0.0003	0.0003
PCB-1221	0	1	0.0003	--	0.0003	0.0003
PCB-1232	0	1	0.0003	--	0.0003	0.0003
PCB-1242	0	1	0.0003	--	0.0003	0.0003
PCB-1248	0	1	0.0003	--	0.0003	0.0003
PCB-1254	0	1	0.0005	--	0.0005	0.0005
PCB-1260	0	1	0.0005	--	0.0005	0.0005

TABLE 2-12 - SUMMARY OF ALL ANALYTICAL DATA FOR COLUMBIA FORMATION GROUNDWATER (continued)

input for this report: colum3.lst

DUPONT-NEWPORT SITE

Parameter	# hits	# samples	Arithmetic Mean (1) (mg/l)	95% UCL (1) (mg/l)	Minimum (2) (mg/l)	Maximum (2) (mg/l)
Pentachlorophenol	0	1	0.0280	--	0.0280	0.0280
Phenanthrene	0	1	0.0055	--	0.0055	0.0055
Phenol	0	1	0.0055	--	0.0055	0.0055
Potassium, Dissolved	4	4	8.8889	33.3584	2.8200	41.1000
Potassium, Total	4	4	9.1315	33.7025	2.5700	38.3000
Pyrene	0	1	0.0055	--	0.0055	0.0055
Selenium, Dissolved	0	4	0.0039	0.0146	0.0015	0.0135
Selenium, Total	0	4	0.0015	0.0015	0.0015	0.0015
Silver, Dissolved	0	4	0.0035	0.0035	0.0035	0.0035
Silver, Total	0	4	0.0035	0.0035	0.0035	0.0035
Sodium, Dissolved	4	4	46.9616	89.8733	23.0000	86.4000
Sodium, Total	4	4	45.3595	86.0336	22.8000	84.9000
Styrene	0	4	0.0025	0.0025	0.0025	0.0025
Tetrachloroethene	3	4	0.0118	0.0465	0.0025	0.0410
Thallium, Dissolved	0	4	0.0033	0.0086	0.0010	0.0050
Thallium, Total	0	4	0.0022	0.0067	0.0010	0.0050
Toluene	1	4	0.0028	0.0037	0.0025	0.0040
Toxaphene	0	1	0.0005	--	0.0005	0.0005
trans-1,3-Dichloropropene	0	4	0.0025	0.0025	0.0025	0.0025
Trichloroethene	3	4	0.0107	0.0463	0.0025	0.0470
Vanadium, Dissolved	1	4	0.0033	0.0061	0.0025	0.0025
Vanadium, Total	2	4	0.0045	0.0105	0.0025	0.0057
Vinyl acetate	0	4	0.0050	0.0050	0.0050	0.0050
Vinyl chloride	0	4	0.0050	0.0050	0.0050	0.0050
Xylenes, Total	1	4	0.0020	0.0034	0.0010	0.0025
Zinc, Dissolved	4	4	1.6377	92.8095	0.0235	43.5000
Zinc, Total	4	4	1.9587	80.6768	0.0499	44.1000

NOTES:

Both dissolved and total metals were reported. Total metal results were used for screening.

(1) Arithmetic mean and 95% UCL are based upon an assumption that non-detects are equal to 1/2 the detection limit

(2) Minimum is the lowest transformed non-detect value if there were any non-detects in the data set

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TABLE 2-13
SUMMARY OF SAMPLES USED
HUMAN HEALTH EVALUATION
DUPONT-NEWPORT SITE

Subgeographic Area	Media	# Samples	Sample IDs
South Disposal Area	Surface soils	6	TB4-001, TB5-002, TB6-002 TB7-002, TP-2, TP-5
South Disposal Area	Surface Water	8	AS01WN, AW01(2X), AQ02, AQ03(2X), AS03WN, AS05WN
CIBA-GEIGY Newport Plant Area	Surface soils	25	B-01-06, B-02-04, B-03-04, B-04-04, B-05-3.5, B-06-04, B-07-04, B-08-04, B-09-04, B-10-04, B-11-04, B-12-04, B-13-04, B-14-04, B-15-04, B-25-04, B-34-04, B-34A-04, B-34B-04, TB-30-4.5, TB-31-04, TB-32-04, TB-33-04, TB-34-04, TB-35-04
Du Pont Holly Run Plant Area	Surface soils	16	B-16-04, B-17-04, B-18-04, B-19-04 B-20-04, HRB-1-04*, HRB-2-04, HRB-3-04, HRB-4-04, MW-29-04, TB-28-04, TB-29-04, TB1-002, TB2-002, HR-POND-S
North Disposal Area	Surface soils	9	SGS-6, SBND-3 S-1, SBND-5 S-1, SGS-3, SGS-4, SGS-5, TB3-002, B-21-04, B-22-04
Ballpark	Surface soils	29	BF-01-06, BF-01-18, BF-01-30, BF-03-06, BF-03-18, BF-03-30, BF-04-06, BF-04-12, BF-04-18, BF-05-06, BF-05-12, BF-06-06 BF-06-12, BF-07-06, BF-07-12, BF-08-06, BF-08-12, BF-09-06, BF-09-12, BF-10-06, BF-10-12, BF-11-06, BF-11-12, BRF-12-06, BF-12-12, BF-13-06, BF-13-12, SGS-1, SGS-2
Potomac Fm. Groundwater	Groundwater (Phase III only)	5	DMU-7, DML-7, MW-19B, MW-26BS, MW-26BD
Columbia Fm. Groundwater	Groundwater (Phase III only)	4	MW-8, MW-9, MW-19A, MW-26A
Christina River	Groundwater Seepage	16 (10 for VOA only)	GWS-02, GWS-04, GWS-09, GWS-11, GWS-12, GWS-14, GWS-16, GWS-17, GWS-19, GWS-20, GWS-COMP1, GWS-COMP3, GWS-COMP4, GWS-COMP5, GWS-COMP6, GWS-COMP7
Christina River	Surface Water	15	RS13WN, RS14WN, RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, RW-7A, RW-8, RW-9, RW-10, RW-11, RW-12

NOTES: - Total metals were used for surface soil, surface water, groundwater seepage and groundwater.
- Analyses on wetlands samples for Total Metals in Amorphous Iron Extract (collected during the Supl. Phase III) were not include the data sets. These samples were collected at the following locations: AS01, RS07, AS12, AS07, and RS15.

* Two samples were identified as HRB-1-04. One was collected from a second boring off-set from the first.

TABLE 2-14

REPORTED INDICATOR CHEMICALS PRESCREENED FROM RISK ASSESSMENT
DUPONT-NEWPORT SITE

Alkalinity
Aluminum
Calcium
Chloride
Dissolved Organic Carbon
Iron
Magnesium
Phosphorus
Potassium
Silica
Sodium
Sulfate
Total Suspended Solids
% Moisture
% Solids
pH

TABLE 2-15

COMPARISON OF SITE SOILS TO BACKGROUND
METAL CONCENTRATIONS (RANGES IN MG/KG (PPM))
DUPONT-NEWPORT SITE

						Background Concentration Ranges		
	So. Disp. Site	No. Disp. Site	Holly Run Plant	CIBA-GEIGY Plant	Ball park	Dragun, 1988 (typical)	Shacklette & Boergnen, 1984 (Eastern, US Range)	Site Soils Above Background
METAL								
Antimony	ND	0.03 - 6.5	ND	3.0 - 461	0.325 - 11	0.6 - 10	< 1 - 8.8	X
Arsenic	0.005 - 12	1.3 - 50	1.2 - 28	0.75 - 6,210	0.92 - 7.3	0.1 - 40	< 0.1 - 73	X
Barium	86 - 19,800	6.3 - 18,800	25 - 2,270	40 - 85,200	44.1 - 10,100	100 - 3,500	10 - 1,500	X
Beryllium	0.29 - 0.84	0.0025 - 0.6	0.25 - 2.7	0.165 - 1.6	0.37 - 8.9	0.1 - 40	< 1 - 7	No[1]
Cadmium	4.1 - 58	0.55 - 149	0.36 - 1.0	0.3 - 1,990	0.445 - 65.8	0.1 - 7.0	--	X
Chromium	15 - 37	0.44 - 44	14.3 - 132	7.2 - 54.7	13 - 79.9	5.0 - 3,000	1 - 1,000	No[1]
Cobalt	4.6 - 10	0.44 - 11	3.5 - 57.29	2.9 - 42.3	4.4 - 20.4	1.0 - 40	< 0.3 - 70	No[1]
Copper	3.4 - 324	0.44 - 1,180	5.6 - 55.2	6.0 - 9,070	7 - 313	2.0 - 100	< 1 - 700	X
Lead	0.0015 - 1,520	14 - 10,500	5.45 - 124	0.3 - 127,000	6.9 - 690	2.0 - 200	< 10 - 300	X
Manganese	129 - 1,820	42 - 535	53.6 - 780	39.79 - 1,980	67.2 - 2,830	100 - 4,000	< 2 - 7,000	No[1]
Mercury	0.0001 - 0.34	0.001 - 5.8	0.0001 - 0.22	0.02 - 11.3	0.001 - 0.72	0.01 - 0.8	0.01 - 3.4	X
Nickel	11 - 49	3.85 - 123	3.75 - 84.5	2.0 - 92.5	7.3 - 35.6	5.0 - 1,000	< 5 - 700	No[1]
Selenium	0.0025 - 7.3	0.0025 - 2.5	0.235 - 11.75	0.23 - 11.6	ND	0.1 - 2.0	< 0.1 - 3.9	X
Silver	0.005 - 3.4	0.005 - 0.8	ND	0.5 - 23.2	ND	0.1 - 5.0	--	X
Thallium	ND	ND	ND	0.05 - 41.9	ND	--	--	No Data
Vanadium	19 - 44	0.44 - 1,140	21.9 - 172	13.0 - 80.8	22.6 - 90.7	20 - 500	< 7 - 300	X
Zinc	43 - 2,810	4.8 - 15,100	27.9 - 354	19.6 - 63,300	30.8 - 5,530	10 - 300	< 5 - 2,900	X

[1] Due to the absence of on-site or local background data needed to make the comparison with the concentrations of these metals detected in site soils, these five metals were retained in the screening performed to evaluate chemicals of concerns from among the list of site contaminants.

TABLE 2-16
FREQUENCY OF DETECTION OF CHEMICALS BY AREA
DUPONT-NEWPORT SITE

	SDS	SOILS	SDS	SW	CG	SOILS	HRP	SOILS
PARAMETER	# hits	# samples	# hits	# samples	# hits	# samples	# hits	# samples
1,2-Dichloroethane								
1,1-Dichloroethene								
1,2-Dichloroethene					1	20		
1,2-Dichlorobenzene					1	19		
1,3-Dichlorobenzene								
1,4-Dichlorobenzene					1	19		
1,2,4-Trichlorobenzene								
2-Butanone	1	6			5	21	4	14
2-Methylnaphthalene					3	20		
4-Chloroaniline					1	21		
4-Methyl-2-pentanone							1	14
4,4'-DDE								
Acenaphthene					2	20		
Acetone	5	6			2	21	10	14
Anthracene					3	20		
Antimony, Total					4	24		
Arsenic, Total	5	6	2	7	23	25	14	16
Barium, Total	6	6	7	7	25	25	16	16
Benzene	1	6			1	20		
Benzo(a)anthracene					9	20		
Benzo(a)pyrene					6	20		
Benzo(b)fluoranthene					11	20		
Benzo(ghi)perylene					5	20		
Benzo(k)fluoranthene					10	20		
Benzyl alcohol								
Benzoic Acid					1	20		
Beryllium, Total	6	6	1	7	23	25	16	16
Beta-BHC					1	19		
bis(2-Ethylhexyl)phthalate					12	21	6	14
Butyl Benzyl Phthalate					2	20		
Cadmium, Total	6	6	1	7	15	25	2	16
Carbon disulfide	1	6						
Carbon tetrachloride								
Chlorobenzene					1	20		
Chloroform					1	20	2	14
Chromium, Total	6	6	1	7	25	25	16	16
Chrysene					8	20		
Cobalt, Total	6	6	3	7	24	25	16	16
Copper, Total	6	6	5	7	25	25	16	16
Dieldrin								
Di-n-Butyl Phthalate	1	3			2	20		
Dibenzo(a,h)anthracene					2	20		
Dibenzofuran					2	20		
Fluoranthene	1	6			10	20		
Fluorene					2	20		
Heptachlor epoxide					1	19		
Indeno(1,2,3-c,d)pyrene					4	20		
Lead, Total	5	6	7	7	24	25	14	16
Manganese,Total	6	6	7	7	25	25	16	16
Mercury,Total	3	6			11	25	2	16
Methylene chloride	6	6			1	21	9	14
Naphthalene					2	20		
Nickel, Total	6	6			23	25	12	16
Phenanthrene					6	21		
Phenol								
Pyrene					9	20		
Selenium, Total	1	6			2	18	4	15
Silver, Total	1	6	2	7	2	25		
Tetrachloroethene					4	21	1	14
Thallium, Total					3	24		
Toluene								
Trichloroethene					2	20	1	14
Vanadium, Total	6	6	3	7	25	25	16	16
Vinyl chloride							1	14
Xylenes,Total							16	16
Zinc, Total	6	6	7	7	25	25		

NOTES:
SDS SOILS = SOUTH DISPOSAL AREA SOILS
SDS SW = SOUTH DISPOSAL AREA SURFACE WATER
CG SOILS = CIBA-GEIGY PLANT SOILS
HRP SOILS = HOLLY RUN PLANT SOILS

TABLE 2-16 (continued)
FREQUENCY OF DETECTION OF CHEMICALS BY AREA
DUPONT-NEWPORT SITE

	NDS SOILS		CR SW		BP SOILS		CR SEEPS	
PARAMETER	# hits	# samples	# hits	# samples	# hits	# samples	# hits	# sample
1,2-Dichloroethane								
1,1-Dichloroethene							1	10
1,2-Dichloroethene							9	10
1,2-Dichlorobenzene							5	6
1,3-Dichlorobenzene							3	6
1,4-Dichlorobenzene							4	6
1,2,4-Trichlorobenzene							1	6
2-Butanone	1	4						
2-Methylnaphthalene							1	6
4-Chloroaniline							4	6
4-Methyl-2-pentanone								
4,4'-DDE	1	4						
Acenaphthene								
Acetone							2	10
Anthracene	1	8						
Antimony, Total	2	9			2	29	1	6
Arsenic, Total	9	9	1	15	29	29	4	6
Barium, Total	9	9	15	15	29	29	6	6
Benzene	1	4					3	10
Benzo(a)anthracene	1	8						
Benzo(a)pyrene								
Benzo(b)fluoranthene								
Benzo(ghi)perylene								
Benzo(k)fluoranthene								
Benzyl alcohol								
Benzoic Acid							1	6
Beryllium, Total	7	9			29	29	1	6
Beta-BHC								
bis(2-Ethylhexyl)phthalate								
Butyl Benzyl Phthalate					1	2		
Cadmium, Total	7	9	2	15	8	29	6	6
Carbon disulfide								
Carbon tetrachloride							2	10
Chlorobenzene							6	10
Chloroform							4	10
Chromium, Total	8	9	13	15	29	29	3	6
Chrysene	1	8						
Cobalt, Total	8	9			29	29	6	6
Copper, Total	8	9	12	15	29	29	6	6
Dieldrin								
Di-n-Butyl Phthalate	1	8						
Dibenzo(a,h)anthracene								
Dibenzofuran							1	6
Fluoranthene	1	8						
Fluorene	1	8						
Heptachlor epoxide								
Indeno(1,2,3-c,d)pyrene								
Lead, Total	9	9	7	15	29	29	6	6
Manganese,Total	9	9	15	15	29	29	6	6
Mercury,Total	3	9			7	29	1	6
Methylene chloride	1	4	9	13			2	10
Naphthalene							2	6
Nickel, Total	8	9			29	29	5	6
Phenanthrene	1	8						
Phenol							1	1
Pyrene	1	8						
Selenium, Total	4	9						
Silver, Total	1	9						
Tetrachloroethene			1	13			10	10
Thallium, Total								
Toluene							1	10
Trichloroethene							9	10
Vanadium, Total	8	9	11	15	29	29	3	6
Vinyl chloride							4	10
Xylenes,Total								
Zinc, Total	9	9	15	15	29	29	6	6

NDS SOILS = NORTH DISPOSAL AREA SOILS
CR SW = CHRISTINA RIVER SURFACE WATER
BP SOILS = BALLPARK SOILS
CR SEEPS = CHRISTINA RIVER SEEPAGE

Prepared by: DW
Checked by: PP

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POTOMAC AND COLUMBIA FORMATION GROUNDWATER WERE NOT INCLUDED O
TABLE SINCE THEY WERE SCREENED SEPARATELY FROM OTHER MEDIA OF CON
(SEE SECTION 2.3.2)

TABLE 2-17

CHEMICALS POTENTIALLY CONTRIBUTING TO RISK BY MEDIA OF CONCERN DUPONT-NEWPORT SITE

Parameter	AREA									
	SDS	SDS SW	CG	HRP	NDS	CRSW	BP	CR Seeps	*CFGW	*PFGW
Antimony			✓		✓		✓	✓		✓
Arsenic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Barium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Benzo(a)anthracene					✓					
Beryllium	✓	✓		✓	✓		✓	✓		✓
Bis(2-ethylhexyl)phthalate										✓
Cadmium	✓	✓	✓		✓	✓	✓	✓	✓	✓
Carbon Tetrachloride								✓		✓
4-Chloroaniline								✓		
Chlorobenzene								✓		
Chromium	✓	✓	✓	✓	✓	✓	✓	✓		✓
Cobalt	✓	✓	✓	✓	✓		✓	✓	✓	✓
Copper	✓				✓		✓			
1,1-Dichloroethene								✓		
Manganese	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mercury					✓					
Nickel	✓			✓	✓				✓	✓
Tetrachloroethene						✓		✓	✓	✓
Thallium			✓							
Trichloroethene									✓	✓
Vanadium				✓	✓	✓	✓			
Vinyl chloride								✓		
Zinc	✓		✓		✓	✓	✓	✓	✓	✓

NOTES:
SDS - South Disposal Area Soils
SDSSW - South Disposal Area Surface Water
CG - CIBA-GEIGY Plant Soils
HRP - Holly Run Plant Soils
NDS - North Disposal Area Soils
CRSW - Christina River Surface Water
BP - Ballpark Soils
CR Seeps - Christina River Seepage
CFGW - Columbia Formation Groundwater
PFGW - Potomac Formation Groundwater

Prepared by: PP
Checked by: LIN

*Only four Columbia Formation wells were screened by the concentration - toxicity screen. No other screening was done for the Columbia Formation wells. All the Potomac Formation wells were screened by the concentration - toxicity screen.

TABLE 2-18
POTENTIAL CHEMICALS OF CONCERN WITHOUT TOXICITY VALUES
DUPONT-NEWPORT SITE

Chemical	Media	Evaluation
2- methylnaphthalene, phenanthrene	Ciba-Geigy Plant Soils	Can be eliminated from quantitative assessn carcinogenic PAH in this media are evaluat
Dibenzofuran	Ciba-Geigy Plant Soils	Detected in 2/20 samples in concentrations ranging from 0.045 to 0.26 ppm. Insufficien data for quantitative assessment.
Phenanthrene	North Disposal Site Soils	Can be eliminated from quantitative assessn carcinogenic PAHs in this media are evaluated(1)
1,3-dichlorobenzene	Christina River Seepage	Can be eliminated from quantitative assessn Detected at up to 0.025 mg/l; other isomers with toxicity values were reported at higher concentrations and were screened
2-methylnaphthalene	Christina River Seepage	Not evaluated; no carcinogenic PAH detect this media
Dibenzofuran	Christina River Seepage	Detected up to 0.025 mg/l; no data availabl quantitative assessment.
Cobalt	Soils and Groundwater	No generally accepted RfD available; Evaluated using 1E-4 as directed by EPA Region III.
Lead	Soils and Groundwater	No RfD available; will be evaluated [redacted] sp case.

(1) Carcinogenic PAHs considered include: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)p Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Indeno(1,2,3-c,d)pyrene, if present.

(2) 1,2- 1,4-Dichlorobenzene

3.0
SITE CHARACTERISTICS

3.1 PHYSICAL CHARACTERISTICS

Physical characteristics pertaining to exposure potential included the Site's geological setting, soil type/vegetation, climate/meteorology and groundwater hydrology. Population characteristics reflected in the exposure assessment included the demographics of the population and land use in the Site study area. Factors affecting potential exposures are discussed below.

3.1.1 Geological Setting

The Du Pont-Newport Site is located approximately three miles southwest of Wilmington, Delaware within the Atlantic Coastal Plain Province, which is characterized by relatively flat and low relief areas, with regional elevations not exceeding 100 feet above mean sea level. The surface elevation for the Site ranges from approximately 2 to 24 feet above mean sea level.

The formations which make up the coastal plain in the region are the Early Cretaceous age Potomac Formation, the Pleistocene age (Quaternary Period) Columbia Formation, and other unnamed Quaternary sediments. Expanded discussions on the Site's geological setting have been presented in previous reports (WCC, 1991b).

The composition of the Potomac Formation is dominated by silts and clays, but hydrologic zones within the formation contain medium to fine sand bodies which are interpreted to be deltaic deposits. The Potomac Formation is divided into upper and lower hydrologic zones separated by a clay/silt layer. The upper hydrologic zone and silt/clay barrier pinch out in the northern portions of the coastal plain.

The Columbia Formation is composed of silt, sand, and gravel, with occasional clay seams/beds. The Columbia Formation is also interpreted as having been deposited by a complex stream system, consisting of straight and meandering channels. The Columbia deposits predominantly consist of moderately- to poorly-sorted sands and gravels.

Above the Columbia Formation are Late Quaternary deposits of medium to fine sands, silts, and clays, including some organic strata. These sediments have been interpreted to be marsh and stream deposits similar to the type of sedimentary facies currently found on the coastal plain, related to current drainage systems.

3.1.2 Soil Type/Vegetation

The Site study area is traversed by the Christina River. The land adjacent to the river banks is comprised mostly of wetlands. The North Disposal site (north of the river) is capped with clayey soil averaging two feet deep and the South Disposal site (south of the river) is covered with variable soils averaging three feet deep. The wetlands and both disposal sites are moderately to heavily vegetated. In contrast to these areas, the land in the plant manufacturing areas is approximately 75% covered with various low permeability surface materials, such as macadam, asphalt and buildings. The Ballpark area is covered with grass and fill material.

The native soils in the vicinity of the Du Pont-Newport Site are described as moderately well-drained and medium textured, and, in most places, have a silty loam surface layer. However, because of human activities over the years (e.g., filling, building, paving), characteristics of the native soils are probably not descriptive of the conditions as they now exist.

3.1.3 Climate/Meteorology

The State of Delaware has a humid, temperate climate typical of the Middle Atlantic states. Available information on the temperature, precipitation and meteorology for the nearby city of Wilmington, Delaware is considered to be representative of the Site. Temperatures in Wilmington range from a monthly normal maximum of 76°F in July to a monthly normal minimum of 31.2°F in January. A temperature of more than 100°F occurs about once every five or six years. The highest temperature recorded was 107°F in August, 1918; the lowest temperature was -15°F in February, 1934.

The annual precipitation in Wilmington averages about 45 inches. Precipitation is generally well-distributed throughout the year, with slightly higher rainfall occurring in the summer months. The percent relative humidity generally ranges from 50-80%.

Based on Wilmington Airport wind rose diagrams, the prevailing regional wind direction is from the northwest; however, local wind directions are considered very variable and seasonally dependent. The mean wind speed for Wilmington is 9.2 mph. The "fastest wind mile" speed is reported to be 58 mph from the south/southwest.

3.1.4 Groundwater Hydrology

In the Newport area, a wedge-shaped mass of sedimentary deposits comprising the Coastal Plain consists of the Pleistocene Columbia Formation and younger sediments overlying the Cretaceous Potomac Formation. The Columbia and Potomac Formations are water-bearing zones in the Site study area. The Columbia Formation has been identified everywhere on the Site, both north and south of the Christina River. The base of the Columbia Formation extends across the Site and beneath the Christina River, which is about 12 feet deep in the area of the Site. The Columbia Formation is variable and contains discontinuous sand beds that together serve as an upper water-bearing unit. A variable clay bed section (predominantly consisting of clayey sands and sandy clays), that exceeds 15 feet in thickness at some locations at the Site, separates the water-bearing Columbia Formation from the intermediate water-bearing zone which belongs to the Lower Potomac Formation. The deep water-bearing zone, which is also Potomac Formation, is typically separated from the intermediate water-bearing zone by up to 20 or 30 feet of clayey sediments.

The Columbia Formation serves as a surficial, unconfined aquifer which is recharged primarily by infiltration from precipitation. Its significance for potential use as an aquifer depends on its thickness and/or its abundance of sand and gravel beds, along with the groundwater quality. The Columbia Formation at the Newport Site, along with the other Quaternary deposits, is not suitable for a potable water supply due to its known indigenous high dissolved minerals content, as demonstrated by the analytical data previously submitted by Du Pont to the EPA for Old Airport Road well samples (WCC, 1988; WCC, 1989; WCC, 1991b). Therefore, DNREC considers this water-

bearing interval to be the equivalent of an EPA Class III groundwater hydrologic unit. However, the EPA's February 11, 1992 letter, labeled the Columbia Formation groundwater Class II-A at the Site.

Regional hydrologic analyses in the Newport area show that much of the valley of the Christina River is an area of groundwater discharge or upward flow from the lower Potomac Formation into the river and marshy areas of the Christina River Valley. Groundwater from the Columbia Formation could potentially infiltrate into the Potomac Formation aquifer only in areas of groundwater recharge, some of which appear to exist at the Site. The rate of recharge would be restricted by the low vertical permeability of semi-confining beds which typically separate the Columbia and Potomac Formations.

The Upper and Lower sand members of the Potomac Formation are both potable water supply aquifers at distant locations south and southeast of the Newport, Delaware region. These units are separated from each other by clays and silts which retard vertical leakage from one unit to another. The Upper sand member of the Potomac Formati pinches out, or sub-crops, a few miles southeast of the Site.

The Lower sand member of the Potomac underlies the Newport Site and crops out northwest of the Site, just south of the Fall Zone. Recharge of this Lower sand member of the Potomac occurs primarily in this out-crop and sub-crop area. The only potential consumptive human receptors for the Potomac Formation in the vicinity of the Site are private residents or commercial establishments along Old Airport Road. All public or other private potable water users in the area of the Site are supplied by public water supply systems. Residents and commercial establishments along Old Airport Road are known to commonly use bottled water for consumption purposes, but groundwater is available from their wells.

Contours of the intermediate and deep zones suggest that potentiometric surfaces generally slope southeastward. Gradients of these contours suggest that the river acts as a hydraulic discharge boundary to some degree. Groundwater flow in some areas is from the intermediate zone through the semiconfining bed and upward into the Columbia Formation. Precipitation that infiltrates into the Columbia Formation n and south of the Christina River at the Site would generally discharge to the Christ

River. In addition, the Columbia Formation is partially recharged from the underlying Potomac Formation in some areas.

Based on two aquifer tests conducted in 1987, the estimated transmissivity of the Potomac Formation ranges from 2000 to 7000 gpd per foot over the entire Site. Estimates of the storage coefficient range from 2×10^{-4} to 4×10^{-4}. The storage coefficients are consistent with the semi-confined nature of the intermediate and deep zones.

Based on the estimated transmissivities, hydraulic gradients, and water-bearing zone thicknesses, groundwater flow velocities were evaluated using a formula derived from the Darcy Equation. Within the intermediate zone, groundwater flow velocities are estimated to range from about 0.2 to 0.4 feet per day north of the Christina River and about 0.2 to 0.6 feet per day south of the Christina River.

3.2 LAND USE AND DEMOGRAPHICS

3.2.1 Land Use

Current Land Use

The Du Pont-Newport Site is located within a highly developed area of northern New Castle County, Delaware, in the Lower Christina planning district of New Castle County. The major land use north of the Christina River in the Site study area is dominated by residential, urban and industrial areas. The major land use south of the Christina River near the Site is dominated by highway structure, wetlands, and industrial areas. The land in the Lower Christina planning district is almost entirely developed.

The narrow strip of land along the north and south banks of the Christina River and wetlands adjacent to the North Disposal site may be occasionally used for recreational purposes by fishermen and boaters. However, during numerous visits by WCC personnel no evidence of use (e.g., trespassers) of these parts of the Site was observed.

In contrast, a grass covered area owned by Du Pont adjacent to and north of the CIBA-GEIGY plant area is frequently used for recreation and identified in this report as the Ballpark. Recreational activities in the Du Pont Ballpark area may involve participants ranging in ages from children to adults.

The major land use in the vicinity of the South Disposal site is associated with wetlands or the high volume interchanges of Interstate 95, State Route 141 and Interstate 295.

The Christina River is used by the public for recreation such as boating, water skiing, and fishing.

Potential Future Land Use

Human health risk assessments may evaluate potential risks associated with the current use of the area as well as those associated with plausible future uses. Often, future residential use of the land is postulated. EPA guidance cautions that an assumption of future residential use may not be justifiable if the probability that a site will support residential use in the future is small. At the Du Pont-Newport Site, future residential development is unlikely to occur in the foreseeable future. Evidence to support this assertion includes:

- The industrial setting and highway structures in the immediate vicinity of the Site make the area an unattractive option for residential development

- The New Castle County Department of Planning has identified the land in this area as having severe restrictions regarding potential suitability for future development

- The land east and southeast of the Site is state-owned and unavailable for development or resale, as supported by the letter from the Delaware Department of Transportation to Du Pont (See Appendix B-2).

- Much of the land to the south and east of the Site is wetlands, as shown on the State of Delaware wetlands map.

- The land surrounding the north, east and west borders of the Site is owned by either Du Pont or CIBA-GEIGY.

- Du Pont has no present plan to use or sell any of the land they own adjacent to the Site.

- The Holly Run Plant recently underwent expansion to increase capacity, thus indicating Du Pont's intent to extend operations well into the future.

- CIBA-GEIGY's intent to continue operations at the Site well in the future similarly seem apparent from their announcement to both Du Pont and the EPA that they have plans to expand the Newport facility.

- Access to the Du Pont land primarily west of the Site is physically restricted by the land-locked nature of the property, the fencing and institutional controls at the plants and the properties adjacent to the Site including 24-hour per day/7-day per week security, and fencing on the north side of the river, and fencing that restricts vehicle access on the south side of the river.

- Natural barriers including steep embankments, dense vegetation and, marshy wetlands also physically restrict access to most of the Site and adjacent property on the north and south sides of the river.

- Population and housing unit growth for the immediate area is generally predicted to be low by the New Castle County Department of Planning as discussed further in Section 3.2.2 and confirmed by a recent newspaper article (see Appendix B-2).

In the future land use scenarios, current exposures are assumed to continue. In addition, construction activities on the South Disposal site and CIBA-GEIGY plant area, and potential future use of groundwater by residents along Old Airport Road are assumed.

3.2.2 Area Population

New Castle County, Delaware is one of three counties which comprise the Wilmington Primary Metropolitan Statistical Area (PMSA). The 1985 population of the Wilmington PMSA was 544,000, with 412,560 residing in New Castle County. The Du Pont-Newport Site lies within both the Lower Christina (north of the river) and New Castle planning districts (south of the river) of New Castle County.

The Lower Christina planning district is the most densely populated of the suburban districts in New Castle County. In 1985, 9.3% of the county population (or 38,540 people) resided in this district at a density of 3,228 people per square mile. Population projections of the New Castle Department of Planning predict a 12% loss of population from this planning district between 1985 and 2010, although the county is projected to experience net growth as a whole. No major increase in new housing units is expected to occur in this same time period (under 2% increase). Those parts of the Site no[rth] of the Christina River lie in an industrialized portion of the district along the river wh[ich] is isolated from the residentially developed areas.

The parts of the Site south of the Christina River lie in a planning district which is much less densely populated than the Lower Christina district (north of the river). In 1985, 14.2% of the county's population (or 58,560 people) resided in this district, at a density of 1,589 people per square mile. According to population projections, the New Castle planning district will experience a net gain in population of about 22% between 1985 and 2010, with about a 45% increase in housing units in the same period. Most of this growth can be expected to occur in the southern section of the district. The northern portion, in which the South Disposal site is located, is characterized by nearly total development. Currently, that part of the Site south of the Christina River is isolated from existing residential developments by wetlands, other vacant land owned by State and/or Federal Departments of Transportation, and the Christina River.

The population residing within one mile of the Du Pont-Newport Site is estimated to be about 3,500 people. All but an estimated 31 people reside north of the Site in either City of Newport or its suburbs.

The age distribution of residents within a two mile radius is relatively evenly distributed among age groups; approximately 23% of the residents within a two mile radius are 17 years old or younger.

4.0
EXPOSURE ASSESSMENT

Exposure bridges the gap between a potential hazard (e.g., presence of a toxic chemical) and a risk. Exposures to chemicals can occur through inhalation of air, ingestion of water or food, or by absorption through the skin. Human health exposure assessment is the determination of magnitude, frequency, duration and routes of exposure for human populations. The objective of an exposure assessment is the identification of: human populations that may potentially be exposed to contaminants of concern; the pathways and routes by which exposures may occur; and the magnitudes, frequencies, and durations of these potential exposures.

Exposure assessment involves the following steps: evaluating constituent releases; identifying potentially exposed populations; identifying potential exposure pathways; estimating exposure point concentrations for specific pathways based on environmental monitoring data and predictive modeling results; and estimating chemical intakes for complete exposure pathways. The exposure assessment results in estimates of pathway-specific intakes for current and future exposures to site-related chemicals of concern.

Key components of the exposure assessment are the following:

- Identification of potentially exposed populations
- Evaluation of exposure pathways/media/routes
- Quantification of exposure

4.1 POTENTIALLY EXPOSED POPULATIONS

The populations that are on or near the Site, or have direct routine access to the Site study area, were considered to be likely receptors in this Human Health Evaluation. The receptor populations were defined in a February 20, 1991 meeting with EPA Region III which was confirmed in a letter dated March 11, 1991 (WCC, 1991c). For the purposes of exposure assessment, the Du Pont-Newport Site was divided into seven subgeographic areas, as listed below.

1. South Disposal Site
2. North Disposal Site
3. CIBA-GEIGY Newport Plant Area
4. Du Pont Holly Run Plant Area
5. Ballpark Area
6. Christina River
7. Old Airport Road/Potomac and Columbia Formation Groundwater.

The geographic relationship between these exposure locations (or subgeographic areas) are illustrated in Figure 4-1. Potential receptors were identified for each of these areas. Figure 4-2 presents the relationship between potential human receptors, media and routes of exposure for each of these exposure locations.

4.1.1 South Disposal Area

Potential receptor populations for the South Disposal area are Du Pont workers, subcontractors (maintenance and potential future construction workers), New Castle county maintenance workers, and trespassers. Receptors in this area can come into contact with both soil and surface water.

New Castle County maintenance workers occasionally inspect a sanitary sewer force main on the South Disposal area. For exposure calculations, a Du Pont maintenance worker is assumed to accompany the county worker during this routine activity plus perform occasional non-routine assignments that are assumed to require that the Du Pont maintenance worker is present at the South Disposal area for up to 2 days/year. This is consistent with scenarios agreed to at the February 20, 1991 Risk Assessment Workshop with the EPA (Table 1, WCC, 1991c) (Appendix A).

In addition to maintenance workers, construction workers who may be involved in future activities at the South Disposal area could be potential receptors. While there are no planned construction activities or development near the South Disposal area at this time, future exposure scenarios consider up to two four-month-long (80 days) construction projects (the period of hypothetical earth moving activity) at this location. Construction workers were assumed to be subject to subchronic (less than one year) exposure

However, it is important to restate that Du Pont considers there to be no opportunities for construction workers to be present in the future at the South Disposal Site at this time.

The South Disposal site is accessible to trespassers. A fence with a gate surrounds part of the site, but it functions primarily to prevent vehicular traffic from gaining access to the site. Foot traffic is restricted by the fence, the wetlands and the heavy vegetation, but access to the site can be gained either by the riverfront or by walking around the fence. Infrequent past or current use of the South Disposal site by trespassers has been indirectly noted, as suggested by the limited presence of occasional general litter (cans, scattered shotgun shells). Based on the restricted access to the site, the potentially exposed population is apt to be limited to teenagers and adults who may infrequently gain illegal access to the site to engage in unauthorized hunting or other transient activities.

Potential trespassers at the South Disposal area were assumed to be adults and adolescents/young adults (ages 14 - 23) who are trespassing and are engaged in exploring, hunting or target shooting activities for up to 48 days per year.

4.1.2 North Disposal Area

Access to the North Disposal site area is limited by its location and security. A fence with a locking gate encompasses the entire site, which makes entry difficult. Access to the North Disposal site is hindered by security at the Holly Run and CIBA-GEIGY manufacturing plants and access via the river is hindered by the steep slope to the river and the heavy vegetation between the river and the fence. Also included in this subgeographic location is some non-wetlands area immediately to the southwest and west of the North Disposal site landfilled area which likewise has restricted entrance due to security and wetlands. A docking facility is next to the James Street Bridge which minimizes the need for boat docking along the riverbanks in the Site study area.

The only identified potential receptors at the North Disposal area are maintenance workers who are assumed to mow the grass at this location for up to 14 days per year and are subject to exposure via soil ingestion, inhalation and dermal contact.

4.1.3 CIBA-GEIGY Newport Plant Area

Due to plant security, only maintenance workers or construction workers are expected to be exposed to soils at the CIBA-GEIGY Plant area. Maintenance workers may be involved in activities which disturb soils for up to 6 days per year. In addition, construction workers associated with up to two hypothetical four-month long construction projects/year (80 days) were considered in a future exposure scenario. All future scenarios involving construction workers were considered subchronic exposures (i.e., less than one year duration).

4.1.4 Du Pont Holly Run Plant Area

Due to plant security, only workers are expected to be exposed to soil at the Holly Run Plant area. Potential receptors were assumed to be maintenance workers who may mow lawns for up to 56 days per year.

4.1.5 Ballpark Area

The potential receptors considered for the Ballpark area are children through young teenagers (ages 6-14) or adults engaged in sports activities for up to 39 days per year (3 days per week for 13 weeks per year) and may be exposed to soils in this area. It was assumed they would be present mostly in summertime.

4.1.6 Christina River

Local residents have access to the Christina River in the vicinity of the Site. Two media of concern were identified in this area: surface water and groundwater seeps. Potential recreational receptors on or in the Christina River considered in this Human Health Evaluation include adults and children (ages 6 to 14 years) engaged in fishing, boating and swimming for up to 39 days per year. These receptors were also assumed to have dermal contact with groundwater seepage entering the river and potentially inhale volatile organic compounds released from that seepage.

4.1.7 Old Airport Road/Potomac and Columbia Formation Groundwater

There are several commercial establishments and some residents living along Old Airport Road who have private water supply wells. It is possible that occupants or residents may ingest water from these wells. Based upon monitoring data, there is currently no apparent impact from the Site on groundwater quality in any of these wells. A future groundwater ingestion scenario from the Potomac and Columbia Formation was directed by EPA to evaluate potential future exposure to Old Airport Road residents.

In considering potential future risks via groundwater ingestion, potential exposure to chemical constituents of concern in the Potomac Formation, used regionally as a public water supply, was considered. Shallow groundwater chemistry in the Fill/Quaternary Zone and the Columbia Formation were also considered as a potential source of exposure. Originally, EPA direction in workshops with Du Pont on February 20, 1991 and October 1, 1991, specified that ingestion of groundwater from the Columbia Formation would not be included in the Human Health Evaluation. However, subsequent clarification by EPA instructed Du Pont to evaluate Potomac and Columbia Formation groundwater using wells designated by EPA Region III as representative of each aquifer. For the Newport Site, ingestion by local residents of Columbia Formation groundwater represents the highest potential risk for the groundwater route.

4.2 SENSITIVE GROUPS OF POTENTIAL CONCERN

There are two schools and portions of two county parks located in a one-mile radius of the Site. One subpopulation of potential concern for the Du Pont-Newport Site is small children, due to their greater tendency to ingest soil (an exposure pathway evaluated in this assessment).

Because of the restricted access to the Site and distance from residential areas, and the limited participation of children less than six years of age in activities at the Ballpark area, it is unlikely that infants are receptors. Therefore, infants or children below the age of 6 years old were not considered as a potentially exposed population under current or future exposure scenarios. No other sensitive subpopulations likely to be exposed to Site chemicals were identified.

4.3 EXPOSURE PATHWAYS/MEDIA AND ROUTES

An exposure pathway describes a site-specific mechanism by which a population or individual can be exposed to chemical constituents present at or originating from a site. An exposure pathway consists of four necessary elements:

- A source of chemicals and release from a source to the environment
- A transport medium for the released chemical
- A point of contact with the contaminated medium, and
- A human exposure route at the point of exposure

All four elements must be present for an exposure pathway to be complete and for exposure to occur. Incomplete pathways do not result in actual human exposure and not evaluated in the risk characterization because risks do not exist in the absence exposures.

This section describes the components of the exposure pathways that were identified at the Du Pont-Newport Site (Table 4-1).

4.3.1 Chemical Release Sources and Release Media

The chemical constituents present in the soils and water in the Du Pont-Newport Site study area were identified as the chemical release sources for all potential exposure pathways under consideration. These source areas were identified as the South Disposal Site, the North Disposal Site, the CIBA-GEIGY Newport Plant area, the Du Pont Holly Run Plant area, and the Ballpark adjacent to the Site.

The exposure media potentially involved in the transport of these chemical constituents include air, soil, surface water and groundwater. Direct exposure to soil and chemical transport via surface water, air and groundwater were considered.

Soil. The potential for movement of constituents in the surface soil of the Site study area are periodic episodes of precipitation and occasional on-site anthropogenic activities (e.g., construction, maintenance, recreation). Due to a combination of the clayey nature of most of the surface soils and abundant vegetation at the Site study area, wind erosion was not considered to be a factor for dust generation in this risk assessment. Hypothetical future construction activities at the South Disposal site and CIBA-GEIGY Newport Plant area, maintenance workers mowing at the North Disposal site, and recreational activities at the Ballpark area may generate airborne particulates which could then be inhaled or ingested by potential receptors at these locations.

The potential for movement of constituents in the sub-surface soil at the Newport Site study area is limited to percolation or leaching of chemicals to the groundwater. Physical transport of soils associated with construction activities could also result from on-site excavations.

Surface Runoff. Surface runoff can transport dissolved chemicals or soil particulates that may contain chemicals from the source area. For example, soil particulates may have been transported during historical plant operations from the South Disposal site to the wetland area adjacent to the Site study area. This release mechanism would be impacted by meteorological conditions, amount of vegetative cover, the particle size of the surface soils at the Site and the topographic contours of the Site.

Air Transport. Chemical constituents adsorbed onto soil particulates may be released into the air as a result of surface disturbance of the source soils and through wind erosion of the surface. Wind erosion of the surface soils at the Site is not expected to be a significant contributor since the Site study area consists of areas covered with buildings, macadam, wetlands, vegetation, or a cap of clayey soil or soil. Dust generation, and subsequent inhalation, was considered for maintenance activities, recreational activities at the Ballpark, and for potential future construction activities. Areas of groundwater seepage have been identified in sections of the intertidal zone on the north bank of the Christina River from the mouth of the North Disposal site drainageway to about 200 feet west (upstream) of the James Street (see Figure 4-1). Volatilization of chemicals from this groundwater seepage into the air was considered a potential pathway for exposure.

Groundwater. Chemical constituents in the groundwater can potentially migrate to an exposure point where they could be ingested by a receptor population. This pathway was evaluated under EPA direction, using representative wells for the Potomac and Columbia Formation aquifers.

4.3.2 Human Exposure Routes

An exposure route is the mechanism by which a chemical constituent comes into contact with a receptor, i.e., by inhalation (respiratory tract/lungs), ingestion (gastrointestinal tract) or dermal absorption (skin).

Oral Ingestion

Ingestion of chemicals of concern was considered for the following exposure pathways:

- Incidental ingestion of soil by all individuals who may come into contact with surface soils
- Incidental ingestion of surface water by swimmers
- Potential future ingestion of Potomac and Columbia Formation groundwater

Potential ingestion of fish caught in the Christina River was also considered, due to concerns over the potential lead content of the fish. An evaluation was made to estimate the potential human health impact that may be related to the consumption of fish considered to be "edible" species and of consumable size from the Christina River near the Site study area. This evaluation utilized data for fish that were collected near the Newport Site, and from fish collected as controls from locations distant from the Site. The lead concentrations in fish fillets from both of the data groups (near-Site and control location) were essentially identical and below method detection limits. This comparison itself suggested no significant impact associated with the Site.

Furthermore, the available lead concentrations in fish tissue from fillets of fish colle near the Site were used to evaluate the subsequent potential increase in blood le

levels of children utilizing the EPA LEAD.4 biokinetic model. It was assumed that children ages 0.5 to 7 years consumed 35g of fish each day. This value is recommended by the EPA to evaluate adult fish consumption for people who are active fishermen and consume their catch and over-estimates actual average fish consumption. It is also assumed that the only fish consumed are obtained from the Christina River near the Site where the fish were collected for this study. These are very conservative assumptions. The EPA estimates that the average fish consumption for adults is 6.5 g/day, an amount which includes total fish consumption from all sources.

The default values of the LEAD.4 biokinetic model were used as the control in this evaluation. Based on the moisture contents and the lead analyses, the average concentration of lead in fish fillets would range from 40 ug to 80 ug per kg of fish. These values represent one half the detection level actually determined in the fish analyses. Using these lead values, the calculated average increases in blood lead concentrations for children consuming 35 g of fish per day were 0.21 ug/dl and 0.42 ug/dl. This increased blood lead level is judged to be insignificant when compared to 10 ug/dl, EPA's current threshold for action for blood lead levels. Therefore, no further action with respect to lead levels in fish is recommended.

Inhalation

Inhalation of chemicals of concern via inhalation of dust and vapor phase chemicals was considered for the following exposure pathways:

- Inhalation of airborne soil particulates by maintenance workers involved with mowing grass or other dust generating activities
- Inhalation of airborne soil particulates by recreational participants at the Ballpark
- Potential future inhalation of airborne soil particulates by construction workers who may engage in on-site excavations.
- Inhalation of chemicals volatilized from groundwater seepage by recreational participants on the Christina River.

Dermal Contact

Dermal contact with and subsequent absorption of chemicals of concern was considered for the following exposure pathways:

- Dermal contact with soils by all individuals who may come into contact with surface soils

- Dermal contact with surface waters by swimmers, other recreational participants, and trespassers.

4.3.3 Exposure Points

An exposure point is defined as a location of potential contact between a receptor population and a chemical constituent. The objective of determining exposure points is to identify specific locations where receptor populations may be potentially exposed, a to estimate chemical concentrations in the environmental media near potential recepto

Expected points for potential exposure to chemical constituents via surface soil include all of the identified source areas. In all cases, the skin is expected to be the primary point of exposure, but maintenance workers, construction workers and children engaged in recreational activities at the Ballpark area may also inhale particulates. Soil from source areas which may be ingested or deposited on the skin or the lining of the upper respiratory tract was also considered. For dermal exposure to surface soils, exposure point concentrations are equivalent to the measured surface soil concentrations.

Subsurface soils found at depths greater than 4.5 feet deep are not expected to contribute to significant exposure. They were not considered as a potential exposure point because there is no realistically anticipated exposure to these soils.

Expected points for potential exposure to chemical constituents via surface water and groundwater seeps include on-site surface waters at the South Disposal site, and the Christina River. Contact with sediments in these locations was not considered significant route of exposure compared to other more contaminated media, such as so

where the potential exposure time is greater. The transport of chemicals from sediment to human skin must take place through an equilibrium transport mechanism that involves surface water associated with the sediment. Consideration of the exposures related to contact with surface water and groundwater seeps is used to evaluate this exposure route. For surface water and groundwater seeps exposures, exposure point concentrations are equivalent to the measured surface water concentrations.

Potential exposure points to chemical constituents via airborne particulates would consist of receptors at the South Disposal site, the CIBA-GEIGY Newport Plant area, the North Disposal site and the Ballpark area. Exposure point concentrations for airborne soil particulates were estimated from measured concentrations of chemicals in surface soils, adjusted for the total amount of respirable soil particles suspended in the air. For inhalation of volatile chemicals emanating from groundwater seepage, simple modeling was used to estimate exposure point concentrations.

Groundwater was also considered in evaluating future ingestion exposure and results in exposure points for residents along Old Airport Road. Exposure point concentrations for groundwater ingestion were based upon EPA direction in assigning specific wells from each aquifer to represent the receptor wells around the area near MW-19.

Additional details concerning estimates of exposure point concentrations are presented in Section 4.5.

4.4 QUANTIFICATION OF POTENTIAL EXPOSURES

4.4.1 Introduction

After defining receptor populations and pathways by which these populations may be exposed to chemicals of potential concern, the next step in the exposure assessment process is to quantify the magnitude, frequency and duration of exposure. This step is conducted in two stages: (1) estimation of exposure point concentrations; and (2) estimation of chemical intake for each of the pathways and media considered in this assessment. Some general considerations in quantifying potential exposures are presented in the remainder of this chapter. This process involves a large number of assumptions and professional judgement, and is thus subject to considerable uncertainty. Conservative assumptions were used throughout the process; therefore, the final result is likely to overestimate actual exposure and associated potential risk.

4.4.2 Quantifying Average and Reasonable Maximum Exposures (RME)

Exposure to a chemical is generally described in terms of intake, expressed in milligrams of chemical per kilogram of body weight per day (mg/kg/day). The magnitude of exposure to a chemical (or intake) is a function of a number of factors, including exposure concentrations and variables that are relevant to the exposed population (e.g., contact rate, exposure frequency, duration, activity and body weight). Each of these variables can be described by a range of values. For purposes of this assessment, two measures of exposure have been defined using two sets of exposure variables: an average exposure and a reasonable maximum exposure (RME). The average exposure is estimated using average exposure concentrations (e.g., average soil or groundwater concentrations) and other conditions that may be typical of an individual with normal activity patterns. The average exposure scenario is intended to be reasonably (moderately) conservative.

The RME is estimated using guidance provided in EPA's Risk Assessment Guidance for Superfund (USEPA, 1989). The RME is developed by selecting intake variable values so that their combination would result in a maximum exposure that could reasonably be expected to occur. The intent is to conceive a conservative exposure case, well above

average, that is still within the range of possible exposures, instead of an absolute worst-case scenario. Because of uncertainty surrounding any estimate of exposure concentration, EPA recommends that the 95th percentile upper confidence limit on the arithmetic average be used for this variable in characterizing the reasonable maximum exposure. Tables 2-1 through 2-8 provide both the mean concentrations, 95th percentile Upper Confidence Limits (UCL) of those averages, and ranges (minimum and maximum values) for the chemicals of potential concern in each area for soils, surface waters and groundwater seeps at the Site.

However, since groundwater at this Site was identified as having a potential impact for a future residential ingestion exposure scenario, very conservative estimates of potential future off-site groundwater concentrations were determined, as directed by EPA in their February 11, 1992 letter. Potential exposures to groundwater were evaluated based upon average and 95th percent UCL concentrations of parameters observed in selected Columbia and Potomac Formation wells on-site in the vicinity of MW-19. Tables 2-9 and 2-10 summarize the selected data for the chemicals of concern at the Site for these wells in the Potomac and Columbia Formations.

4.5 DETERMINATION OF EXPOSURE CONCENTRATIONS

As indicated earlier, current receptor populations identified in the assessment include on-site workers, recreational participants and occasional trespassers. Future exposure scenarios include construction workers and residents along Old Airport Road. For most routes, exposure point concentrations for the identified receptors were based on sampling and analysis of data for chemicals of concern at the Site study area for the media to which receptors are exposed. For example, exposure point concentrations for dermal contact and ingestion of soil in a given area were simply the measured mean and RME (95th percentile) concentrations of chemicals measured in the surface soils in that area.

For two exposure pathways, exposure point concentrations were estimated based upon modeling. These routes of exposure are:

- Inhalation of dust (soil particulates) and

- Inhalation of volatile organics emanating from seepage water.

Methods of estimating exposure concentrations for each of these routes are described below.

In addition, groundwater concentrations for the Potomac and Columbia Formations were determined by EPA's decision to use analytical data from various wells in the vicinity of MW-19 to represent a continuous contaminant source.

4.5.1 Inhalation of Dust

Potential exposures via inhalation of soil particulates was identified for the South Disposal site, the North Disposal site, the CIBA-GEIGY Newport Plant area and the Ballpark area. In agreement with EPA Region III, the exposures for this route are based upon an assumed total respirable airborne dust concentration of 100 ug/m^3. It was t' assumed that this airborne dust would have the same composition as the near surf soils in a given area. Airborne contaminant concentrations on particulates were estimated by the simple relationship:

$$C_{ap} = C_s \times 100 \times 10^{-9}$$

where:

C_{ap} = concentration of contaminant in airborne particulate (mg/m^3)

C_s = concentration of contaminant in soil (mg/kg)

100 = total particulates in air (ug/m^3)

10^{-9} = conversion factor (kg/ug)

Thus,

$$C_{ap} = C_s \times 10^{-7}$$

Average and RME scenarios for inhalation of airborne particulates were estimated using average and RME soil concentrations.

4.5.2 Inhalation of Organic Vapors From Groundwater Seepage

Exposure to adult and children (ages 6-14) recreational receptors on the Christina River near groundwater seepage emanating from the north bank of the river adjacent to the CIBA-GEIGY operations area and the North Disposal site was considered. Potential airborne concentrations of volatile organics were estimated from a simple conservative model. The following assumptions were used:

- A given seepage source is approximately 10 feet in length, and flows at 2 gallons per minute (gpm), based upon observations at the Site
- All of the volatile organics in the seepage water volatilize instantaneously
- A light wind (2 m/sec) blows directly from the seepage source to the receptor
- The volatiles are mixed only to a breathing height of 6 ft

Airborne volatile concentrations were related to groundwater seepage concentrations using the following relationship:

$$C_{av} = \frac{C_{sp} \times 2\ gal/min \times 3.785\ l/gal \times 1\ min/60\ sec}{2\ m/sec \times 6\ ft \times 0.305m/ft \times 10\ ft \times 0.305m/ft}$$

$$= \frac{C_{sp} \times 0.126\ l/sec}{2m/sec \times 1.83m \times 3.05m}$$

$$= C_{sp} \times 0.0113\ l/m^3$$

where:

C_{av} = concentration of contaminant in airborne volatile (mg/m^3)

C_{sp} = concentration of volatile organics in the groundwater seepage (mg/l).

The remaining factors are consistent with the stated assumptions and unit conversion factors. Due to low vapor pressures, non-volatile organic compounds and metals were not considered for potential inhalation exposures through volatilization.

4.5.3 Groundwater Ingestion (Future)

Under EPA's direction in a letter dated, February 11, 1992, data from specified wells in the area of MW-19 were used to represent the Potomac and Columbia aquifers.

These wells represent a future hypothetical use scenario, since there is no current potable water use from these aquifers at the site in the vicinity of MW-19, and no future use is anticipated. During transport of groundwater from this area, significant attenuation (decrease) in chemical concentrations would be expected, due to dilution, dispersion, retardation, and degradation of chemicals. Because the groundwater concentrations used in the assessment do not account for attenuation during transport, they overestimate concentrations which are likely to occur downgradient. Monitoring conducted to date has not detected significant concentrations of site-related chemicals in wells along Old Airport Road.

4.6 ESTIMATION OF CHEMICAL INTAKE

4.6.1 Introduction

The last step in the exposure assessment process is the estimation of exposure or intake by each receptor population for each of the pathways considered in this assessment. The extent of potential intake through the various pathways is dependent upon an individual's activities. To estimate the level of exposure for specific individuals, it is necessary to make a series of assumptions to derive an estimate of potential human exposure.

In an exposure assessment, it is generally necessary to provide at least two different measures of intake or dose, depending on the nature of the effect being evaluated. The EPA (USEPA, 1989) recommends that when evaluating longer-term exposure to a non-carcinogenic toxicant, the intake be calculated by averaging the intake over

period of exposure, referred to here as averaging time (AT). The resulting intake is either termed a subchronic daily intake (SDI) or chronic daily intake (CDI). This depends on whether the exposure occurs for less than a one year period, which would be defined as a subchronic exposure by EPA Region III, (WCC, 1991c) or if the exposure is for more than one year, it is defined as a chronic exposure. For carcinogens, intakes are calculated by averaging the total cumulative dose over a lifetime, referred to by EPA as a chronic daily intake or lifetime average daily intake.

The two different methods (i.e., different averaging times) for estimating intakes are based on currently held scientific opinion that the mechanism of action of carcinogens and non-carcinogens is different, as discussed in Section 5 of this assessment. For example, for all chronic exposure scenarios addressed in this assessment, the averaging time (AT) for the non-carcinogens is equivalent to the duration of exposure (years) times 365 days/year. For subchronic exposures, averaging time equals exposure frequency times exposure duration (AT=EFxED). For carcinogens, the averaging period in both the average and reasonable maximum cases would be an assumed 70 year lifetime (25,550 days) (USEPA, 1989).

As discussed in the previous sections, four potentially exposed groups were evaluated in this assessment: 1) maintenance and construction workers; 2) occasional trespassers; 3) recreational receptors; and 4) residents along Old Airport Road.

The frequencies and durations of potential exposures for the populations evaluated in this baseline assessment under the no-action (or limited action) scenario are discussed below. The remainder of this section describes the assumptions and general equations used to estimate intake for each of the populations by the relevant pathways of exposure.

4.6.2 Calculation of Intake Factors

An intake factor represents the relationship between an exposure to a given contaminant, expressed as a concentration in a medium, to the intake of the contaminant by a receptor, expressed in mg/kg/day. Development of intake factors for each potential route of exposure is described below.

Inhalation of Airborne Particulates

Construction and maintenance workers and Ballpark recreational participants engaged in dust generating activities could be exposed to chemicals through inhalation of particulates. The equation and parameters that were used to estimate the extent of exposure from inhalation are summarized as follows:

$$\text{Intake Factor} = \frac{(IR)(ET)(EF)(ED)(ME)(DF)(CC)(FI)(SS)}{(BW)(AT)}$$

where:

IR	=	Inhalation Rate (m^3/hour)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
ME	=	Matrix Effect (unitless)
DF	=	Deposition Factor (unitless)
CC	=	Ciliary Clearance (unitless)
FI	=	Fraction Contaminated (unitless)
SS	=	Site Specific Factor (unitless; used only for specific conditions)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

The values used for this exposure route are found in Table 4-2 (children at the Ballpark), Table 4-3 (construction workers at the South Disposal Site), Table 4-4 (construction workers at the CIBA-GEIGY Newport Plant area), and Table 4-5 (maintenance workers at the North Disposal Site).

For both carcinogenic and noncarcinogenic exposure scenarios, the inhalation rates for adults assumed moderate activity for construction workers and light activity for the maintenance workers and recreational participants for both the average and RME scenarios. All intake values are given for average and RME scenarios in the subsequent discussions. Average adult inhalation rates were assumed to be 20 m^3 per day as described in Exhibit 6-16 of RAGS (USEPA, 1989). Inhalation rates vary with age a

activity. For construction workers, an inhalation rate of 2.5 m^3/hr was used. For children/adolescents (ages 6-14) participating in recreational activities, the inhalation rates used were 1.9 m^3/hr (average) and 3.7 m^3/hr (RME). These values are based upon mean breathing rates for a 10-year old child engaged in various levels of activity. Percentages of time at each level of activity were those given for individuals engaged in outdoor activities (USEPA, 1990).

Specific exposure times, frequencies, and durations were based on the WCC's March 11, 1991 letter to EPA (Appendix A), EPA guidelines, site-specific data and professional judgment.

Exposure times were assumed to be eight hours per day for maintenance and construction workers, and two (average) and four (RME) hours per day for Ballpark recreational adolescents.

Exposure frequencies for average and RME scenarios were assumed to be:

- Forty and eighty days per year for construction workers
- Seven and fourteen days per year for maintenance workers at the North Disposal site, and
- Twenty-six and thirty-nine days per year for Ballpark recreational adolescents.

Exposure durations were assumed to be one (average) and two years (RME) for construction workers, nine (average) and forty-five years (RME) for maintenance workers and nine years for both average and RME scenarios for Ballpark recreational adolescents (ages 6-14, inclusive). Construction worker exposure were considered subchronic exposures, because they are expected to be limited to one or two episodes, each with a duration of about 4 months or less.

The soil matrix effect (ME) represents an adjustment factor for the amount of a given chemical present in soil that is not available for absorption by a receptor. The amount of unavailable chemical is a function of the other constituents in soil which interfere with

the absorption of that chemical. Soil is known to retard the absorption of many chemicals (Poiger and Schlatter, 1980). However, for this risk assessment, soil is assumed not to retard absorption. Therefore, a conservative matrix effect value of 1.0 (assumed complete absorption of all chemicals in the soil) was used in all relevant exposure scenarios addressed in this risk assessment.

The deposition factor (DF) is the fraction of inhaled particulates that is deposited on the inner lining of the respiratory tract. The ciliary clearance (CC) factor is the fraction of deposited particulates that is retained in the lungs after particles are cleared by ciliary action in the respiratory tract. For all inhalation exposure scenarios involving particulates, the DF and CC values were assumed to be 0.75 (Holly, 1985) and 0.375 (MRI, 1985), respectively.

The fraction contaminated (FI) is that portion of a contaminated medium which is assumed to be in contact by a receptor. This assumption is usually based on an exposure area consideration (i.e. the amount of a given media actually contaminated in a gi unit area) or an exposure time consideration (amount of time in hours a receptor is contact with a medium during an assumed 12 hour period of daylight per day). For dust inhalation, it was assumed that all dust inhaled during the exposure time was contaminated, i.e. FI = 1.0.

All adult body weight values were assumed to be 70 kg (USEPA, 1989). For children, average body weight values (ages 6-14) were calculated to be 33.3 kg for both carcinogenic and non-carcinogenic exposure scenarios. These body weight values are 50th percentile averages (males and females) based on the Exposure Factors Handbook (USEPA, 1990, Tables SA-3 and SA-4).

Averaging times for carcinogens were 70 years (25,550 days). For non-carcinogens, the averaging time was equivalent to the exposure duration for chronic exposures, and to the exposure frequency times exposure duration for subchronic exposures, consistent with RAGS (USEPA, 1989).

In estimating airborne particulate exposures, a site-specific (SS) factor of 1×10^{-7} was used to convert surface soil concentrations to airborne particulate concentrations, as discussed in Section 4.3.

4.6.3 Direct Dermal Contact with Soil

All potential receptors identified for this Site study area were presumed to be exposed to the soil by the dermal route. Outdoor activities may result in the transfer of chemicals from the soil through skin into the blood stream. To estimate exposure to chemicals through dermal contact with soils, it was assumed that chemical concentrations in soils remain constant over time.

Exposure of maintenance and construction workers, recreational participants, occasional trespassers and future residents to chemicals of potential concern through direct dermal contact with soil was estimated by consideration of the following variables: (1) the amount of skin surface exposed to the soil; (2) the fraction of contacted soil that originates from the contaminated area; (3) the amount of soil that adheres to the skin; (4) the frequency and duration of exposure; and (5) the extent to which chemicals adsorbed to soil are subsequently absorbed through the skin. The equation and parameters used to estimated intake of chemicals via dermal contact with soil are summarized as follows:

$$\text{Intake Factor} = \frac{(SA)(AF)(EF)(ED)(ME)(FI)(ABS)(SS)(CF)}{(BW)(AT)}$$

where:

SA	=	Surface Area of skin exposed to soil (cm^2/event)
AF	=	Soil-to-skin Adherence Factor (mg/cm^2)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
ME	=	Matrix Effect (unitless)
FI	=	Fraction Contaminated (unitless)
ABS	=	Absorption Factor (unitless)
SS	=	Site Specific Factor (unitless)
CF	=	Conversion Factor (10^{-6} kg/mg)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Specific values which were used for this exposure route are presented in Table 4-6 (trespassers at the South Disposal site), Table 4-7 (children at the Ballpark), Table 4-8 (construction workers at the South Disposal site), Table 4-9 (construction workers at the CIBA-GEIGY plant area), Table 4-10 (maintenance workers at the North Disposal area), Table 4-11 (maintenance workers at the Holly Run plant area), Table 4-12 (maintenance workers at the CIBA-GEIGY plant area), and Table 4-13 (maintenance workers at the South Disposal area).

Throughout this assessment, it was assumed that a given receptor's exposed surface area is a function of that receptor's age and activities. All surface area values used in this assessment were averaged for males and females. Calculations of various surface areas for the receptors used in the assessment are found in Appendix D. The activities of a given receptor were assumed to determine the site-specific location, frequency and duration that receptor would be in contact with the various on-site soils. Soil adherence factors were assumed to be 1.48 mg/cm^2 for both average and RME scenarios, consistent with the WCC letter of March 11, 1991 to EPA (WCC, 1991c).

It was assumed that a conservative matrix effect of 1.0 (total release) for all Site dermal exposure scenarios. For all soil dermal exposure scenarios, the absorption factors

organics and metals were assumed to be 0.01 and 0.001, respectively, and is based on professional judgement, considering the limited transport potential of soil bound chemicals onto and through the skin. For metals, absorption through skin is expected to be neglible, considering the low permeability of skin to inorganics, and the tendency of metals to bind to soil particles. A value of 0.001 for dermal absorption of soil bound metals have been used in previous risk assessments prepared by WCC and approved by EPA, including the baseline assessments performed for the Baier and McCarl Superfund sites in Lee County, Iowa. For organics, the value of 0.01 (1%) is consistent with data for low solubility organics (chlorinated dioxins). For example, Driver, et al, (1989), report that 0.28% of TCDD on soil was absorbed after 24 hours of dermal contact. Poiger and Schlatter (1980) with human skin in vitro reported detection of only 0.05% of the dose of TCDD recovered after administration in a soil water paste. Values in the range of 1% absorbed dose for soil bound TCDD have commonly been applied in risk assessment. This value can be reasonably applied to other low volatility hydrophobic organic compounds. Data for dermal absorption low molecular weight organic compounds bound to soil are generally lacking. The value used, 0.01 (1%), is reasonable based upon:

- The low absorption of high molecular weight organics
- The tendency of even low molecular weight organics to bind to soils, and
- The tendency of low molecular weight organics on soil to volatilize when exposed to air, which would minimize the time of dermal contacts.

For purposes of estimating carcinogenic and non-carcinogenic health risks, all workers (maintenance workers at the Holly Run Plant and CIBA-GEIGY plant areas and the North and South Disposal sites, construction workers at the South Disposal site and CIBA-GEIGY Newport Plant area) were assumed to have their hands exposed for the average scenarios and their hands and forearms exposed for the RME scenarios. Both trespassers and recreational receptors (except for children/adolescents playing ball in the Ballpark area) were assumed to have their hands and feet exposed for the average scenarios and their hands, feet and forearms exposed for the RME scenario. Recreational ballpark receptors were assumed to have their hands, feet, and face

exposed for the average scenarios and their hands, feet, face, arms and legs exposed for the RME scenarios. All derived surface area calculations used in these scenarios were based on values adjusted for body weights in accordance with the EFH (USEPA, 1990). (Additional details are provided in Appendix D).

Exposure frequencies estimating carcinogenic and non-carcinogenic health risks for average and RME scenarios were assumed to be:

- Twenty-four and forty-eight days per year for trespassers (adult and adolescent) at the South Disposal area
- Twenty-six and thirty-nine days per year for Ballpark and river recreational participants
- Forty and eighty days per year for construction workers
- Seven and fourteen days per year for maintenance workers at the North Disp area
- Twenty-eight and fifty-six days per year at the Holly Run Plant area
- Three and six days per year for maintenance workers at the CIBA-GEIGY Plant area
- One and two days per year for maintenance workers at the South Disposal site

Exposure durations estimating carcinogenic and non-carcinogenic health risks were assumed to be:

- Nine and thirty years for adult trespassers and river recreational participants
- Nine years for adolescent tr passers
- Nine years for Ballpark recreational children

- One and two years for construction workers (subchronic)

- Nine and forty-five years for maintenance workers

The fraction of soils contaminated (FI) was assumed to be a function of the number of hours a day a receptor was on-site divided by the total number of potential exposure hours for that day (12 hrs). FI values for all maintenance and construction workers who are assumed to work eight-hour days, would be 0.67. Trespassers at the South Disposal area would have FI values of 0.083 and 0.17 for 1 and 2 hours per day on-site, respectively. The FI values for recreational participants were similarly assumed to be 0.17 and 0.33 for Ballpark areas based upon 2 (average) and 4 (RME) hours of exposure at the Site out of a 12 hour day.

A site-specific factor of 1.0 was used, since no adjustment was made for other site-specific conditions. Body weights were the same as described in Section 4.6.2. In addition, body weights for adolescents (ages 14 - 23) were calculated to be 61.2 kg for both carcinogenic and non-carcinogenic exposure scenarios (USEPA, 1990). The averaging time was equivalent to the exposure duration for chronic exposure for non-carcinogens and 70 years for carcinogens (USEPA, 1989). For subchronic exposures, the averaging time was equivalent to the exposure frequency times exposure duration.

4.6.4 Ingestion of Soil

For exposure of workers, recreational receptors and occasional trespassers to chemicals of potential concern via incidental ingestion of soil, it is conservatively assumed that chemical concentrations remain constant over time (e.g., will not volatilize, leach or degrade). The equation for estimating intake of chemicals through soil ingestion is shown below:

$$\text{Intake Factor} = \frac{(IR)(EF)(ED)(ME)(FI)(SS)(CF)}{(BW)(AT)}$$

where:

IR	=	Ingestion Rate (mg/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
ME	=	Matrix Effect (unitless)
FI	=	Fraction Contaminated (unitless)
SS	=	Site Specific Factor (unitless)
CF	=	Conversion Factor (10^{-6} kg/mg)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Specific intake parameters which are used for evaluation of this exposure route are presented in Table 4-14 (trespassers at the South Disposal site), Table 4-15 (children the Ballpark), Table 4-16 (construction workers at the South Disposal site), Table 4 (construction workers at the CIBA-GEIGY Newport Plant area), Table 4-18 (maintenance workers at the North Disposal site), Table 4-19 (maintenance workers at the Holly Run Plant area), Table 4-20 (maintenance workers at the CIBA-GEIGY Newport Plant area), and Table 4-21 (maintenance workers at the South Disposal site).

As agreed to by the EPA Region III and WCC, all RME scenario ingestion rates for adults and children/adolescents were assumed to be 100 and 200 milligrams of soil per day, respectively. The average scenario ingestion rates were assumed to be 15 mg/day for workers, 20 mg/day for adult trespassers and 100 mg/day for adolescent trespassers and recreation receptors. The soil ingestion route was not evaluated for adult recreational receptors.

Assumptions for exposure frequencies, durations, fraction contaminated, body weights, and averaging times were the same as used for dermal exposures (Section 4.6.3).

For all ingestion exposure scenarios for soils, the matrix effects and site-specific fac were assumed to be 1.0, i.e., no adjustments were made for site-specific conditions.

4.6.5 Dermal Contact with Surface Water and/or Groundwater Seepage

Recreational participants along the river and occasional trespassers on the South Disposal site may experience direct contact with the surface waters. The equation used to calculate the absorbed dose from surface water is shown below:

$$\text{Intake Factor} = \frac{(SA)(PC)(ET)(EF)(ED)(SS)(CF)}{(BW)(AT)}$$

where:

SA	=	Surface Area (cm^2)
PC	=	Permeability Constant (cm/hr)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
SS	=	Site Specific Factor (unitless)
CF	=	Conversion Factor (10^{-3} l/cm^3)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Specific intake parameters which are assumed or adopted for evaluation of this exposure are presented in Table 4-22 (trespassers at the South Disposal site), Table 4-23 (recreational swimmers in the river), and Table 4-24 (recreational non-swimmers near the river exposed to groundwater seepage).

Specific input factors used for the direct dermal contact with surface water and groundwater were derived from information in the EPA's Exposure Factors Handbook (USEPA, 1990) and the WCC March 11, 1991 letter to the EPA Region III (WCC, 1991c).

Exposure times were 2 (average) and 4 (RME) hours/day for trespassers and 2 (average) and 3 (RME) hours/day for recreational participants. Exposure frequencies were 24

(average) and 48 (RME) days/year for trespassers and 26 (average) and 39 (RME) days/year for recreational participants. These values are consistent with the March 11, 1991 letter (Appendix A).

The permeability constant (PC) reflects the rate of migration of chemicals in water through the skin, which represents an effective barrier to many chemicals. Permeability constants used were consistent with values agreed to by WCC and EPA Region III (WCC, 1991c). For metals, a permeability constant of 7.2 E-6 cm/hr was used, based upon the permeability constant for aluminum ions (USEPA, 1988). For organics, a value of 8 E-4 cm/hr was used based on a letter from R. Sturgeon, USEPA, to J. Karmazyn, Du Pont, dated December 2, 1991.

The activities of a given receptor were assumed to determine the site-specific location, frequency and duration that receptor would be in contact with either the Christina River or the groundwater seeps.

All swimmers were assumed to have their total body surface in contact with river wa for the duration of exposure. Trespassers were assumed to have their hands and feet (average) and hands, feet and lower legs (RME) exposed to surface waters. Recreational participants in contact with the groundwater seepage were assumed to have their feet (average) and feet and lower legs (RME) exposed. Calculations of surface areas used are presented in Appendix D.

No site-specific adjustment was made (i.e., SS = 1.0). Assumptions for other variables are consistent with those used in other exposure scenarios discussed above.

4.6.6 Ingestion of Water

In the current use scenario, surface water in the Christina River may be inadvertently ingested by swimmers. In the future use scenario, potential future groundwater ingestion by residents along Old Airport Road was considered. The equation and parameters used to estimate the intake of chemicals via the ingestion of water are summarized as follows:

$$\text{Intake Factor} = \frac{(IR)(EF)(ED)(FI)(SS)}{(BW)(AT)}$$

where:

IR	=	Ingestion Rate (liters/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
FI	=	Fraction Ingested (unitless)
SS	=	Site Specific Factor (unitless)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Specific values which were used for evaluation of this exposure route are presented in Table 4-25 (recreational swimmers in the river), and Table 4-26 (Old Airport Road residents ingesting groundwater).

Assumed ingestion rates for swimmers were based on swallowing 50 ml water per hour. For adults and children, the average and RME scenario ingestion rates were estimated to be 0.1 and 0.15 liters per day. For residents ingesting groundwater, the average and RME ingestion rates were estimated to be 1.4 and 2 liters per day, respectively. Exposure frequencies were assumed to be twenty-six (average) and thirty nine (RME) days per year for swimmers. Exposure frequencies for residents were assumed to be 365 days per year.

Exposure durations were assumed to be nine (average) and thirty (RME) years for recreational adults, and nine years for recreational children aged 6 to 14 for both average and RME cases. The fraction of water contaminated was assumed to be 1 for all exposure scenarios. Body weights were assumed to be 70 kilograms for adults and 33.3 kg for children, consistent with other scenarios. A site-specific factor of 1.0 was used. Other assumptions are consistent with those used in other exposure scenarios described above.

4.6.7 Inhalation of Volatiles from Groundwater Seepage

Recreational users of the Christina River, such as fishermen, may occasionally be exposed via inhalation to volatile organics that may be released from seeps along certain areas of the northern river bank. The equation and variables used to estimate intake for this pathway are as follows:

$$\text{Intake Factor} = \frac{(IR)(ET)(EF)(ED)(ME)(DF)(CC)(FI)(SS)}{(BW)(AT)}$$

where:

IR	=	Inhalation Rate (m^3/hour)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
ME	=	Matrix Effect (unitless)
DF	=	Deposition Factor (unitless)
CC	=	Ciliary Clearance (unitless)
FI	=	Fraction Contaminated (unitless)
SS	=	Site Specific Factor (unitless)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

The values for variables used for this pathway are given in Table 4-27 (recreational adult inhalation of groundwater seeps).

An inhalation rate of 0.8 m^3/hr for an adult was used for both average and RME exposures, consistent with low exertion recreational activities such as fishing. Exposure times were assumed to be 2 hr (average) and 3 hr (RME).

Exposure frequencies and duration were assumed to be 26 days/year (average) and 39 days/year (RME). Exposures durations were 9 (average) and 30 years (RME) for adults.

The matrix effect (ME), ciliary clearance (CC), and deposition factor (DF) are all 1.0, since no adjustment is made for volatile organics. The fraction contaminated (FI) was assumed to be 1.0 for the exposure duration.

A site specific factor of 0.0113 was used to convert seep concentrations to air concentrations, as described in Section 4.5.2.

The remaining assumptions were consistent with those used in other exposure scenarios described above.

4.7 SUMMARY OF INTAKE FACTORS

Intake factors were calculated by WCC's ASSESS© risk assessment computer application. Calculated intake factors for each route of exposure, and each pathway considered, are presented in Appendix E. A summary of these intake factors for each route of exposure is presented in Table 4-28. These intake factors were used in quantifying potential risks as described in Section 6.

TABLE 4-1

AREAS OF CONCERN, POTENTIAL RECEPTORS, MEDIA AND PATHWAYS DUPONT-NEWPORT SITE

AREA	POTENTIAL RECEPTOR	MEDIUM	ROUTE
1. South Disposal Area	Maintenance Worker	Soil	Ingestion Dermal
	Construction* Worker	Soil	Ingestion* Inhalation* Dermal*
	Trespasser (Adult/Adolescent)	Soil	Ingestion Dermal
	Trespasser (Adult/Adolescent Ages 14-23)	Surface Water	Dermal
2. North Disposal Area	Maintenance Worker	Soil	Ingestion Inhalation Dermal
3. CIBA-GEIGY Plant Area	Maintenance Worker	Soil	Ingestion Dermal
	Construction* Worker	Soil	Ingestion* Inhalation* Dermal*
4. Du Pont Holly Run Plant Area	Maintenance Worker	Soil	Ingestion Dermal
5. Ballpark Area	Recreational (Children Ages 6-14)	Soil	Ingestion Inhalation Dermal
6. Christina River	Recreational (Adult/Child Ages 6-14)	Surface Water (Swimming)	Incidental Ingestion Dermal
		Groundwater Seepage (non-swimmer)	Dermal Inhalation (volatile organics)
7. Old Airport Road Area	Residential*	Potomac and Columbia Formation Groundwater	Ingestion*

* Future exposure scenarios only.

TABLE 4-2

BALLPARK RECREATIONAL CHILD-SOIL, INHALATION (PARTICULATES)
DUPONT-NEWPORT SITE

CHILDREN (Ages 6-14, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (m^3/hr)	1.9	3.7	1.9	3.7	1
(ET) Exposure Time (hrs/day)	2	4	2	4	2
(EF) Exposure Frequency (days/yr)	26	39	26	39	3
(ED) Exposure Duration (years)	9	9	9	9	3
(DF) Deposition Factor (unitless)	0.75	0.75	0.75	0.75	4
(CC) Ciliary Clearance (unitless)	0.375	0.375	0.375	0.375	4
(ME) Matrix Effect(unitless)	1	1	1	1	4
(FI) Fraction Contaminated (unitless)	1.0	1.0	1.0	1.0	4
(SS) Site Specific Factor (unitless)	10^{-7}	10^{-7}	10^{-7}	10^{-7}	5
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	6
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	3

(1) Exposure Factors Handbook, USEPA, 1990.
(2) Site-specific assumption, see text.
(3) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(4) Site-specific assumption, see text.
(5) Used to convert constituent soil concentrations to airborne particulate concentrations, see text.
(6) Derived from Exposure Factors Handbook, USEPA, 1990.

by: MN, RK
checked by: JR

TABLE 4-3

SOUTH DISPOSAL AREA
CONSTRUCTION WORKERS - SOIL, INHALATION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (m^3/hr)	2.5	2.5	2.5	2.5	1
(ET)Exposure Time (hrs/day)	8	8	8	8	2
(EF)Exposure Frequency (days/yr)	40	80	40	80	1,2
(ED) Exposure Duration (years)	1	2	1	2	1,2
(DF) Deposition Factor (unitless)	0.75	0.75	0.75	0.75	1
(CC) Ciliary Clearance (unitless)	0.375	0.375	0.375	0.375	1
(ME) Matrix Effect (unitless)	1.0	1.0	1.0	1.0	1
(FI) Fraction Contaminated (unitless)	1.0	1.0	1.0	1.0	1
(SS) Site Specific Factor (unitless)	10^{-7}	10^{-7}	10^{-7}	10^{-7}	3
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	40(4)	160(4)	2

(1) Site-Specific assumption, see text
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(3) Used to convert constituent soil concentrations in mg/kg to air concentrations in mg/m^3, see text.
(4) For subchronic exposures AT = EF x ED

by: MI
checked

TABLE 4-4

CIBA-GEIGY PLANT
CONSTRUCTION WORKERS - SOIL, INHALATION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (m^3/hr)	2.5	2.5	2.5	2.5	2
(ET) Exposure Time (hrs/day)	8	8	8	8	3
(EF) Exposure Frequency (days/yr)	40	80	40	80	3,4
(ED) Exposure Duration (years)	1	2	1	2	3,4
(DF) Deposition Factor (unitless)	0.75	0.75	0.75	0.75	4
(CC) Ciliary Clearance (unitless)	0.375	0.375	0.375	0.375	4
(ME) Matrix Effect (unitless)	1.0	1.0	1.0	1.0	4
(FI) Fraction Contaminated (unitless)	1.0	1.0	1.0	1.0	4
(SS) Site Specific Factor (unitless)	10^{-7}	10^{-7}	10^{-7}	10^{-7}	5
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,550	25,550	40(1)	160(1)	2

(1) For subchronic exposure, AT = EF x ED
2) Exposure Factor Handbook, USEPA, 1990
3) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
4) Site Specific assumption, see text
5) Used to convert soil concentration in mg/kg to air concentration in mg/m^3, see text.

by: MN, RK
checked by: JR

TABLE 4-5

NORTH DISPOSAL AREA
MAINTENANCE WORKERS - SOIL, INHALATION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (m^3/hr)	0.8	0.8	0.8	0.8	1
(ET) Exposure Time (hrs/day)	8	8	8	8	2
(EF) Exposure Frequency (days/yr)	7	14	7	14	2
(ED) Exposure Duration (years)	9	45	9	45	2
(DF) Deposition Factor (unitless)	0.75	0.75	0.75	0.75	3
(CC) Ciliary Clearance (unitless)	0.375	0.375	0.375	0.375	3
(ME) Matrix Effect (unitless)	1.0	1.0	1.0	1.0	3
(FI) Fraction Contaminated (unitless)	1.0	1.0	1.0	1.0	3
(SS) Site Specific Factor (unitless)	10^{-7}	10^{-7}	10^{-7}	10^{-7}	4
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) Exposure Factor Handbook, USEPA, 1990.
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(3) Site specific assumptions, see text.
(4) Used to convert constituent soil concentrations in mg/kg to air concentration in mg/m^3, see text.

by: MI
checked l

TABLE 4-6

SOUTH DISPOSAL AREA
TRESPASSERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

ADULT

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	2,129	3,354	2,129	3,354	1,2
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	30	9	30	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.083	0.17	0.083	0.17	3
(ABS) Absorption Factor, [Organics] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

ADOLESCENT (Ages 14-23, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	2,115	10,310	2,115	10,310	1,2
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	9	9	9	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.083	0.17	0.083	0.17	3
(ABS) Absorption Factor, [Organics] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	61.2	61.2	61.2	61.2	4
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R Sturgeon, USEPA, dated March 11, 1991
(2) See Appendix D
(3) Site-Specific assumption, see text
(4) Derived from Exposure Factor Handbook, USEPA, 1990

by: MN, RK
checked by: JF

TABLE 4-7

BALLPARK
RECREATIONAL CHILD-SOIL, DERMAL
DUPONT-NEWPORT SITE

CHILDREN (Ages 6-14, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Sour
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	1,502	6,565	1,502	6,565	1,
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	9	9	9	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.17	0.33	0.17	0.33	3
(ABS) Absorption Factor, [Organics] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	4
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(2) See Appendix D.
(3) Site-specific assumption, see text.
(4) Derived from Exposure Factors Handbook, USEPA, 1990.

by: M
checked

TABLE 4-8

SOUTH DISPOSAL AREA
CONSTRUCTION WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

ADULT

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	2,3
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.481	2
(EF) Exposure Frequency (days/year)	40	80	40	80	2,4
(ED) Exposure Duration (years)	1	2	1	2	2,4
(ME) Matrix Effect (unitless)	1	1	1	1	4
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	2,4
(ABS) Absorption Factor, Organics (unitless)	0.01	0.01	0.01	0.01	4
(ABS) Absorption Factor, Metals (unitless)	0.001	0.001	0.001	0.001	4
(SS) Site Specific Factor (unitless)	1.0	1.0	1.0	1.0	4
Conv, Conversion Factor (mg/kg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,550	25,550	40(1)	160(1)	2

(1) For subchronic exposure, AT = EF x ED
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(3) See Appendix D
(4) Site-Specific assumption, see text

by: MN, RK
checked by: JR

TABLE 4-9

CIBA-GEIGY PLANT
CONSTRUCTION WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	2,3
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	2
(EF) Exposure Frequency (days/year)	40	80	40	80	2,4
(ED) Exposure Duration (years)	1	2	1	2	2,4
(ME) Matrix Effect (unitless)	1	1	1	1	4
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	4
(ABS) Absorption Factor, [Organics] (unitless)	0.01	0.01	0.01	0.01	4
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	4
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,550	25,550	40(1)	160(1)	2

(1) For subchronic exposure, AT = EF x ED
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(3) See Appendix D
(4) Site-specific assumption, see text.

by: MN,
checked by:

AR312657

TABLE 4-10

NORTH DISPOSAL AREA
MAINTENANCE WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	1,2
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	7	14	7	14	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	3
(ABS) Absorption Factor, [Organics] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) See Appendix D
(3) Site specific assumption, see text

by: MN, RK
checked by: JR

TABLE 4-11

HOLLY RUN PLANT
MAINTENANCE WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	1,2
(AF) Adherence Factor ($mg\backslash cm^2$)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	28	56	28	56	3
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	3
(ABS) Absorption Factor, [Organic] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) See Appendix D
(3) Site specific assumption, see text.

by: MN,
checked by:

TABLE 4-12

CIBA-GEIGY PLANT
MAINTENANCE WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	1,2
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	3	6	3	6	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	3
(ABS) Absorption Factor, [Organic] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor, [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) See Appendix D
(3) Site specific assumption, see text

by: MN, RK
checked by: JR

TABLE 4-13

SOUTH DISPOSAL AREA
MAINTENANCE WORKERS - SOIL, DERMAL
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	904	2,129	904	2,129	1,2
(AF) Adherence Factor (mg/cm^2)	1.48	1.48	1.48	1.48	1
(EF) Exposure Frequency (days/year)	1	2	1	2	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	3
(ABS) Absorption Factor [Organic] (unitless)	0.01	0.01	0.01	0.01	3
(ABS) Absorption Factor [Metals] (unitless)	0.001	0.001	0.001	0.001	3
(SS) Site Specific Factor (unitless)	1.0	1.0	1.0	1.0	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	

(1) WCC letter to R. Sturgeon, USEPA dated March 11, 1991
(2) See Appendix D
(3) Site-Specific assumption, see text.

by: MN,
checked by:

TABLE 4-14

SOUTH DISPOSAL AREA
TRESPASSERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

ADULT					
Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	20	100	20	100	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	30	9	30	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.083	0.17	0.083	0.17	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

ADOLESCENT, (Ages 14 -23, inclusive)					
Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	100	200	100	200	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	9	9	9	1,2
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.083	0.17	0.083	0.17	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	61.2	61.2	61.2	61.2	3
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) Site-Specific assumption, see text
(3) Derived from Exposure Factor Handbook, USEPA, 1990.

by: MN, RK
checked by: JR

TABLE 4-15

BALLPARK
RECREATIONAL CHILD - SOIL, INGESTION
DUPONT-NEWPORT SITE

CHILDREN (Ages 6-14, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		
	AVE	RME	AVE	RME	Source
(IR) Ingestion Rate (mg/day)	100	200	100	200	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	9	9	9	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.17	0.33	0.17	0.33	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	3
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	

(1) WCC letter to R. Sturgeon, USEPA, dated March 14, 1991.
(2) Site-specific assumption, see text.
(3) Derived from Exposure Factors Handbook, USEPA, 1990.

by: MN, R
checked by: .

TABLE 4-16

SOUTH DISPOSAL AREA
CONSTRUCTION WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	2
(EF) Exposure Frequency (days/year)	40	80	40	80	2,3
(ED) Exposure Duration (years)	1	2	1	2	2,3
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	2,3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,550	25,550	40(1)	160(1)	2

(1) For subchronic exposure, AT = EF x ED
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(3) Site-Specific assumption, see text.

by: MN, RK
checked by: JR

TABLE 4-17

CIBA-GEIGY PLANT
CONSTRUCTION WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	2
(EF) Exposure Frequency (days/year)	40	80	40	80	2,3
(ED) Exposure Duration (years)	1	2	1	2	2,3
(ME) Matrix Effect (unitless)	1	1	1	1	3
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	3
(SS) Site Specific Factor (unitless)	1	1	1	1	3
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,550	25,550	40(1)	160(1)	2

(1) For subchronic exposure, AT = EF x ED
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(3) Site specific assumption, see text.

by: MN, F
checked by:

TABLE 4-18
NORTH DISPOSAL AREA
MAINTENANCE WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	1
(EF) Exposure Frequency (days/year)	7	14	7	14	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) Site specific assumption, see text.

by: MN, RK
checked by: JR

TABLE 4-19

HOLLY RUN PLANT
MAINTENANCE WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	1
(EF) Exposure Frequency (days/year)	28	56	28	56	1,2
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) Site specific assumption, see text.

by: MN, F
checked by:.

TABLE 4-20

CIBA-GEIGY PLANT
MAINTENANCE WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	1
(EF) Exposure Frequency (days/year)	3	6	3	6	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) Site specific assumption, see text

by: MN, RK
checked by: JR

TABLE 4-21

SOUTH DISPOSAL AREA
MAINTENANCE WORKERS - SOIL, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (mg/day)	15	100	15	100	1
(EF) Exposure Frequency (days/year)	1	2	1	2	1
(ED) Exposure Duration (years)	9	45	9	45	1
(ME) Matrix Effect (unitless)	1	1	1	1	2
(FI) Fraction Contaminated (unitless)	0.67	0.67	0.67	0.67	1,2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
Conv, Conversion Factor (kg/mg)	10^{-6}	10^{-6}	10^{-6}	10^{-6}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	16,425	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) Site-Specific assumption, see text.

by: MN, F
checked by:

TABLE 4-22

SOUTH DISPOSAL AREA
TRESPASSERS - SURFACE WATER, DERMAL
DUPONT-NEWPORT SITE

ADULT

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	2,129	4,499	2,129	4,499	1,2
(PC) Permeability Constant [Metals] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organics] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	4	2	4	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	30	9	30	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

ADOLESCENT (Ages 14-23, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	2,149	10,253	2,149	10,253	1,2
(PC) Permeability Constant [Metal] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organic] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	4	2	4	1
(EF) Exposure Frequency (days/year)	24	48	24	48	1
(ED) Exposure Duration (years)	9	9	9	9	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	61.2	61.2	61.2	61.2	5
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991
(2) See Appendix D
(3) R. Sturgeon, USEPA, letter to J. Karmazyn, dated December 2, 1991
(4) Site specific assumption, see text
(5) Derived from Exposure Factor Handbook, USEPA, 1990

by: MN, RK
checked by: JR

TABLE 4-23

CHRISTINA RIVER
RECREATIONAL (SWIMMER) - RIVER WATER, DERMAL
DUPONT-NEWPORT SITE

ADULT

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	18,150	18,150	18,150	18,150	1, 2
(PC) Permeability Constant [Metals] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organics] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	3	2	3	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	30	9	30	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

CHILDREN (Ages 6-14, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	11,901	11,901	11,901	11,901	1, 2
(PC) Permeability Constant [Metal] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organic] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	3	2	3	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	9	9	9	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	1
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(2) See Appendix D
(3) R. Sturgeon, USEPA, letter to J. Karmazyn, dated December 2, 1991.
(4) Site-specific assumption, see text.

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TABLE 4-24

CHRISTINA RIVER
RECREATIONAL (NON-SWIMMER)
GROUNDWATER SEEPS, DERMAL
DUPONT-NEWPORT SITE

ADULT

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	2,129	4,499	2,129	4,499	1, 2
(PC) Permeability Constant [Metals] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organic] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	3	2	3	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	30	9	30	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

CHILDREN (Ages 6-14, inclusive)

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(SA) Surface Area (cm^2)	1,491	6,453	1,491	6,453	1, 2
(PC) Permeability Constant [Metal] (cm/hr)	7.2 E-6	7.2 E-6	7.2 E-6	7.2 E-6	1
(PC) Permeability Constant [Organic] (cm/hr)	8E-4	8E-4	8E-4	8E-4	3
(ET) Exposure Time (hours/day)	2	3	2	3	1
(EF) Exposure Frequency (days/year)	26	39	26	39	1
(ED) Exposure Duration (years)	9	9	9	9	1
(SS) Site Specific Factor (unitless)	1	1	1	1	4
Conv, Conversion Factor (l/cm^3)	10^{-3}	10^{-3}	10^{-3}	10^{-3}	
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	1
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	1

(1) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(2) See Appendix D
(3) R. Sturgeon, USEPA, letter to J. Karmazyn, dated December 2, 1991.
(4) Site-specific assumption, see text.

by: MN, RK
checked by: JR

TABLE 4-25

CHRISTINA RIVER
RECREATIONAL-RIVER WATER, INCIDENTAL INGESTION
DUPONT-NEWPORT SITE

ADULT					
Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (l/day)	0.1	0.15	0.1	0.15	1
(EF) Exposure Frequency (days/year)	26	39	26	39	2
(ED) Exposure Duration (years)	9	30	9	30	2
(FI) Fraction Contaminated (unitless)	1	1	1	1	1
(SS) Site Specific Factor (unitless)	1	1	1	1	1
(BW) Body Weight (kg)	70	70	70	70	2
(AT) Averaging Time (days)	25,500	25,500	3,285	10,950	2

CHILD SWIMMER (Ages 6-14, inclusive)					
Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (l/day)	0.1	0.15	0.1	0.15	1
(EF) Exposure Frequency (days/year)	26	39	26	39	2
(ED) Exposure Duration (years)	9	9	9	9	2, 3
(FI) Fraction Contaminated (unitless)	1	1	1	1	1
(SS) Site Specific Factor (unitless)	1	1	1	1	1
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	2
(AT) Average Time (days)	25,550	25,550	3,285	3,285	2

(1) Site-specific assumption, see text.
(2) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.

by: MN
checked by

88C2076\DPN1_4.TAB
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TABLE 4-26

OLD AIRPORT ROAD
POTOMAC AND COLUMBIA FORMATION
RESIDENTIAL-GROUNDWATER, INGESTION
DUPONT-NEWPORT SITE

Population/Parameter	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Ingestion Rate (l/day)	1.4	2	1.4	2	1
(EF) Exposure Frequency (days/year)	365	365	365	365	1
(ED) Exposure Duration (years)	9	30	9	30	1
(FI) Fraction Contaminated (unitless)	1	1	1	1	2
(SS) Site Specific Factor (unitless)	1	1	1	1	2
(BW) Body Weight (kg)	70	70	70	70	1
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	1

(1) Exposure Factors Handbook, USEPA, 1990.
(2) Site-specific assumption, see text.

by: MN, RK
checked by: JR

TABLE 4-27

CHRISTINA RIVER RECREATIONAL-GROUNDWATER SEEPS, INHALATION OF VOLATILES DUPONT-NEWPORT SITE

ADULT

Population/Parameter (1)	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (m^3 /hr)	0.8	0.8	0.8	0.8	2
(ET) Exposure Time (hr/day)	2	3	2	3	3
(EF) Exposure Frequency (days/yr)	26	39	26	39	3
(ED) Exposure Duration (years)	9	30	9	30	3
(ME) Matrix Effect (unitless)	1	1	1	1	1
(DF) Deposition Factor (unitless)	1	1	1	1	1
(CC) Ciliary Clearance (unitless)	1	1	1	1	1
(FI) Fraction Contaminated (unitless)	1	1	1	1	1
(SS) Site Specific Factor (unitless)	0.0113	0.0113	0.0113	0.0113	4
(BW) Body Weight (kg)	70	70	70	70	3
(AT) Averaging Time (days)	25,550	25,550	3,285	10,950	3

CHILDREN (Ages 6-14, inclusive)

Population/Parameter (1)	Carcinogenic		Noncarcinogenic		Source
	AVE	RME	AVE	RME	
(IR) Inhalation Rate (M^3 /hr)	1.9	3.7	1.9	3.7	2
(ET) Exposure Time (hours/day)	2	3	2	3	3
(EF) Exposure Frequency (days/year)	26	39	26	39	3
(ED) Exposure Duration (years)	9	9	9	9	3
(ME) Matrix Effect (unitless)	1	1	1	1	1
(DF) Deposition Factor (unitless)	1	1	1	1	1
(CC) Ciliary Clearance (unitless)	1	1	1	1	1
(FI) Fraction Contaminated (unitless)	1	1	1	1	1
(SS) Site Specific Factor (unitless)	0.0113	0.0113	0.0113	0.0113	4
(BW) Body Weight (kg)	33.3	33.3	33.3	33.3	2
(AT) Averaging Time (days)	25,550	25,550	3,285	3,285	3

(1) Matrix Effect (ME), Deposition Factor (DF), Ciliary Clearance (CC), and Fraction Contaminated (FI) are all 1.0 for this scenario, see text.
(2) Exposure Factors Handbook, USEPA, 1990.
(3) WCC letter to R. Sturgeon, USEPA, dated March 11, 1991.
(4) Used to convert constituent concentrations in groundwater seeps (mg/l) to airborne concentrations in mg/m^3, see text.

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Checked

TABLE 4-28

INTAKE FACTORS SUMMARY FOR DUPONT-NEWPORT SITE

Abbrev.	Pathway	Description	Carcinogenic		Non-Carcinogenic	
			Average	RME	Average	RME
10SG	INGESTION - SOLIDS	ADULT WORKER SDS SOIL AREA 1	5.1E-11	3.4E-09	3.9E-10	5.2E-09
10SD	DERMAL - SOLIDS	ADULT WORKER SDS DERMAL CONTACT SOIL (ORGANICS) AREA 1	4.5E-11	1.1E-09	3.5E-10	1.7E-09
20SG	INGESTION - SOLIDS	ADULT WORKER NDS INGESTION SOIL AREA 2	3.5E-10	2.4E-08	2.8E-09	3.7E-08
20SI	INHALATION	ADULT WORKER NDS INHALATION SOIL AREA 2	6.3E-12	6.3E-11	4.9E-11	9.9E-11
20SD	DERMAL - SOLIDS	ADULT WORKER NDS DERMAL CONTACT SOIL (ORGANICS) AREA 2	3.2E-10	7.4E-09	2.5E-09	1.2E-08
7AGG	INGESTION - WATER	ADULT RESIDENT INGESTION GROUNDWATER AREA 7 (POTOMAC FORM.)	2.6E-03	1.2E-02	2.0E-02	2.9E-02
1CSG	INGESTION - SOLIDS	ADULT CONSTRUCTION WORKER INGESTION SOIL AREA 1	2.3E-10	6.0E-09	1.4E-07	9.6E-07
1CSI	INHALATION	ADULT CONSTRUCTION WORKER INHALATION SOIL AREA 1	2.3E-11	5.0E-11	8.0E-09	8.0E-09
1CSD	DERMAL - SOLIDS	ADULT CONSTRUCTION WORKER DERMAL CONTACT SOIL (ORGANICS) AREA 1	2.0E-10	1.9E-09	1.3E-07	3.0E-07
3CSG	INGESTION - SOLIDS	ADULT CONSTRUCTION WORKER INGESTION SOIL AREA 3	2.3E-10	6.0E-09	1.4E-07	9.6E-07
3CSI	INHALATION	ADULT CONSTRUCTION WORKER INHALATION SOIL AREA 3	1.3E-11	5.0E-11	8.0E-09	8.0E-09
1ASG	INGESTION - SOLIDS	ADULT TRESPASSER INGESTION SOIL AREA 1	2.0E-10	2.7E-08	1.6E-09	6.2E-08
1ASD	DERMAL - SOLIDS	ADULT TRESPASSER DERMAL CONTACT SOIL (ORGANICS) AREA 1	3.2E-10	6.8E-09	2.5E-09	1.6E-08
3CSD	DERMAL - SOLIDS	ADULT CONSTRUCTION WORKER DERMAL CONTACT SOIL (ORGANICS) AREA 3	2.0E-10	1.9E-09	1.3E-07	3.0E-07
1AWL	DERMAL - WATER	ADULT TRESPASSER DERMAL CONTACT WATER (METALS) AREA 1	3.7E-09	1.0E-07	2.9E-08	2.4E-07
1KSD	DERMAL - SOLIDS	CHILD TRESPASSER DERMAL CONTACT SOIL (ORGANICS) AREA 1	3.6E-10	7.2E-09	2.8E-09	5.6E-08
1KWL	DERMAL - WATER	CHILD TRESPASSER DERMAL CONTACT WATER (METALS) AREA 1	4.3E-09	8.2E-08	3.3E-08	6.3E-07
6AWG	INGESTION - WATER	ADULT RECREATIONAL INGESTION WATER AREA 6	1.3E-05	9.8E-05	1.0E-04	2.3E-04
6AWD	DERMAL - WATER	ADULT RECREATIONAL DERMAL CONTACT WATER (ORGANICS) AREA 6	3.8E-06	2.9E-05	3.0E-05	6.7E-05
6APD	DERMAL - WATER	ADULT RECREATIONAL DERMAL CONTACT SEEPS (ORGANICS) AREA 6	4.5E-07	7.1E-06	3.5E-06	1.7E-05
6KWG	INGESTION - WATER	CHILD RECREATIONAL INGESTION WATER AREA 6	2.8E-05	6.2E-05	2.1E-04	4.8E-04
6KWD	DERMAL - WATER	CHILD RECREATIONAL DERMAL CONTACT WATER (ORGANICS) AREA 6	5.2E-06	1.2E-05	4.1E-05	9.2E-05
6KPD	DERMAL - WATER	CHILD RECREATIONAL DERMAL CONTACT SEEP (ORGANICS) AREA 6	6.6E-07	6.4E-06	5.1E-06	5.0E-05
5KSG	INGESTION - SOLIDS	CHILD RECREATIONAL INGESTION SOIL AREA 5	4.7E-09	2.7E-08	3.6E-08	2.1E-07

TABLE 4-28

INTAKE FACTORS SUMMARY FOR DUPONT-NEWPORT SITE

Abbrev.	Pathway	Description	Carcinogenic		Non-Carcinogenic	
			Average	RME	Average	RME
5KSI	INHALATION	CHILD RECREATIONAL INHALATION SOIL AREA 5	2.9E-11	1.7E-10	2.3E-10	1.3E-09
5KSD	DERMAL - SOLIDS	CHILD RECREATIONAL DERMAL CONTACT SOIL (ORGANICS) AREA 5	1.0E-09	1.3E-08	8.1E-09	1.0E-07
1KSG	INGESTION - SOLIDS	CHILD TRESPASSER INGESTION SOIL AREA 1	1.2E-09	1.8E-08	8.9E-09	1.4E-07
910SL	DERMAL - SOLIDS	ADULT WORKER SDS DERMAL CONTACT SOIL (METALS) AREA 1	4.5E-12	1.1E-10	3.5E-11	1.7E-10
20SL	DERMAL - SOLIDS	ADULT WORKER NDS DERMAL CONTACT SOIL (METALS) AREA 2	3.2E-11	7.4E-10	2.5E-10	1.2E-09
1CSL	DERMAL - SOLIDS	ADULT CONSTRUCTION WORKER DERMAL CONTACT SOIL (METALS) AREA 1	2.0E-11	1.9E-10	1.3E-08	3.0E-08
1ASL	DERMAL - SOLIDS	ADULT TRESPASSER DERMAL CONTACT SOIL (METALS) AREA 1	3.2E-11	6.8E-10	2.5E-10	1.6E-09
3CSL	DERMAL - SOLIDS	ADULT CONSTRUCTION DERMAL CONTACT SOIL (METALS) AREA 3	2.0E-11	1.9E-10	1.3E-08	3.0E-08
1KSL	DERMAL - SOLIDS	CHILD TRESPASSER DERMAL CONTACT SOIL (METALS) AREA 1	3.6E-11	7.2E-10	2.8E-10	5.6E-09
30SL	DERMAL - SOLIDS	ADULT WORKER CG DERMAL CONTACT SOIL (METALS) AREA 3	1.4E-11	3.2E-10	1.1E-10	5.0E-10
40SL	DERMAL - SOLIDS	ADULT WORKER HR DERMAL CONTACT SOIL (METALS) AREA 4	1.3E-10	3.0E-09	9.8E-10	4.6E-09
6AWL	DERMAL - WATER	ADULT RECREATIONAL DERMAL CONTACT WATER (METALS) AREA 6	3.4E-08	2.6E-07	2.7E-07	6.0E-07
6APL	DERMAL - WATER	ADULT RECREATIONAL DERMAL CONTACT SEEPS (METALS) AREA 6	4.0E-09	6.4E-08	3.1E-08	1.5E-07
6KWL	DERMAL - WATER	CHILD RECREATIONAL DERMAL CONTACT WATER (METALS) AREA 6	4.7E-08	1.1E-07	3.7E-07	8.3E-07
6KPL	DERMAL - WATER	CHILD RECREATIONAL DERMAL CONTACT SEEP (METALS) AREA 6	5.9E-09	5.8E-08	4.6E-08	4.5E-07
5KSL	DERMAL - SOLIDS	CHILD RECREATIONAL DERMAL CONTACT SOIL (METALS) AREA 5	1.0E-10	1.3E-09	8.1E-10	1.0E-08
30SG	INGESTION - SOLIDS	ADULT WORKER CG INGESTION SOIL AREA 3	1.5E-10	1.0E-08	1.2E-09	1.6E-08
30SD	DERMAL - SOLIDS	ADULT WORKER CG DERMAL CONTACT SOIL (ORGANICS) AREA 3	1.4E-10	3.2E-09	1.1E-09	5.0E-09
40SG	INGESTION - SOLIDS	ADULT WORKER HR INGESTION SOIL AREA 4	1.4E-09	9.4E-08	1.1E-08	1.5E-07
40SD	DERMAL - SOLIDS	ADULT WORKER HR DERMAL CONTACT SOIL (ORGANICS) AREA 4	1.3E-09	3.0E-08	9.8E-09	4.6E-08
6API	INHALATION	ADULT RECREATIONAL INHALATION SEEPS AREA 6	2.4E-06	1.8E-05	1.8E-05	4.1E-05
6KPI	INHALATION	CHILD RECREATIONAL INHALATION SEEPS AREA 6	1.2E-05	5.2E-05	9.2E-05	4.0E-04
7RGG	INGESTION - WATER	ADULT RESIDENT INGESTION GROUNDWATER AREA 7 (COLUMBIA FORM.)	2.6E-03	1.2E-02	2.0E-02	2.9E-02

Note: The in[illegible]or times the [illegible] concentration equals the intake in mg/kg/day for a given ch[illegible]

5.0 TOXICITY ASSESSMENT

5.1 INTRODUCTION AND APPROACH

The purpose of the toxicity assessment is to evaluate available evidence regarding the potential for site-related chemicals to cause adverse effects in exposed populations, and to provide an estimate of the relationship between the extent of exposure and the increased likelihood of adverse effects, i.e., dose-response relationship. The results of the toxicity assessment are integrated with the exposure assessment to estimate the potential excess lifetime cancer risks and potential non-carcinogenic health hazards.

As discussed in the previous chapter, chemicals of concern for soil, surface water and groundwater seeps at the Newport Site were identified by frequency of detection, comparison to background, and application of concentration-toxicity screening and other screening criteria. All of this prescreening was not performed for groundwater constituents. Toxicological profiles of these chemicals are included in Appendix C.

The two principal indices of toxicity are the Reference Dose (RfD) and Slope Factor (SF). An RfD for a substance is the intake or dose per unit of body weight per day (mg/kg/day) that is likely to be without appreciable risk to human populations, including sensitive subgroups. The RfD allows for the existence of a threshold dose, that is, a certain minimum intake of substance below which there is no observable toxic effect based on the body's detoxifying capacity. For carcinogens, on the other hand, the EPA assumes no threshold or a zero-threshold. That assumption means that there is some finite cancer risk no matter how small the dose. The SF is used to estimate an upper-bound probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. A second important factor for carcinogens is the weight-of-evidence classification whereby carcinogens are grouped depending on the quality and quantity of data that indicate that an agent may be a human carcinogen.

The RfD and SF values used in this risk assessment were obtained from the following sources:

- EPA's Integrated Risk Information System (IRIS)
- Health Effects Assessment Summary Tables (USEPA, 1991)
- Estimated slope factors for carcinogenic PAHs other than benzo(a)pyrene were based on relative carcinogenic potencies, and the published slope factors for benzo(a)pyrene (See the toxicological profile for PAHs, Appendix C).
- Lead was considered as a special case, since EPA approved RfDs have not been established.
- The RfD for cobalt was provided by the EPA Region III.

5.2 TOXICITY ASSESSMENT FOR NON-CARCINOGENIC EFFECTS

Non-carcinogenic effects are generally thought to have a threshold dose below which there are no observable adverse health effects. In developing a toxicity value for non-carcinogenic effects, the approach is to identify this threshold dose or no-observed-adverse-effect level (NOAEL) through studies with laboratory animals. RfDs are generally calculated by dividing the NOAEL by uncertainty factors which generally range from 10 to 1000. These uncertainty factors, or safety margins, are intended to account for specific types of uncertainty inherent in the extrapolation of animal data to human exposures. Uncertainties include variations in the sensitivity of individuals in a population, extrapolation from animal data to human exposures, and other limitations in the experimental data.

The majority of our toxicological knowledge of chemicals comes from experiments with laboratory animals due to the limited studies available for humans. Experimental animal data have historically been relied upon by regulatory agencies and other expert groups to assess the hazards and safety of human exposure. Even though this reliance has been supported in general by empirical observations, there are known interspecies differences in chemical absorption, metabolism, excretion and toxic response. There may also be uncertainties concerning the relevance of animal studies using exposure routes which differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short-term or subchronic animal studies to humans exposed over a lifetime has inherent uncertainty.

Although experimental data from animals have many limitations, they are widely believed to be a necessary part of toxicity assessment, especially in the absence of human epidemiological evidence. The safety factors used in RfD extrapolations and the over-estimates of risks for single chemicals are intended to compensate for any unknown effects of synergistic exposures. This conservative approach is likely to over-estimate the actual human health risks of a site.

EPA has developed various types of RfDs depending on the exposure route (either ingestion/oral or inhalation), the critical effect and the length of exposure being evaluated (i.e., chronic, subchronic or single event). EPA often bases the RfD for non-carcinogenic effects on the most sensitive animal species test data available, i.e., the species which experiences adverse effects at the lowest dose. This risk assessment has incorporated the EPA RfD values which were derived in this manner. The use of these conservatively derived RfD values is likely to over-estimate the actual health impacts for non-carcinogenic chemicals at the Newport Site.

The EPA defines a chronic RfD as an estimate of a daily exposure level for the human population that is unlikely to result in deleterious effects during a lifetime. A chronic RfD is used to evaluate the potential non-carcinogenic effects associated with exposure periods longer than seven years.

Subchronic RfDs have also been developed to characterize potential non-carcinogenic effects associated with shorter term exposures. The EPA defines subchronic exposure as periods between two weeks and seven years. Subchronic RfDs tend to be higher, generally by an order-of-magnitude, than chronic RfDs because of shorter exposure duration. In this assessment, subchronic exposures were only considered for short-term exposures associated with potential future construction activities.

Chronic and subchronic RfDs for the chemicals of potential concern are shown in Table 5-1. For the ingestion route, the chemical RfD is for the administered dose assuming 100% absorption by the gastrointestinal tract, unless otherwise noted. RfD values for inhalation exposure are often reported by the EPA as a concentration in air (mg/m^3). For most substances, a body weight of 70 kg and breathing rate of 20 m^3/day were used to convert an inhaled intake expressed in mg/m^3 concentration in air to units

of mg/kg/day. For the inhalation route, 100% of a chemical that is inhaled and retained by the lungs was assumed to be absorbed into the bloodstream unless otherwise noted.

In the absence of specific information for RfDs for dermal exposure, oral RfDs were used in estimating effects via dermal exposure. In general, RfDs were selected using a conservative approach. For example, the RfD used for chromium represents hexavalent chromium, the more toxic form compared to trivalent chromium, despite the fact that there are no data suggesting that chromium found on-site is predominantly hexavalent. Similarly, the RfD used for cadmium in soils was the RfD specified for water, which is more conservative than the RfD for cadmium in food. This more conservative RfD was used because there is no basis for establishing which RfD better represents cadmium species occurring at the Site.

Likewise, there is no generally accepted RfD for cobalt. An RfD of 0.0001 mg/kg/day was utilized for cobalt, based upon direction by EPA Region III, relayed in a telephone conversation of July 12, 1991 between J. Karmazyn of Du Pont and R. Sturgeon of the EPA. This RfD appears to be based upon a single study of cobalt exposure to heavy beer drinkers which has not been replicated in other studies which suggest much lower toxicity of cobalt. The RfD used likely overstates the actual hazard associated with cobalt ingestion. A more realistic RfD for cobalt is 0.01 mg/kg/day, as documented in the letter of July 10, 1991 from WCC to R. Sturgeon of the EPA. EPA Region III personnel have noted that the RfD is intended to be protective of sensitive subpopulations, and that the EPA Environmental Criteria and Assessment Office (ECAO) in Cincinnati recommends use of an RfD for cobalt ten times lower than the value recommended by Region III (letter from R. Sturgeon to J. Karmazyn, dated December 2, 1991). Region III believes an additional uncertainty factor of 10 for interspecies extrapolation used by ECAO is not appropriate because the beer drinkers represent a sensitized subpopulation. Region III believes the cobalt RfD specified for this assessment represents an intermediate position, rather than the most conservative position.

5.3 TOXICITY ASSESSMENT FOR CARCINOGENIC EFFECTS

In assessing the potential risk posed by carcinogens, it is common practice of the EPA and other regulatory agencies to assume that any exposure level is associated with a finite probability of producing a carcinogenic response. The EPA uses a two-part evaluation in which the substance is assigned a weight-of-evidence classification. A slope factor is then calculated that defines quantitatively the relationship between average lifetime dose and carcinogenic risk.

The slope factors are based primarily upon the results of animal studies. There is uncertainty whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animals but not in others raises the possibility that not all animal carcinogens are human carcinogens. The EPA assumes that humans are as sensitive to all animal carcinogens as the most sensitive animal species. This policy decision is designed to prevent under-estimating risk and introduces the potential to over-estimate carcinogenic risk.

The EPA's carcinogen weight-of-evidence classification is based on the evidence that chemicals are carcinogenic in humans and experimental animals. The EPA's weight-of-evidence classification system for carcinogenicity is summarized as follows:

Group	Description
A	Human carcinogen
B1 or B2	Probable human carcinogen. B1 indicates that limited human data are available. B2 indicates sufficient evidence in animals and inadequate or no evidence in humans.
C	Possible human carcinogen

D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

Substances in groups A, B or C are considered potential carcinogens.

A number of mathematical models and procedures have been developed to extrapolate from carcinogenic responses observed at high doses in experimental animals to responses expected at low doses in humans. The EPA uses the linearized multistage model for low-dose extrapolation. This mathematical model is based on the multi-stage theory of carcinogenesis where the response is assumed to be linear at low doses. The EPA further calculates the 95th percent upper confidence limit of the slope of the resulting dose-response curve. This value, the slope factor (SF), expressed in units of $(mg/kg/day)^{-1}$, converts the average daily intake of chemical normalized over a lifetime directly to a cancer risk.

This model provides a conservative estimate of cancer risk at low doses, and is likely to over-estimate the actual cancer risk. The EPA acknowledges that the actual slope factors are likely to be between zero and the estimate provided by the linearized multistage model.

RfDs have also been developed for many of the carcinogens to account for their non-carcinogenic effects. The SF and weight-of-evidence classification for the chemicals of potential concern are included in Table 5-1.

5.4 UNCERTAINTY RELATED TO TOXICITY DATA

In general, the available scientific data on subchronic and chronic toxic effects of chemicals in humans by the different routes of exposure are limited. Consequently, varying degrees of uncertainty surround the assessment of adverse health effects in exposed populations. Sources of uncertainty include:

- Use of dose-response data from experiments on homogeneous, sensitive animal populations to predict effects in heterogeneous human populations with a wide range of sensitivities (interspecies extrapolation)

- Extrapolations of data from high doses in animals to low doses in humans, from acute or subchronic to chronic exposure, and from one route to another, e.g., from ingestion to inhalation or dermal absorption, and

- Use of single chemical data that do not account for synergistic or antagonistic responses

Despite the many limitations, animal experiments are widely believed to be a necessary part of toxicologic evaluations, especially in the absence of human epidemiological evidence.

5.5 SUMMARY OF TOXICOLOGICAL PROPERTIES

Table 5-1 summarizes the SFs of extrapolated dose response data and reference doses used in this risk assessment for selected chemicals of concern. In general, chemicals with high SFs and low RfDs exhibit higher toxicities than the chemicals with low SFs and high RfDs. These toxicity indicators are integrated with the exposure assessment results (Chapter 4) to characterize the human health risks associated with the Site study area's chemicals of concern. The inhalation slope factor for trichloroethlene (TCE) reflects the value for a metabolized dose as given in HEAST, and was used based on EPA direction in their December 2, 1991 letter to J. Karmazyn of Du Pont. Use of this slope factor does not follow guidance presented in Section 7.3.3 in RAGS (USEPA, 1989).

Detailed toxicity profiles for chemicals of concern at the Site are presented in Appendix C. These data provide some insight into the environmental distribution and mobility/fate characteristics of selected chemicals and their exposure potential. More information on the toxicological properties can be found in IRIS, ATSDR Toxicological Profiles (ATSDR, 1988), ACGIH, 1990-91 and other references cited in this report.

TABLE 5-1

SLOPE FACTORS (SF) AND REFERENCE DOSES (RfD) FOR SELECTED CHEMICALS OF CONCERN
DUPONT-NEWPORT SITE

Chemical (Weight-of-Evidence) (if Carcinogen)	Slope Factor $(mg/kg/day)^{-1}$		Reference Dose mg/kg/day			
	Inhalation	Ingestion	Inhalation		Ingestion	
			Subchronic	Chronic	Subchronic	Chronic
Antimony	–	–	ND	ND	4E-4	4E-4
Arsenic (A)[1]	5E+1	1.75E+0	ND	ND	1E-3	3E-4
Barium	–	–	1E-3	1E-4	5E-2	5E-2
Benzo(a)anthracene[2](B2)	8.85E-1	1.67E+0	ND	ND	ND	ND
Beryllium (B2)	8.40E+0	4.3E+0	ND	ND	5E-3	5E-3
Bis(2-ethylhexyl)phthalate (B2)	–	1.40E-2	ND	ND	2E-2	2E-2
Cadmium (B1)	6.1E+0	ND	ND	ND	5E-4	5E-4
Carbon Tetrachloride (B2)	1.3E-1	1.3E-1	ND	ND	7E-3	7E-4
4-chloroaniline	–	–	ND	ND	4E-3	4E-3
Chlorobenzene	–	–	5E-2	5E-3	2E-1	2E-2
Chromium VI[3]	4.1E+1	ND	5.7E-6	5.7E-7	2E-2	5E-3
Cobalt[4]	–	–	1E-4	1E-4	1E-4	1E-04
Copper[5]			ND	ND	3.71E-2	3.71E-2
1,1-Dichloroethene (c)	1.80E-1	6.00E-1	ND	ND	9E-3	
Manganese[6]	–	–	1.1E-4	1.1E-4	1E-1	1E-1
Mercury	–	–	8.57E-5	8.57E-5	3E-4	3E-4
Nickel[7]	8.4E-1	ND	ND	ND	2E-2	2E-2
Tetrachloroethene (B2)	1.82E-3	5.1E-2	ND	ND	1E-1	1E-2
Thallium	–	–	ND	ND	7E-4	7E-5
Trichloroethene (B2)[8]	1.7E-2	1.1E-2	ND	ND	ND	ND
Vanadium	–	–	ND	ND	7E-3	7E-3
Vinyl chloride (A)	2.96E-1	1.9E+0	ND	ND	ND	ND
Zinc	–	–	ND	ND	2E-1	2E-1

NOTES: ND = Not Determined

(1) Arsenic oral slope factor extrapolated from proposed drinking water unit risk of 5E-5 $(\mu g/L)^{-1}$ (USEPA, 1991)

(2) Slope factors for PAHs were derived from potency estimates relative to Benzo[a]Pyrene (see Appendix C).

(3) Chromium VI inhalation RfD extrapolated from 2E-5 (subchronic) and 2E-6 (chronic) mg/m^3 RfC using 20 m^3 air and 70 kg body weight.

(4) Cobalt RfD provided by USEPA Region III. See text.

(5) Copper oral RfD extrapolated from 1.3 mg/l water (HEAST) using 2 liters drinking water and 70 kg body weight.

(6) Manganese inhalation RfD extrapolated from 4E-4 mg/m^3 RfC (chr and subchronic) using 20 m^3 air and 70 kg body weight.

(7) A slope factor of 8.4E-1 was used based upon exposure to nickel car and nickel refinery dust (USEPA, 1991).

(8) HEAST inhalation slope factor for TCE is 1.7E-2 based on metabolized dose. Value was used based on direction by USEPA Region III. This value does not follow guidance presented in RAGS.

6.0
RISK CHARACTERIZATION

In risk characterization, the results of the toxicity assessment (Slope Factors, RfDs) and the exposure assessment (chemical intakes for potentially exposed populations) are integrated to arrive at quantitative estimates of carcinogenic risks and hazard indices. A general discussion of the measures or indicators of risks and hazards follows in Section 6.1. The methodology used for identifying the specific risks and hazards associated with exposure to selected chemicals of concern is presented in Section 6.2. The carcinogenic risks and hazard quotients/indices for multiple chemicals and pathways are discussed in Section 6.3. These estimates include both current land use conditions and the future exposure scenarios discussed with the EPA Region III. The results of this risk characterization, summarized in Section 6.4, potentially provide a basis for any remedial action that might be needed to protect public health.

An integral part of the risk assessment process is the characterization of the uncertainties associated with exposure and toxicity assessments and underlying assumptions. The key assumptions and major uncertainties associated with this risk assessment are discussed in Section 7.

6.1 INDICATORS OF POTENTIAL ADVERSE HEALTH EFFECTS AND RISKS

Human health risks or hazards are generally classified into (1) incremental excess risk of cancer, and (2) non-cancer effects as determined by the hazard index.

For carcinogens, risks are estimated as the incremental (or excess) probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. This is referred to as the incremental or excess lifetime cancer risk, and is expressed as a unitless probability. For example, 10^{-6} excess lifetime cancer risk represents a one in one million chance of developing cancer over a lifetime from a given exposure above the existing or background risk of cancer from other sources. For comparison, this "background" risk of cancer in the U.S. at present is about 2 in 10 (2×10^{-1}) (Lehr, J.H., 1990).

According to the 1990 National Oil and Hazardous Substances Contingency Plan (NCP, 1990) that provides the framework for the implementation of the Superfund program, the lifetime incremental (excess) cancer risk should not exceed the 10^{-6} to 10^{-4} range. OSWER Directive 9355.0-30 (USEPA, 1991a) indicates that, "Where the cumulative carcinogenic site risk to an individual based on an RME scenario for current and future use is less than 10^{-4}, and the non-carcinogenic hazard quotient (index) is less than one, remedial action is generally not warranted..."

Non-carcinogenic health hazards are expressed in terms of Hazard Quotient (HQ) for a single substance or Hazard Index (HI) for multiple substances and/or exposure pathways. These are ratios of particular chemical intakes to Reference Doses as discussed further below. If the magnitude of an HQ is less than 1, the hazards are not considered to pose a threat to public health including sensitive subgroups.

6.2 QUANTIFICATION OF RISKS AND HAZARDS

6.2.1 Carcinogenic Risk

Carcinogenic risks are estimated as the excess lifetime cancer risk, i.e., the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the chronic (lifetime) daily intake (CDI) by the risk per unit dose of cancer slope factor (SF) as follows:

Cancer Risk = CDI x SF

where

Risk	=	likelihood of developing cancer from lifetime exposure (70 years) expressed as unitless probability
CDI	=	chronic daily intake of a substance averaged over a lifetime (mg/kg/day)
SF	=	slope factor $(mg/kg/day)^{-1}$

Carcinogenic risks estimated using this approach are upper-bound estimates. The actual risk may be much lower and could even be zero.

EPA guidance for evaluating potential cancer risk from simultaneous exposure to several carcinogens assumes that incremental cancer risks are additive. The concept that cancer risks are additive is based on a number of assumptions. If these assumptions are incorrect, over- or under-estimation of the actual risk could result. (USEPA,1989). The total cancer risk is estimated as follows:

$$\text{Risk}_T = \Sigma \text{Risk}_i$$

where

Risk_T = total cancer risk
Risk_i = the risk estimate for the ith toxicant, etc.

EPA policy must be considered in order to interpret the significance of the cancer risk estimates. In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 1990) EPA states that: "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}." The Agency further states in the preamble to the NCP that the 10^{-6} risk level be used as a point of departure for establishing remediation goals for the risks from constituents at Superfund sites. OSWER Directive 9355.0-30 indicates that only cancer risks greater than 10^{-4} warrant action.

Risk Calculation

The parameters presented below represent the format utilized in the spread sheet risk calculations for carcinogenic health risks. The carcinogenic risk is calculated as follows:

Chemical Concentration (mg/kg)	Intake Factor (mg/kg/day)	Lifetime Daily Intake (mg/kg/day)	Slope Factor $(mg/kg/day)^{-1}$	Cancer Risk
A	B	C	D	E

Lifetime Daily Intake = (Chemical Concentration)(Intake Factor)

C = (A)(B)

Cancer Risk = (Slope Factor)(Lifetime Daily Intake)

E = (D)(C)

The cancer risk is calculated by multiplying the chronic daily intake (CDI) by the slope factor as discussed in Section 6.2.1. The CDI (Column C) is obtained by multiplying the intake factor (Column B) by the chemical concentration in media (Column A). The CDI (Column C) is then multiplied by the slope factor (Column D) to determine a numerical estimate of excess lifetime cancer risk (Column E).

The cancer risks are summed over all of the chemicals evaluated for each exposure pathway. The risk quantification spread sheets show the average and reasonable maximum exposure scenario calculations and risk totals on the same sheet. To determine the total carcinogenic risk to a given receptor population, the cancer risks for each exposure pathway contributing to the exposure of that population are summed. The total (cumulative) carcinogenic risk is calculated as follows:

Total Exposure Cancer Risk = Risk (exposure $pathway_1$) + Risk (exposure $pathway_2$). . . + Risk (exposure $pathway_i$)

These computations are performed by Woodward-Clyde's ASSESS© risk assessment computer application. Summaries of computation are presented in Appendix E. Potential carcinogenic risks for each potentially exposed population are discussed in Section 6.4.

6.2.2 Hazard Index for Non-Carcinogenic Effects

The potential for non-carcinogenic health effects, expressed as the hazard quotient and hazard index, are calculated in a similar manner. The calculations of chronic and subchronic hazard quotients and hazard indices are performed identically and are shown schematically below. The hazard quotient applies to individual chemicals; whereas, the hazard index applies to the sum of potential non-carcinogenic health effects for all chemicals of concern in a given exposure scenario.

Chemical Concentration (mg/kg)	Intake Factor (mg/kg/day)	Daily Intake (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
A	B	C	D	E

$$\text{Hazard Quotient} = \frac{\text{Daily Intake}}{\text{RfD}}$$

$$E = \frac{C}{D}$$

$$\text{Daily Intake} = \text{(Intake Factor)(Chemical Concentration)}$$

$$C = (B)(A)$$

The hazard quotient is calculated by dividing the daily intake by the reference dose. The daily intake (Column C) is obtained by multiplying the chemical concentration in media (Column A) with the intake factor (Column B). The hazard quotient (Column E) is then derived by dividing the daily intake (Column C) with the reference dose (Column D).

The individual chemical hazard quotients are summed over all the chemicals evaluated to provide a hazard index for a given exposure scenario. The total (cumulative) hazard index for a given receptor population is obtained by combining the hazard indices for each exposure pathway contributing to the exposure of that population. The total hazard index for multiple pathways is calculated as follows:

Total Exposure Hazard Index = Hazard Index (exposure pathway$_1$) + Hazard Index (exposure pathway$_2$) + . . . Hazard Index (exposure pathway$_i$).

Computations of hazard quotients and hazard indices were performed using WCC's ASSESS© risk assessment computer application. Detailed summaries of the computations performed are included in Appendix E.

6.3 RISK CHARACTERIZATION

The carcinogenic and non-carcinogenic risks were calculated for all identified receptor populations, exposures routes, and chemicals of concern using the approach described in Section 6.2. Table 6-1 presents a summary of the estimates of carcinogenic risks and non-carcinogenic hazard indices for the baseline exposure scenario (existing conditions and no-action alternative). This table summarizes risks and hazards to Site workers, visitors, as well as the off-site residential receptor population along Old Airport Road. Detailed calculations are presented in Appendix E. Table 6-2 summarizes findings f chemicals and pathways most likely to contribute to potential risks. This table prese information for those chemicals, by pathway, which were estimated to contribute an incremental excess lifetime cancer risk above 10^{-6}, or a hazard index greater than 1.0. The potentially significant chemicals and pathways are discussed below for each receptor population.

The following sections discuss potential risks for both current and future land use scenarios.

6.3.1 Current Land Use

Seven potential receptor populations were considered for current land use at the Site:

- Maintenance Workers at the South Disposal site
- CIBA-GEIGY Plant Area Maintenance Workers
- Holly Run Plant Area and North Disposal site Maintenance Workers
- Recreational Participants (Adults and Children)
- Trespassers (Adults and Children)

Estimated risks for each of these receptor populations for current land use are discussed below.

Maintenance Workers at the South Disposal Site

Two potential routes of exposure were considered for maintenance workers who may be exposed to surface soils via ingestion or dermal contact. As shown in Table 6-1, cumulative carcinogenic risks from these pathways were 8.4×10^{-10} (average) and 9.0×10^{-8} (RME), well below the acceptable risk range. Total (or cumulative) chronic non-carcinogenic hazard indices were about 0.000097 (average) and 0.0027 (RME), well below 1.0, suggesting no unacceptable risk under existing conditions.

CIBA-GEIGY Maintenance Workers

Potential risks associated with ingestion of, and dermal contact with, soil by maintenance workers at the CIBA-GEIGY Plant were considered. Cumulative carcinogenic risks were 7.8×10^{-8} (average) and 1.4×10^{-5} (RME), below or well within the acceptable risk range. Total chronic non-carcinogenic hazard indices were 0.0022 (average) and 0.068 (RME), well below 1.0.

Holly Run Plant and North Disposal Site Maintenance Workers

Du Pont maintenance workers may be exposed to soils at the Holly Run Plant area and the North Disposal site. Potential risks associated with ingestion of, and contact with, soils by workers at the Holly Run Plant area, and ingestion, dermal contact and inhalation exposures at the North Disposal site were considered. Potential carcinogenic risks were well below or within the acceptable range under both average and RME assumptions, at 5.0×10^{-8} and 4.1×10^{-6}, respectively. Total chronic non-carcinogenic hazard indices were well below 1, at 0.0061 (average) and 0.075 (RME).

Trespassers

Potential exposures to trespassers (adults and adolescents) at the South Disposal site were evaluated. Routes of exposure considered were incidental ingestion of soils and dermal contact with soil and surface water.

For adult trespassers, cumulative carcinogenic risks were 3.6×10^{-9} (average) and 7.0×10^{-7} (RME), well below the acceptable risk range. Total chronic non-carcinogenic hazard indices were 0.00042 (average) and 0.032 RME, well below 1.0.

For adolescent trespassers, cumulative carcinogenic risks were 1.8×10^{-8} (average) and 4.9×10^{-7} (RME), well below the acceptable risk range. Total chronic non-carcinogenic hazard indices were 0.0021 (average) and 0.074 (RME), well below 1.0.

These results suggest that unacceptable risks to trespassers under current land use a not anticipated.

Recreational Participants

Recreational participants include adults who may fish or play in the Christina River near the Site, and children who may fish or play in the river and play in the Ballpark adjacent to the Site.

For adults, cumulative carcinogenic risk was estimated to be 3.1×10^{-7} (average) and 6.5×10^{-6} (RME). The average value was well below the acceptable risk range, while the RME was well within the acceptable risk range. The primary contributors to the estimated risk were, based upon conservative assumptions, related to dermal contact with, and inhalation of organic compounds from groundwater seeps. This risk, below 10^{-4} under RME assumptions, is not considered significant. Total non-carcinogenic hazard indices were 0.0036 (average) and 0.016 (RME), well below 1.0. Overall, estimated risks for adult recreational participants were acceptable under current land use conditions.

For children, cumulative carcinogenic risk was estimated to be 9.6×10^{-7} (average) and 9.8×10^{-6} (RME). The average value was well below the acceptable risk range, while the RME value was well within the acceptable risk range. The primary routes of exposure associated with this risk were dermal contact with, and inhalation of organic compounds from groundwater seeps. The inhalation route was based upon very conservative exposure modeling. This risk, well below 10^{-4} under RME assumptions, is not considered significant. Total non-carcinogenic hazard indices were 0.027 (average) and 0.19 (RME), well below 1.0. In summary, the estimated potential risks and potential hazards to child recreational participants under current land use conditions were considered acceptable.

6.3.2 Future Land Use

Three hypothetical scenarios were considered for future land use at the Site:

- Potential construction activities at the CIBA-GEIGY Newport Plant area
- Potential construction activities at the South Disposal site
- Potential future groundwater use (ingestion) by residents along Old Airport Road.

Potential risks for these activities are discussed below.

Construction - CIBA-GEIGY Newport Plant Area

Future exposure to workers via inhalation, ingestion, and dermal contact with, soils during potential future construction activities at the CIBA-GEIGY Plant area were considered. Cumulative estimated carcinogenic risks were 3.1×10^{-7} (average) and 1.1×10^{-5} (RME), well within or below the acceptable risk range. For non-carcinogens, total subchronic hazards were considered because of the projected short duration of potential exposures. Total subchronic non-carcinogenic hazard indices were 0.3 (average) and 2.5 for the RME case. The estimated non-carcinogenic risk under the RME case was associated primarily with potential ingestion of soil particulates containing antimony, arsenic, barium, cadmium and cobalt (Table 6-2).

In this baseline assessment, it was assumed that no personal protective equipment would be worn by workers. Since any intrusive work in areas with potentially elevated chemical concentrations at the CIBA-GEIGY Plant area would reportedly be performed in accordance with a Health and Safety Plan, actual exposures and risks would be less than the values estimated in this assessment. CIBA-GEIGY has instituted provisions to control worker exposure to potentially contaminated subsurface soils during soil borings and other intrusive activities, which presumably would conform to all applicable government regulations, including OSHA. These procedures should reduce potential future worker exposure below the values estimated in this assessment.

Construction-South Disposal Site

Exposure to workers via inhalation, ingestion, and dermal contact with soils during potential future construction activities at the South Disposal site was considered. Cumulative carcinogenic risks via these pathways were 2.4×10^{-8} (average) and 2.8×10^{-7} (RME), well below the acceptable risk range. For non-carcinogens, total subchronic hazards were considered because of the projected short duration of potential exposure. Total subchronic non-carcinogenic hazard indices were 0.15 (average) and 0.70 (RME), both below 1.0.

Resident Adult - Groundwater Ingestion

Current monitoring data from residential wells at Old Airport Road do not indicate any impact on groundwater from any chemical constituents related to the Newport Site study area. However, in order to evaluate hypothetical future impacts, the concentrations of chemicals from the Site study area in both the Potomac and Columbia Formations were considered. Potential exposures were evaluated based upon EPA's direction to use various on-site monitoring well data to conservatively estimate potential future off-site exposures (see Section 4.3.3).

Potomac Formation

Based upon this hypothetical exposure scenario, cumulative carcinogenic risks of 5.7 x 10^{-7} (average) and 4.6 x 10^{-6} (RME) were below or well within the acceptable risk range. Total chronic hazards indices were 0.98 (average) and 3.6 (RME).

For the non-carcinogens, potential health hazards are associated primarily with cobalt (Table 6-2). The calculated potential hazard for cobalt likely greatly overstates the actual hazard, because it is based upon a conservative RfD for cobalt provided by the EPA Region III (1 x 10^{-4} mg/kg/day). The study utilized by the EPA as a basis for this RfD involved protecting a sensitive subpopulation of heavy beer drinkers (see Appendix C). Region III believes the cobalt RfD used is an intermediate position, since ECAO suggests use of an even more conservative RfD for cobalt, which incorporates an uncertainty factor of 10 considered inappropriate by Region III (see Section 5.2). If the contribution of cobalt is not considered in this hypothetical future exposure scenario, or if a more realistic RfD of 10^{-2} mg/kg/day was utilized (WCC letter of July 10, 1991 to R. Sturgeon at the EPA), the estimated hazard indices for this hypothetical exposure route would be about 0.18 (average) and 0.48 (RME), both well below 1.0.

Columbia Formation

Based upon EPA's direction in evaluating this future residential groundwater exposure scenario (EPA letter to J. Karmazyn, dated February 11, 1992), cumulative carcinogenic risks of 2.1 x 10^{-5} (average) and 3.0 x 10^{-4} (RME) were estimated. The estimated carcinogenic risk under the average case falls in the acceptable risk range. The estimated carcinogenic risk under the RME case was associated primarily with potential ingestion of groundwater containing arsenic.

Total chronic hazard indices were 9.7 (average) and 170 (RME). The estimated non-carcinogenic hazard associated with ingestion of groundwater in this scenario is primarily associated with cobalt. As stated above for hazard indices for the Potomac Formation scenario, the calculated potential hazard for cobalt likely overstates the actual hazard since it is based on a conservative RfD for cobalt. If a more realistic RfD of 10^{-2} mg/kg/day was used to evaluate cobalt, the estimated hazard indices for this future

hypothetical exposure route would be 1.6 (average) and 16 (RME), still above the acceptable hazard index of 1.

Manganese, for both average and RME hazard indices, and arsenic and zinc for the RME case, also contribute to the estimated non-carcinogenic hazards for this future groundwater ingestion scenario.

6.3.3 Potential Exposure to Lead

An RfD value for lead is not available from the EPA. The EPA withdrew the lead RfD value that had been used on Superfund health risk assessments through September 7, 1989, when OSWER Directive 99355.4-02 was issued. That directive was supplemental to OSWER Directive 9355.4-02A, which states that the original Directive is guidance and not a regulation. The current OSWER Directive in effect recommends a surface soil lead action level within a range of 500 to 1000 parts per million (ppm), which is a range the EPA considers safe for a residential use scenario.

An action level of 1000 ppm for lead in all surface soils was proposed by Du Pont, based upon previous EPA Records of Decision (ROD), by letter to the EPA Region III dated July 10, 1990. Subsequent discussions between Du Pont and the EPA Region III resulted in an agreement for using an action level of 500 ppm for lead in surface soils in areas where exposure to children or adolescents is considered likely. Likewise, Du Pont and the EPA Region III agreed to use an action level of 1000 ppm for lead in surface soils in areas where only industrial exposure is anticipated.

In order to determine the potential contribution of lead to the hazard indices already estimated for the exposure scenarios, EPA directed Du Pont (EPA letter to J. Karmazyn, dated February 11, 1992) to compute the hazard quotient (HQ) for lead for the different pathways. In an industrial exposure scenario, i.e., for maintenance or construction workers, the lead concentration in soil was divided by the 1000 ppm action level agreed to by EPA and Du Pont. In exposure scenarios which involved children or adolescents, the 500 ppm action level was used. To evaluate the potential hazards of lead for scenarios involving ingestion of groundwater, Du Pont was directed to use 15 ppb, [illegible] action level for lead in drinking water. Table 6-3 summarizes the HQs for lead for [illegible]

different exposure scenarios using this approach. The highest HQs for lead (19.4 and 19.8) were estimated for the future groundwater ingestion from the Columbia Formation and the workers (current and future) at the CIBA-GEIGY Plant. Other HQs which are greater than 1 were scenarios involving the North Disposal site maintenance worker (3.96), the future residential groundwater ingestion from the Potomac Formation (2.25) and the child trespasser at the South Disposal site (1.85). Methods for eliminating or controlling exposure to lead in surface soils or groundwater above the action level will be evaluated in the Feasibility Study for the Site.

A variety of "edible" fish species representing different trophic levels were collected from the Christina River in the Site vicinity near the upstream reference station. Fillets (edible portions) were analyzed for lead content to address lead exposure to humans via ingestion. In all samples from the river, the lead concentration was below the method detection limit. Utilizing one-half the detection limit for the lead analyses, the available lead concentrations in fish fillet tissues were used to evaluate the potential increase in blood lead levels of children based on the EPA LEAD.4 biokinetic model. The calculated increase in blood lead level was insignificant compared to the advisory range for blood lead levels. These results eliminated concerns for potential lead risks in fish from the Site study area and obviate need for any further action regarding lead in fish at the Site.

6.4 RESULTS AND CONCLUSIONS

The results suggest that potential human health risks associated with most pathways of exposure at the Newport Site study area are well within the acceptable risk range, as summarized below.

Carcinogenic Risks

For carcinogenic risks, all potential cumulative risks associated with current land use were estimated to be below 10^{-6} lifetime cancer risk. For the very conservative RME assumptions, all estimated potential excess lifetime cumulative carcinogenic risks were at or below 1.4×10^{-5} RME, which is well within the accepted risk range, and represents acceptable risk under RME assumptions according to current EPA guidelines.

For future construction scenarios, cumulative carcinogenic risks were below 10^{-6} for potential future construction scenarios under average conditions, and at or below 1.1×10^{-5} under RME assumptions. These results suggest no unacceptable cancer risks are associated with potential construction activities.

Potential carcinogenic risk for the hypothetical future ingestion of groundwater are below or within the acceptable risk range, 5.7×10^{-7} (Potomac) and 2.1×10^{-5} (Columbia) for the average case. RME assumptions are within the acceptable risk range for ingestion of Potomac Formation groundwater (4.6×10^{-6}), but are above the 10^{-4} guideline for groundwater ingestion from the Columbia Formation (3.0×10^{-4}). These estimates are considered very conservative due to the conservative approach used in estimating potential exposure concentrations for groundwater.

Overall, all projected cumulative carcinogenic risks were below, or well within the acceptable risk range of 10^{-4} to 10^{-6} for both current and future land use scenarios, with the exception of the hypothetical scenario for ingestion of Columbia Formation groundwater.

Non-carcinogenic Hazards

For non-carcinogenic hazards other than lead, all cumulative chronic hazard indices under average and RME case conditions were below 1.0 for current land use, suggesting no unacceptable potential non-carcinogenic health hazards.

For potential future construction activities, total non-carcinogenic hazard indices are below 1.0 for average conditions, but slightly above 1 for RME assumptions for the CIBA-GEIGY Plant area construction worker (HI = 2.5 for subchronic exposure). For the CIBA-GEIGY workers, the calculated risks were associated primarily with incidental ingestion of soil particulates containing antimony, arsenic, barium, cadmium and cobalt. CIBA-GEIGY has instituted provisions to control worker exposure to potentially contaminated subsurface soils during soil borings and other intrusive activities. These procedures should reduce potential future worker exposure below the values estimated in this assessment.

For the hypothetical ingestion of Potomac Formation groundwater, the hazard index was just below one under average case assumptions, but above 1 (3.6) for the RME assumptions. Cobalt was the primary contributor to both these hazard indices. If a less conservative RfD value for cobalt is used, the hazard index for ingestion of Potomac Formation groundwater is less than 1.

For the hypothetical future ingestion of Columbia Formation groundwater, cumulative hazard indices were well above 1.0 for both average and RME cases. Cobalt and manganese were the primary contributors to the hazard index for the average case. These same two chemicals, in addition to zinc and arsenic, were primary contributors to the hazard index for the RME scenario. Reported arsenic concentrations were below Maximum Contaminant Levels (MCL) for drinking water. If a less conservative RfD for cobalt is used, the hazard index is still well above 1 under RME assumptions, due to the hazards associated with zinc and manganese.

Groundwater in the Old Airport Road area does not represent a potential community water supply due to the low yield of the Potomac Formation in this area. However, as evidenced by the existing residential wells, the Potomac and Columbia Formation may be used for private water supply. Current monitoring data do not indicate any impact on groundwater at Old Airport Road from any chemical constituent related to the Newport Site study area.

Lead

As discussed in Section 4.3.2, potential intake of lead from ingestion of fish caught in the Christina River was considered. Monitoring of fish tissue for lead content, and subsequent modeling of lead exposure for humans eating the fish, indicated that no significant risk was associated with lead via this route of exposure.

Since there is no accepted RfD for lead, the potential hazards associated with lead in surface soils and groundwater at the Site study area could not be quantified in the same manner as the other chemicals of concern at the Site. Risks associated with lead in surface soils were evaluated based upon comparison to an action level, as per EPA direction. Du Pont and EPA Region III have agreed to an action level of 500 ppm for

lead in surface soils in areas where exposure to children or adolescents is considered likely. Likewise, Du Pont and EPA have agreed to an action level of 1000 ppm for lead in surface soils where only industrial exposure is anticipated. HQs were determined for lead based upon the ratio of observed concentrations to the action level. Several exposure scenarios had HQs for lead above 10: CIBA-GEIGY workers (current and future) and future residential ingestion of Columbia Formation groundwater. Other scenarios with HQs for lead above 1.0 included the North Disposal site maintenance worker, residential ingestion of Potomac Formation groundwater and the adolescent trespasser at the South Disposal site. Methods for eliminating or controlling exposure to lead in surface soils and groundwater above the action level will be evaluated in the Feasibility Study for the Site.

Chemicals of Concern

As shown in Table 6-2, relatively few chemicals are associated with potentially significant estimated risks for the potential pathways of exposure at the Du Pont-Newport Site stu area. This table summarizes the chemicals contributing to potential risks for vario paths of exposures. Potential carcinogens were compared to the acceptable risk range of 10^{-6} to 10^{-4} incremental excess lifetime cancer risk. Non-carcinogens were compared against a hazard index of 1.0. Any chemical contributing greater than 10 percent to a hazard index greater than 1.0 was summarized, in order to identify those chemicals most likely to contribute to significant non-carcinogenic hazards for a given medium.

Only two chemicals were associated with potential cancer risks above 10^{-5}, even under the conservative RME assumptions. The Columbia Formation groundwater ingestion scenario was associated with a cancer risk of 2.1×10^{-5} (average) and 3.0×10^{-4} (RME). Arsenic was the primary contributor to these estimated risks. Tetrachloroethene also had an estimated risk above 10^{-5} under RME assumptions. Arsenic was also associated with risks slightly above 10^{-5} for the CIBA-GEIGY Plant maintenance workers. All other chemicals in all other media were associated with cancer risks below 10^{-5}. Only three additional chemicals (vinyl chloride, bis(2-ethylhexyl)phthalate, and trichloroethene) were associated with RME cancer risks above 10^{-6} in any media (Table 6-2).

For non-carcinogenic hazards, only three media were associated with potential hazard indices greater than one under RME conditions: CIBA-GEIGY Plant Area soils, and Potomac Formation and Columbia Formation groundwater. For CIBA-GEIGY Plant Area soils, several metals (antimony, arsenic, barium, cadmium, and cobalt) were associated with hazard quotients of greater than 1.0; however, no individual chemical was associated with a hazard quotient greater than 1.0. The only significant potential route of exposure to CIBA-GEIGY Plant Area soils was through potential incidental ingestion of soils during future construction activities in areas where concentrations of metals in soils are elevated. Standard personnel protective equipment worn in accordance with an appropriate OSHA approved health and safety program should provide protection from these potential hazards.

For the Potomac Formation groundwater, only cobalt was associated with a hazard quotient (3.1) greater than one under RME assumptions. For the Columbia Formation groundwater, cobalt, zinc, manganese and arsenic had hazard quotients above 1 under RME assumptions. These values were based on assumed ingestion of Potomac Formation and Columbia Formation groundwater and a conservative RfD for cobalt.

Lead should also be considered a chemical of concern in areas where its concentration in surface soils exceeds the action level and in groundwater in the Potomac Formation and Columbia Formation.

TABLE 6-1

RECEPTOR DETAIL REPORT FOR DUPONT-NEWPORT SITE

Receptor/Pathway	Average Exposure		Reasonable Maxim[illegible]posu	
	Cancer Risk	Hazard Index[1]	Cancer Risk	[illegible]rd Index[1]
Adult - Trespasser				
INGESTION SOIL SDS	3.1E-09	0.00036	6.9E-07	0.031
DERMAL CONTACT SOIL (ORGANICS) SDS	--	--	--	--
DERMAL CONTACT SOIL (METALS) SDS	4.8E-10	0.000056	1.8E-08	0.0008
DERMAL CONTACT WATER (METALS) SDS	3.9E-11	0.0000056	1.8E-09	0.000078
TOTAL FOR RECEPTOR	3.6E-09	0.00042	7.0E-07	0.032
Adolescent - Trespasser				
INGESTION SOIL SDS	1.8E-08	0.0023	4.7E-07	0.071
DERMAL CONTACT SOIL (ORGANICS) SDS	--	--	--	--
DERMAL CONTACT SOIL (METALS) SDS	5.5E-10	0.000064	1.9E-08	0.0028
DERMAL CONTACT WATER (METALS) SDS	4.5E-11	0.0000064	1.4E-09	0.0002
TOTAL FOR RECEPTOR	1.8E-08	0.0021	4.9E-07	0.074
Adult - Recreational				
INGESTION WATER CR	1.1E-07	0.003	9.2E-07	0.0082
DERMAL CONTACT WATER (ORGANIC) CR	6.2E-10	0.0000094	6.8E-09	0.000003[illegible]
DERMAL CONTACT WATER (METALS) CR	2.7E-10	0.0000077	2.3E-09	0.000002[illegible]
INHALATION SEEPS CR	9.7E-08	--	1.7E-06	--
DERMAL CONTRACT SEEPS (ORGANIC) CR	1.1E-07	0.00061	3.9E-06	0.0069
DERMAL CONTACT SEEPS (METALS) CR	1.4E-10	0.00004	6.4E-09	0.00039
TOTAL FOR RECEPTOR	3.1E-07	0.0036	6.6E-06	0.016
Child/Adolescent - Recreational				
INGESTION SOIL BP	5.6E-08	0.0058	4.4E-07	0.045
INHALATION SOIL BP	3.7E-08	0.014	2.6E-07	[illegible]11
DERMAL CONTACT SOIL (ORGANICS) BP	--	--	--	[illegible]
DERMAL CONTACT SOIL (METALS) BP	1.2E-09	0.00013	2.1E-08	[illegible]22
SUBTOTAL BALLPARK	9.42E-08	0.020	7.21E-07	0.16
INGESTION WATER CR	2.2E-07	0.0063	5.8E-07	0.017
DERMAL CONTACT WATER (ORGANICS)CR	8.5E-10	0.000013	2.8E-09	0.000043
DERMAL CONTACT WATER (METALS) CR	3.8E-10	0.000011	9.7E-10	0.00002[illegible]
INHALATION SEEPS CR	4.8E-07	--	4.9E-06	--
DERMAL CONTACT SEEPS (ORGANICS) CR	1.5E-07	0.0009	3.6E-06	0.021
DERMAL CONTACT SEEPS (METALS) CR	2.1E-10	0.000059	5.8E-09	0.0012
SUBTOTAL RIVER	8.5E-07	0.0073	9.1E-06	0.039
TOTAL FOR RECEPTOR	9.6E-07	0.027	9.8E-06	0.19
Adult - Resident (Future)				
INGESTION GROUNDWATER (FF)	5.7E-07	0.98	4.6E-06	3.6
INGESTION GROUNDWATER (CF)	2.1E-05	9.67	3.0E-04	170
Adult - SDS Construction (Future)				
INGESTION SOIL SDS	3.4E-09	0.03	1.6E-07	0.45
INHALATION SOIL SDS	2.0E-08	0.12	1.2E-07	0.24
DERMAL CONTACT SOIL (ORGANICS) SDS	--	--	--	--
DERMAL CONTACT SOIL (METALS) SDS	3.1E-10	0.0026	4.9E-09	0.014
TOTAL FOR RECEPTOR	2.4E-08	0.15	2.8E-07	0.70
Adult - CG Construction (Future)				
INGESTION SOIL CG	1.1E-07	0.15	8.2E-06	2.2
INHALATION SOIL CG	1.9E-07	0.14	2.1E-06	0.22
DERMAL CONTACT SOIL (ORGANICS) CG	1.3E-10	0.0000076	2.7E-09	0.00000[illegible]
DERMAL CONTACT SOIL (METALS) CG	9.4E-09	0.013	2.6E-07	0.069
TOTAL FOR RECEPTOR	3.1E-07	0.30	1.1E-05	2.5

TABLE 6-1

RECEPTOR DETAIL REPORT FOR DUPONT-NEWPORT SITE

	Average Exposure		Reasonable Maximum Exposure	
Adult - Worker (NDS and HR)				
INGESTION SOIL NDS	9.3E-09	0.00073	1.2E-06	0.022
INHALATION SOIL NDS	1.0E-08	0.0033	1.8E-07	0.013
DERMAL CONTACT SOIL (ORGANICS) NDS	1.1E-09	--	6.5E-08	--
DERMAL CONTACT SOIL (METALS) NDS	7.2E-10	0.000065	3.3E-08	0.00068
INGESTION SOIL HR	2.6E-08	0.0018	2.5E-06	0.039
DERMAL CONTACT SOIL (ORGANICS) HR	3.9E-12	0.0000001	1.5E-10	0.00000079
DERMAL CONTACT SOIL (METALS) HR	2.4E-09	0.00016	8.0E-08	0.0012
TOTAL FOR RECEPTOR	5.0E-08	0.0061	4.1E-06	0.075
Adult - Worker (CG)				
INGESTION SOIL CG	7.1E-08	0.002	1.4E-05	0.066
DERMAL CONTACT SOIL (ORGANICS) CG	9.1E-11	0.000000063	4.6E-09	0.00000033
DERMAL CONTACT SOIL (METALS) CG	6.3E-09	0.00018	4.3E-07	0.0021
TOTAL FOR RECEPTOR	7.8E-08	0.0022	1.4E-05	0.068
Adult - Worker (SDS)				
INGESTION SOIL SDS	7.7E-10	0.00009	8.7E-08	0.0026
DERMAL CONTACT SOIL (ORGANICS) SDS	--	--	--	--
DERMAL CONTACT SOIL (METALS) SDS	6.9E-11	0.000008	2.7E-09	0.000083
TOTAL FOR RECEPTOR	8.4E-10	0.000097	9.0E-08	0.0027

Notes: SDS - South Disposal Site
NDS - North Disposal Site
CG - CIBA-GEIGY
HR - Holly Run
BP - Ballpark
CR - Christina River
PF - Potomac Formation
CF - Columbia Formation

(1) - Hazard Index is for chronic hazards, except for future construction scenarios, which represent subchronic hazards.

Prepared by: PE
Checked by: LIN

TABLE 6-2

SUMMARY OF CHEMICALS/PATHWAYS CONTRIBUTING TO ESTIMATED RISK
DUPONT-NEWPORT SITE

	Average		RME	
Receptor/Pathway	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient
Adult-Recreational (CR)				
Inhalation of Seeps	–	–	Vinyl Chloride 1.3E-6	–
Dermal Contact of Seeps (organics)	–	–	Vinyl Chloride 3.3E-6	–
Child-Recreational (CR)				
Inhalation of Seeps	–	–	Vinyl Chloride 3.7E-6	–
Dermal Contact of Seeps (organics)	–	–	Vinyl Chloride 3.0E-6	–
Adult - Maintenance Worker (NDS & HR)				
Ingestion of Soil (HR)	–	–	Arsenic 9.9E-07 Benzo(a)anthracene 2.1E-07	–
Ingestion of Soil (NDS)	–	–	Arsenic 2.1E-6	–
Adult - Maintenance Worker (CIBA-GEIGY)				
Ingestion of Soil	–	–	Arsenic 1.4E-5	–
Future Construction Worker (CIBA-GEIGY)				
Ingestion of Soil	–	–	Arsenic 8.1E-6	Antimony 0.27 Arsenic Barium Cadmium 0.62 Cobalt 0.18
Inhalation of Soil	–	–	Arsenic 2.0E-6	–
Future Resident				
Groundwater Ingestion Potomac Formation	–	Cobalt 0.8	Tetrachloroethene 3.7E-06	Cobalt 3.14 –
Groundwater Ingestion Columbia Formation	Arsenic 1.9E-05 Tetrachloroethene 1.6E-06	Cobalt 7.92 Manganese 1.0	Arsenic 2.61E-04 Tetrachloroethene 2.6E-05 Bis(2-ethylhexyl)phthalate 2.2E-06 Trichloroethene 6.2E-06	Cobalt 155 Arsenic 1.6 Manganese 5.8 Zinc 6.3

Notes:

CR - Christina River
NDS - North Disposal Site
HR - Holly Run

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Checked

88C2076/DPN5_8.TAB
March 18, 1992

TABLE 6-3

HAZARD QUOTIENTS FOR LEAD CONCENTRATIONS IN SOILS AND GROUNDWATER

Receptor/Pathway	Media	95% Upper Confidence Limit Lead concentration (ppm)	Hazard Quotient
Adult Trespasser (SDS) dermal contact; ingestion	Soil	925.73	0.93
Child Trespasser (SDS) dermal contact; ingestion	Soil	925.73	1.85
Child-Recreational (BP) ingestion; dermal contact	Soil	109.33	0.22
Adult-Resident (PF) ingestion	Groundwater	.0337	2.25
Adult-Resident (CF) ingestion	Groundwater	0.2907	19.38
Worker (NDS) ingestion; inhalation; dermal contact	Soil	3,955.49	3.96
Worker (HR) ingestion; dermal contact	Soil	63.33	0.063
Worker (CG) ingestion; dermal contact	Soil	19,814.15	19.81
Worker (SDS) ingestion; dermal contact	Soil	925.73	0.93
Worker (SDS) Future ingestion; inhalation; dermal contact	Soil	925.73	0.93
Worker (CG) Future ingestion; inhalation; dermal contact	Soil	19,814.15	19.81

Notes: SDS - South Disposal Site
CR - Christina River
BP - Ballpark
PF - Potomac Formation
CF - Columbia Formation
NDS - North Disposal Site
HR - Holly Run
CG - CIBA-GEIGY

Prepared by: P
Checked by: S