HUMAN HEALTH RISK ASSESSMENT

OCCIDENTAL CHEMICAL CORPORATION
DELAWARE CITY, DELAWARE

Prepared For:
Glenn Springs Holdings, Inc.

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1.0 INTRODUCTION

This report presents a Human Health Risk Assessment (HHRA) to examine the human health risks related to the Occidental Chemical Corporation (OxyChem) Facility located in Delaware City, Delaware (Site). The Site is located in a heavily industrial and commercial setting, surrounded by rural agricultural land. The Site is operated by OxyChem, and is known to contain groundwater with elevated mercury, chlorinated benzenes, benzene, chlorinated alkanes and alkenes, phthalates, and metal concentrations. Additional chemicals of potential concern (COPCs) in Site soil and groundwater are present, although mercury and chlorobenzenes are expected to be the primary chemicals of potential concern.

Conestoga-Rovers & Associates (CRA), on behalf of Glenn Springs Holdings, Inc. (GSHI), has developed Site-specific Standards (SSSs) for the Site through the HHRA process. USEPA Region III, in an email dated February 22, 2007, requested an interim deliverable describing the receptors, scenarios, and exposure assumptions to be applied to the Site in the development of the SSSs through the HHRA process. A draft HHRA was prepared to meet this request, and submitted to the USEPA Region III in April 2007. Comments on the draft HHRA were provided by USEPA in emails dated October 19, 2007, and March 14, 2008, and were addressed by CRA in letters dated December 12, 2007, and April 23, 2008. The revised HHRA incorporates the aforementioned comments.

Section 2.0 below outlines the overall rationale for the development of SSSs protective of human health. Outlining the steps involved in the HHRA process, Sections 3.0, 4.0, 5.0, and 6.0 present the Hazard Identification, Exposure Assessment, Toxicity Assessment, and Derivation of SSSs, respectively, for the Site. Section 7.0 provides a brief summary of the approach to and results of developing human health based SSSs for the Site, and Section 8.0 presents all references cited herein.

The HHRA conducted for the Site consists of the following components:

i) Hazard Identification/Site Characterization/Selection of Chemicals of Potential Concern (COPCs);

ii) Exposure Assessment;

iii) Toxicity Assessment; and

iv) Derivation of Site-Specific Standards (SSSs).

2.0 RATIONALE FOR THE DEVELOPMENT OF SITE-SPECIFIC STANDARDS (SSSs)

2.1 OBJECTIVE OF THE SSSs

The purpose of developing SSSs for the Site is to provide a means by which to evaluate potential hazards and risks to human receptors at the Site resulting from exposure to contaminated environmental media at the Site. The SSSs are developed in consideration of the current land use of the Site, and potential future land uses for the Site. The specific goals of this work include:

- provide a basis for comparing potential health risks related to different potential land use scenarios for the Site;
- provide a basis for determining the level of chemicals that can remain on the Site and still not adversely impact human health;
- identify what areas of the Site may require further remedial action; and
- provide a basis for comparing potential health impacts of various remedial alternatives.

2.2 APPROACH FOR DEVELOPMENT OF SSSs

The Site lies south of the confluence of Red Lion Creek and the Delaware River, and incorporates a tributary that feeds into the Red Lion Creek (the Tributary). Given the proximity of the Site to these water bodies, a large portion of the Site is occupied by wetlands, as indicated on Figure 2.1. The primary risk issues associated with these wetlands are ecological in nature, and are being examined under a separate Ecological Risk Assessment (ERA) report. As such, the wetlands portion of the Site will not be considered in the development of SSSs based on the protection of human health. Figure 2.2 indicates the portion of the Site that will be considered herein. Although a variety of Solid Waste Management Units (SWMU) and areas of concern (Areas) have previously been identified within this portion of the Site (CRA, 2006), for the purpose of identifying Chemicals of Potential Concern (COPCs) and assessing potential human exposure pathways in the current work, the Site will be treated as one large exposure unit. The future redevelopment of the Site will likely focus on specific portions of the Site, rather than the whole Site; however, the treatment of the Site as one large unit in the current work is seen as a conservative approach to identifying potential human health risks at the Site.

2.3 GUIDANCE FOR DEVELOPMENT OF SSSs

The SSSs will be developed in accordance with the following USEPA guidance:

- USEPA Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual, Part A, EPA/540/1-89/002, December 1989;
- USEPA RAGS Supplemental Guidance, Standard Default Exposure Factors, Interim Final, OSWER Directive 9285.6-03, March 25, 1991;
- USEPA RAGS Part B, Development of Risk-based Preliminary Remediation Goals, Interim, December 1991;
- USEPA Exposure Factors Handbook, EPA/600/P-95/002Fa, August 1997;
- USEPA RAGS Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments, Final, Publication 9285.7-O1D, December 2001;
- USEPA Child-Specific Exposure Factors Handbook, September 2002a;
- USEPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002c; and
- USEPA RAGS Part E, Supplemental Guidance, Dermal Risk Assessment, Final, July 2004.

The USEPA acceptable cancer risk range is 1E-06 to 1E-04, and acceptable hazard level is 1.0. For the purpose of developing human health based SSSs for the Site, a target cumulative cancer risk of 1.0E-05 and target cumulative hazard of 1.0 will be applied.

In accordance with the guidance, the first steps of the HHRA process include Hazard Identification, Exposure Assessment, Toxicity Assessment. Sections 3.0, 4.0, and 5.0 outline each of these steps, respectively. Section 6.0 presents the derivation of SSSs and any uncertainties associated with their derivation.

3.0 HAZARD IDENTIFICATION

Hazard Identification involves the selection of COPCs for the Site. The selection of COPCs follows USEPA RAGS Part A, and all chemicals were screened against the Risk-Based Concentrations (RBCs) developed by USEPA Region III (USEPA, 2007b). Select metals were also screened against background concentrations, where appropriate. Specifically, natural arsenic levels are known to exceed the Region III RBC for arsenic of 1.9 mg/kg in the vicinity of the Site. Thus, arsenic concentrations detected at the Site were screened against a background arsenic concentration of 11 mg/kg, as determined by the State of Delaware's Department of Natural Resources and Environmental Control (DNREC) (DNREC, 2007).

For mercury, the USEPA Region III provides a screening value of 6.5 mg/kg (USEPA, 2007a). Concentrations of mercury detected in Site soil however, were screened to a value of 3.31 mg/kg, derived by following USEPA Region III guidance and incorporating updated inputs, as outlined below. Email correspondence from USEPA dated October 19, 2007 (USEPA, 2007c) approved the updated inputs. As outlined in the USEPA (2007a) email, the screening value is based on an ambient air inhalation exposure scenario for an industrial worker, as follows:

$$RBC_{Hg} = \frac{THQ \times AT \times 365 days/year \times 24 hr/day}{ET \times EF \times ED \times \left[\frac{1}{RfC} \times \frac{1}{VF} \right]}$$

Where:

RBC_{Hg}	-	risk-based concentration for mercury in soil (mg/kg);
THQ	-	target hazard quotient, equal to 1.0 (unitless);
AT	-	averaging time, equal to 25 years;
ET	-	exposure time, equal to 8 hours per day;
EF	-	exposure frequency, equal to 250 days per year;
ED	-	exposure duration, equal to 25 years;
RfC	-	reference concentration for elemental mercury, equal to 3.0E-04 mg/m^3; and
VF	-	volatilization factor, equal to 4,932 m^3/kg.

While the majority of these parameters are obtained from USEPA (2002c), as appropriate, the calculation of the VF diverged from this document. As outlined in USEPA (2007a), USEPA Region III's VF is based on an exposure interval (T) of

1.8E+08 seconds, a Q/C value of 53.89 g/m^2-s per kg/m^3 (based on Huntington, West Virginia and a 0.5-acre site), and a soil-water partition coefficient (K_d) of 10 cm^3/g. This K_d value is referenced in USEPA (2007a) as the lowest possible applicable K_d, assuming elemental mercury will not have a high affinity for soil.

Based on the calculations presented in USEPA (2002c; Equation 4-8), a time interval of 1.8E+08 seconds is not appropriate for the industrial worker. The exposure interval is to be calculated as the exposure duration multiplied by the number of seconds per year (31,536,000 sec/yr). For the industrial worker, with the assumed exposure duration of 25 years, this would equal an exposure interval of 7.9E+08 seconds.

The Q/C value of 53.89 g/m^2-s per kg/m^3 applied by USEPA Region III was obtained from USEPA (1996). Following USEPA's updated guidance, the Q/C would be calculated according to Exhibit D-3 of USEPA (2002c). Applying the constants indicated in Exhibit D-3 for Huntington, West Virginia, and an assumed site area of 0.5 acres, produces a Q/C of 58.17 g/m^2-s per kg/m^3. As this Q/C reflects updated guidance, this value is more appropriate in the calculation of a RBC for mercury than the value report in USEPA (1996).

Finally, specific reference to a K_d of 10 cm^3/g could not be found in USEPA (1996) or USEPA (2002c). However, USEPA (2002c; Equation 4-8) indicates that a pH of 6.8 should be assumed when selecting default K_d values for metals. USEPA (2002c; Exhibit C-4) reports a K_d of 52 cm^3/g for mercury at a pH of 6.8. Again, as this reflects updated guidance, a K_d of 52 cm^3/g is more appropriate in the calculation of a RBC for mercury than the K_d of 10 cm^3/g applied by USEPA Region III.

Table 3.1 presents the derivation of the SSS of 33.1 mg/kg for mercury in soil based on the updated volatilization factor. For the soil screening process, the derived mercury value was adjusted by a factor of 10 to incorporate the appropriate hazard index of 0.1. Table 3.2 presents the derivation of the Q/C value and volatilization factor incorporating the most current guidance.

The selection of the appropriate RBCs to apply in the screening process is based on the land use of the Site, and thus, the potentially exposed receptors. As such, the Hazard Identification must begin with an examination of the exposure setting of the Site.

3.1 CHARACTERIZATION OF EXPOSURE SETTING

As part of the HHRA process, potential exposure pathways are determined through an evaluation of the physical setting of the Site and the potentially exposed populations. A detailed description of the physical setting of the Site is presented in the Summary of Site Conditions Report (CRA, 2006). The current and future potential land uses that are reasonably expected for the Site determine what populations may potentially be exposed. The Site impacts requiring consideration for human health effects do not extend off Site to neighboring properties; thus, an examination of off-Site impacts is not required. The current and potential future land uses of the Site are discussed in the following subsections.

3.1.1 CURRENT LAND USE

The Site is currently operating under industrial land use for the manufacture of Anhydrous Potassium Hydroxide. It is located in a heavily industrial and commercial setting, surrounded by rural agricultural land. Based on the current land use, the current potentially exposed population includes persons who may infrequently trespass at the Site, industrial workers employed at the Site, and construction/utility workers involved in ground intrusive activities at the Site.

3.1.2 FUTURE LAND USE

As the long-term use of the Site and surrounding area for heavy industry has led to a widespread chemical presence in soil and shallow groundwater, the concept of a residential area supplanting this industrial area is not practical in the near or long term. This fact was documented in "Justification for a Future Land-Use Scenario" submitted to USEPA in 1998 (CRA, 1998). As such, three potential future land use scenarios are being considered for the Site. The first scenario involves the continued use of the Site for industrial purposes. The second scenario involves the redevelopment of the Site for recreational land use. This second scenario may involve the development of the Site as a golf course, soccer fields, baseball diamonds, or other recreational space. The third scenario involves the vacancy of the Site, with only continued lawn maintenance. This third scenario reflects a situation wherein industrial operations do not continue at the Site, but the grounds continue to be maintained by lawn maintenance staff. For the purpose of the current work, this scenario will consider the entire Site, although it is likely that lawn maintenance would only be conducted on portions of the Site, if the Site were vacated. SSSs will be developed based on each of these three scenarios.

The future potentially exposed population for the Site based on the first scenario, industrial land use, includes trespassers, industrial workers, and construction/utility workers. The future potentially exposed population for the Site based on the second scenario, recreational land use, would depend upon the specific development of the Site. For example, the development of soccer fields at the Site would lead to soccer player receptors. The development of baseball diamonds at the Site would lead to baseball player receptors. For the purpose of the current work, the development of the Site as both a soccer field and a golf course will be considered, and the potentially exposed population will include soccer players, golfers, golf course employees, and construction/utility workers. The future potentially exposed population for the Site based on the third scenario, Site vacancy with lawn maintenance, includes trespassers and lawn maintenance staff.

It should be noted that active groundwater extraction and treatment on Site, with discharge to the Delaware River, will continue for the foreseeable future. Some labor will be required to operate and maintain the groundwater extraction and treatment system. For the purpose of the current work, a wastewater treatment operator will not be explicitly included as a receptor in each of the three scenarios as the nature and function of a long-term wastewater treatment operation is not yet well defined for the Site. Although a potential wastewater treatment operator will not be explicitly included in the current assessment, the SSSs developed for the industrial worker under the industrial land use scenario will be protective of a wastewater treatment operator at the Site.

3.1.3 SUMMARY OF EXPOSURE SCENARIOS

Three different exposure scenarios will be considered in the development of human health based SSSs. These scenarios have been selected based on the current land use, and potential future land uses of the Site. The data tables associated with each exposure scenario in the application of the HHRA process for the development of SSSs are presented in separate appendices, as follows:

(i)	Industrial Land Use	-	Appendix A;
(ii)	Recreational Land Use	-	Appendix B; and
(iii)	Vacant (Lawn Maintenance Only)	-	Appendix C.

The following sections present the human health Conceptual Site Models (CSMs) developed for the Site based on these three exposure scenarios, and the identification of Site COPCs.

3.2 CONCEPTUAL SITE MODEL

In order to evaluate the significance of the impacted media at the Site, the potential pathways by which individuals may come in contact with these media must be determined. The combination of factors (chemical source, media of concern, release mechanisms, and potential receptors) that could produce a complete exposure pathway and lead to human uptake of chemicals at the Site are assessed in what is defined as a Conceptual Site Model (CSM).

Three CSMs were developed for the Site, based on the three exposure scenarios identified in Section 3.1. Briefly, the following potential human receptors may be exposed to Site media under the given exposure scenarios:

Scenario 1: Industrial Land Use	***Scenario 2: Recreational Land Use***	***Scenario 3: Vacant (Lawn Maintenance Only)***
Trespasser Industrial Worker Construction/Utility Worker	Soccer Player Golfer Golf Course Employee Construction/Utility Worker	Trespasser Lawn Maintenance Staff

Impacted media within the portion of the Site under consideration in the development of human health based SSSs (see Figure 2.2) include surface and subsurface soil, groundwater, and waste. Although Site groundwater is not currently used for any application—and its future use will be restricted through institutional controls (ICs), engineering controls and/or active remedies —a mandate exists at the Site to remediate groundwater to the Safe Drinking Water Act's Maximum Contaminant Levels (MCLs). While the MCLs are considered protective of ingestion exposure, they do not consider potential inhalation exposure to vapors derived from groundwater. As such, the groundwater to indoor air pathway is of concern for this medium. Similarly, the groundwater to outdoor ambient air pathway is potentially complete at the Site; however, this exposure point will not be evaluated as the groundwater to ambient air exposures are generally considered *de minimis* for surface receptors since the volatile chemicals are significantly diluted upon release to ambient air. Note that groundwater

SSSs will also not be developed for construction/utility worker exposure during ground intrusive activities, as ICs, along with Health and Safety procedures, will be sought to inhibit construction/utility worker exposure to Site groundwater. The Corrective Measures Study (CMS) will specify, as part of the final remedy for the Site, ICs, engineering controls, or active remedies to prevent such exposure. A comprehensive outline for the implementation of ICs and appropriate engineering controls at the Site will be presented in the CMS. Waste materials will not be considered in the current work as all waste material on-Site is currently located within capped landfills and future subsurface excavation and building construction within these areas will be prohibited. Only surface use of the capped landfills (e.g., for recreational use or lawn maintenance) will be permitted as surface receptors will not be exposed to the waste materials in the subsurface. Air will be considered an additional impacted medium based on the potential for volatile impacts in soil to migrate to ambient and/or indoor air, and for volatile impacts in groundwater to migrate to indoor air.

Based on the physical conditions of the Site, potential exposure routes associated with Site soil include incidental ingestion, direct dermal contact, and inhalation (airborne particulates and/or vapors). The potential exposure route associated with Site groundwater is inhalation (vapors).

The CSMs for Scenarios 1, 2, and 3 are presented on Figures 3.1, 3.2, and 3.3, respectively. The Site contains soil impacted by metals, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs), and groundwater impacted by metals, SVOCs, and VOCs.

Summaries of the potentially complete pathways and relevant receptors to be evaluated for each exposure scenario are also presented in the tables referenced below.

Scenario	*Receptors*	*Appendix*	*Appendix Table Reference*
Industrial Land Use	Current/Future Trespasser Current/Future Industrial Worker Future Construction/Utility Worker	A	A.1.1
Recreational Land Use	Future Child Soccer Player (6 to 16 years old) Future Child Golfer (6 to 16 years old) Future Adult Golfer Future Golf Course Employee Future Construction/Utility Worker	B	B.1.1
Vacant (Lawn Maintenance Only)	Future Trespasser Future Lawn Maintenance Staff	C	C.1.1

3.3 SELECTION OF CHEMICALS OF POTENTIAL CONCERN (COPCs)

This section presents the process for establishing the chemicals of potential concern (COPCs) at the Site. COPCs are chemicals related to the Site that pose the greatest potential human health risk. In general, detected chemicals were identified as COPCs based upon their concentrations and known toxicity characteristics. Note that all detected chemicals were considered in the selection of COPCs for the Site, although mercury and chlorobenzenes are expected to be the primary chemicals of concern in the HHRA. The selection of COPCs considered analytical data reported for the portion of the Site under consideration for the development of human health based SSSs. As indicated in Section 3.2, soil and groundwater are the only media for which human health based SSSs were developed; thus, only soil and groundwater chemical data were examined for the identification of COPCs. Note that for each screening process, the applied screening criteria for carcinogenic compounds were based on a target risk level of 1.0E-06 and for non-carcinogenic compounds were based on a target hazard of 0.1, to be protective of a cumulative target risk of 1.0E-05 and cumulative target hazard of 1.0.

For the Industrial Land Use and Vacant (Lawn Maintenance Only) exposure scenarios, the concentration of each chemical detected in surface soil and soil (surface and subsurface) was compared to USEPA Region III Industrial Soil RBCs (USEPA, 2007b). The detected concentration of mercury was compared to the screening value of 3.31 mg/kg derived by CRA, and consistent with the October 19, 2007 email response received by CRA from the USEPA (2007c). The Region III RBCs and SSS for mercury are based on a target risk level of 1.0E-06 and a target hazard of 1.0; thus, RBCs based on

non-carcinogenic impacts were adjusted by a factor of 10 to meet a target hazard of 0.1. The criterion for lead was established by the USEPA using the IEUBK model, and was therefore not adjusted by a factor of 10. The detected concentration of arsenic was compared to a background arsenic concentration of 11 mg/kg (DNREC, 2007). For the soil to indoor air pathway under the Industrial Land Use scenario, appropriate screening criteria were not available; thus, all detected volatile chemicals, as defined by USEPA (2002b), were selected as COPCs.

For the soccer player and golfer exposures under the Recreational Land Use exposure scenario, the concentration of each chemical detected in surface soil was compared to USEPA Region III Residential Soil RBCs (USEPA, 2007b), for conservatism. For the golf course employee and construction/utility worker, the concentrations of each chemical detected in surface soil and soil, respectively, were compared to USEPA Region III Industrial Soil RBCs (USEPA, 2007b). The detected concentration of mercury was compared to the screening value of 3.31 mg/kg derived by CRA, and consistent with the October 19, 2007 email response received by CRA from the USEPA (2007c). Again, the Region III RBCs are based on a target risk level of 1.0E-06 and a target hazard of 1.0; thus, RBCs based on non-carcinogenic impacts were adjusted by a factor of 10 to meet a target hazard of 0.1. The detected concentration of arsenic was also compared to a background arsenic concentration of 11 mg/kg (DNREC, 2007) for each screening process. For the soil to indoor air pathway, appropriate screening criteria were not available; thus, all detected volatile chemicals, as defined by USEPA (2002b), were selected as COPCs.

For the Industrial Land Use and Recreational Land Use exposure scenarios, each chemical detected in groundwater was compared to USEPA groundwater criteria developed to be protective of indoor air inhalation exposure (USEPA, 2002b; Table 2c). It should be noted that in this guidance most chemicals have screening values that are based on risk for the groundwater to indoor air pathway; however, some default to MCLs. The screening criteria for most chemicals are risk-based values for the groundwater to indoor air pathway and are based on a target risk level of 1.0E-06 and a target hazard index of 1.0. For criteria based on non-carcinogenic impacts, we adjusted the screening criteria by a factor of 10 to meet a target hazard index of 0.1. For several chemicals detected in Site groundwater, the screening criteria from the USEPA 2002 guidance are MCLs rather than risk-based values for the groundwater to indoor air pathway.

The chemical data for each medium were evaluated to identify chemicals with detected concentrations higher than the appropriate screening criteria. All chemicals determined to be present at elevated concentrations were retained as COPCs and will be carried

through the HHRA evaluation, although mercury and chlorobenzenes are expected to be the primary chemicals of potential concern in the HHRA. All essential nutrients such as calcium, magnesium, potassium, and sodium were disregarded from further evaluation. All parameters reported at concentrations below the appropriate screening criteria were not identified as COPCs for the investigated medium. Additionally, any parameter that had a level of detection frequency (LDF) less than 5 percent was not identified as a COPC for the investigated medium.

The analytical results for samples collected from surface soil, soil, and groundwater samples will be summarized and discussed in Section 3.3.1. The surface soil data set consists of all soil data collected from 0 to 2 feet below ground surface (ft bgs). The soil (surface and subsurface) data set established to examine construction/utility worker exposure to soil consists of all soil data collected from 0 to 15 ft bgs, as it is assumed that excavation activities would not exceed a depth of 15 ft bgs. The soil (surface and subsurface) data set established to examine potential soil to indoor air exposure consists of all soil data from the vadose zone. The depth to groundwater at the Site has been found to range from 0.5 ft bgs to 22 ft bgs, with an average depth of 12 ft bgs. For conservatism, the depth to groundwater at the Site was thus approximated as 15 ft bgs, and the soil data set for examining soil-to-indoor air exposure was established as all soil data collected from 0 to 15 ft bgs. Groundwater data collected at water wells only (i.e., within the overburden groundwater located directly beneath the vadose zone) were included in the COPC selection process, as it is this shallow groundwater that has the greatest potential to impact indoor air quality.

3.3.1 INDUSTRIAL LAND USE SCENARIO

Surface Soil (0 to 2 ft bgs)

As presented in Table A.2.1 of Appendix A, benzo(a)pyrene, arsenic, copper, iron, lead, manganese, mercury, and Aroclor-1260 were detected in surface soil at maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site surface soil. In addition, cyclohexane, aluminum and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

Soil (Surface and Subsurface Soil; 0 to 15 ft bgs)

As presented in Table A.2.2 of Appendix A, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, vinyl chloride, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, copper, iron, lead, manganese, mercury, and Aroclor-1260 were detected at

maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site soil. In addition, cyclohexane, methyl cyclohexane, aluminum, and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

Soil to Indoor Air (Surface and Subsurface Soil; 0 to 15 ft bgs)

As presented in Table A.2.3 of Appendix A, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2-butanone, acetone, benzene, carbon disulfide, chlorobenzene, chloroform, cyclohexane, methyl cyclohexane, methylene chloride, tetrachloroethene, vinyl chloride, xylene (total), 2-methylnaphthalene, acetophenone, anthracene, benzaldehyde, benzo(b)fluoranthene, chrysene, fluoranthene, hexachlorobenzene, naphthalene, nitrobenzene, phenanthrene, pyrene, and mercury were identified as COPCs for the soil to indoor air pathway at the Site. There are no applicable screening criteria for this pathway; thus, all volatile chemicals, as defined by USEPA (2002b), with a detection frequency greater than 5 percent were identified as COPCs.

Groundwater to Indoor Air

As presented in Table A.2.4 of Appendix A, 1,1-dichloroethene, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, toluene, trichloroethene, vinyl chloride, 2-chlorophenol, hexachloroethane, naphthalene, and mercury were detected at maximum concentrations greater than the screening criteria for groundwater developed by USEPA (2002b). As a result, these chemicals were identified as COPCs for Site groundwater. In addition, cyclohexane was retained as a COPC due to a lack of appropriate criterion.

3.3.2 RECREATIONAL LAND USE SCENARIO

Note again that the recreational land use scenario is being developed based on the assumption that the Site will be redeveloped as either a soccer field or a golf course. This, in fact, represents only two potential recreational scenarios for the Site. The Site may alternatively be developed as baseball diamonds, or other recreational space. However, for the purpose of the current work, and as two examples of the potential development of the Site for recreational land use, the development of the Site as a soccer field or as a golf course are considered herein.

Surface Soil (0 to 2 ft bgs) – Soccer Player (Child) and Golfer (Child and Adult) Exposure

As presented in Table B.2.1 of Appendix B, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, hexachlorobenzene, indeno(1,2,3-cd)pyrene, antimony, arsenic, beryllium, copper, iron, lead, manganese, mercury, nickel, thallium, vanadium, zinc, and Aroclor-1260 were detected in surface soil at maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site surface soil based on the potential soccer player or golfer receptor. In addition, cyclohexane, aluminum, and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

Surface Soil (0 to 2 ft bgs) – Golf Course Employee Exposure

As presented in Table B.2.2 of Appendix B, benzo(a)pyrene, arsenic, copper, iron, lead, manganese, mercury, and Aroclor-1260 were detected in surface soil at maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site surface soil based on the potential golf course employee receptor. In addition, cyclohexane, aluminum, and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

Soil (Surface and Subsurface Soil; 0 to 15 ft bgs)

As presented in Table B.2.3 of Appendix B, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, vinyl chloride, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, copper, iron, lead, manganese, mercury, and Aroclor-1260 were detected at maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site soil. In addition, cyclohexane, methyl cyclohexane, aluminum, and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

Soil to Indoor Air (Surface and Subsurface Soil; 0 to 15 ft bgs)

As presented in Table B.2.4 of Appendix B, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2-butanone, acetone, benzene, carbon disulfide, chlorobenzene, chloroform, cyclohexane, methyl cyclohexane, methylene chloride, tetrachloroethene, vinyl chloride, xylene (total), 2-methylnaphthalene, acetophenone, anthracene, benzaldehyde, benzo(b)fluoranthene, chrysene, fluoranthene, hexachlorobenzene, naphthalene, nitrobenzene, phenanthrene, pyrene, and mercury were identified as COPCs for the soil to indoor air pathway at the Site. There are no applicable screening criteria for this pathway; thus, all volatile chemicals, as defined by USEPA (2002b), with a detection frequency greater than 5 percent were identified as COPCs.

Groundwater to Indoor Air

As presented in Table B.2.5 of Appendix B, 1,1-dichloroethene, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, toluene, trichloroethene, vinyl chloride, 2-chlorophenol, hexachloroethane, naphthalene, and mercury were detected at maximum concentrations greater than the screening criteria for groundwater developed by USEPA (2002b). As a result, these chemicals were identified as COPCs for Site groundwater. In addition, cyclohexane was retained as a COPC due to a lack of appropriate criterion.

3.3.3 VACANT (LAWN MAINTENANCE ONLY) SCENARIO

Surface Soil (0 to 2 ft bgs)

As presented in Table C.2.1 of Appendix C, benzo(a)pyrene, arsenic, copper, iron, lead, manganese, mercury, and Aroclor-1260 were detected in surface soil at maximum concentrations greater than the applicable screening criteria. As a result, these chemicals were identified as COPCs for Site surface soil. In addition, cyclohexane, aluminum, and cobalt were retained as COPCs due to a lack of appropriate screening criteria.

4.0 EXPOSURE ASSESSMENT

Exposure is defined as the contact of a receptor (i.e., person, animal, or other flora or fauna) with a chemical or physical agent. The exposure assessment is the estimation of the magnitude, frequency, duration, and routes of exposure for all potentially complete pathways, as identified in the CSMs (see Section 3.2). As indicated in Section 3.1.3, three different exposure scenarios are considered for the Site, based on the current land use and potential future land uses of the Site, including:

- Industrial Land Use;
- Recreational Land Use; and
- Vacant (Lawn Maintenance Only).

The following sections present the potentially complete exposure pathways for each exposure scenario, based on the CSMs and identification of Site COPCs.

4.1 EXPOSURE SCENARIOS AND COMPLETED EXPOSURE PATHWAYS

Based on the current/future conditions of the Site and the results of the media-specific screening presented in Section 3.3.1, human exposure pathways were identified in the HHRA as indicated below.

4.1.1 INDUSTRIAL LAND USE SCENARIO

The exposure scenarios and pathways that were to be considered in the development of SSSs under the Industrial Land Use scenario are summarized in Table A.1.1 of Appendix A. The Conceptual Site Model shown on Figure 3.1 presents a summary of the exposure media, exposure pathways, exposure routes, and exposed receptors considered in the development of SSSs for this scenario. Note that the groundwater to ambient air pathway is potentially complete for the industrial worker, construction/utility worker, and trespasser in this scenario; however, groundwater to ambient air exposures are generally considered *de minimis* for surface receptors since the volatile chemicals are significantly diluted upon release to ambient air. Subsequently, SSSs were not developed for groundwater based on the groundwater to ambient air pathway at the Site. The following Site media and potential human exposures (i.e., complete pathways) have been considered in the development of SSSs for the Industrial Land Use scenario:

(1) Surface Soil – Current/Future Condition:

- Dermal contact with surface soil by trespasser and industrial worker; and
- Incidental ingestion of surface soil by trespasser and industrial worker.

(2) Soil (surface and subsurface) – Future Condition:

- Dermal contact with soil by construction/utility worker; and
- Incidental ingestion of soil by construction/utility worker.

(3) Ambient Air – Current/Future Condition:

- Inhalation of airborne particulate and vapors originating from surface soil by trespasser and industrial worker; and
- Inhalation of airborne particulate and vapors originating from soil by construction/utility worker.

(4) Indoor Air - Current/Future Condition:

- Inhalation of airborne vapors originating from soil or groundwater by industrial worker.

Descriptions of each of these potential exposure scenarios are presented in Section 4.2.

4.1.2 RECREATIONAL LAND USE SCENARIO

The recreational land use scenario is being developed based on the assumption that the Site will be redeveloped as either a soccer field or a golf course. The Site may alternatively be developed as baseball diamonds, or other recreational space. However, for the purpose of the current work, and as examples of the potential development of the Site for recreational land use, the development of the Site as either a soccer field or a golf course is considered herein.

The exposure scenarios and pathways that were to be considered in the development of SSSs under the Recreational Land Use scenario are summarized in Table B.1.1 of Appendix B. The Conceptual Site Model shown on Figure 3.2 presents a summary of the exposure media, exposure pathways, exposure routes, and exposed receptors considered in the development of SSSs for this scenario. Again, the groundwater to ambient air pathway is potentially complete for the golfer and golf course employee in this scenario; however, groundwater to ambient air exposures are generally considered *de minimis* for surface receptors. Subsequently, SSSs have not been developed for groundwater based on the groundwater to ambient air pathway at the Site. The

following Site media and potential human exposures (i.e., complete pathways) were considered in the development of SSSs for the Recreational Land Use scenario:

(1) Surface Soil – Future Condition:

- Dermal contact with surface soil by soccer player, golfer, and golf course employee; and
- Incidental ingestion of surface soil by soccer player, golfer, and golf course employee.

(2) Soil (surface and subsurface) – Future Condition:

- Dermal contact with soil by construction/utility worker; and
- Incidental ingestion of soil by construction/utility worker.

(3) Ambient Air – Future Condition:

- Inhalation of airborne particulate and vapors originating from surface soil by soccer player, golfer, and golf course employee; and
- Inhalation of airborne particulate and vapors originating from soil by construction/utility worker.

(4) Indoor Air - Future Condition:

- Inhalation of airborne vapors originating from soil or groundwater by golfer and golf course employee.

Descriptions of each of these potential exposure scenarios are presented in Section 4.2. Note that although the soil and groundwater to indoor air exposure pathways are potentially complete for the soccer player, golfer, and golf course employee, this pathway has only been evaluated for the golf course employee as this receptor will experience the greatest potential exposure and will thus be most sensitive receptor.

4.1.3 VACANT (LAWN MAINTENANCE ONLY) SCENARIO

The exposure scenarios and pathways that have been considered in the development of SSSs under the Vacant (Lawn Maintenance Only) scenario are summarized in Table C.1.1 of Appendix C. The Conceptual Site Model shown on Figure 3.3 presents a summary of the exposure media, exposure pathways, exposure routes, and exposed receptors considered in the development of SSSs for this scenario. Once again, the groundwater to ambient air pathway is potentially complete for the trespasser and lawn maintenance staff in this scenario; however, groundwater to ambient air exposures are generally considered *de minimis* for surface receptors and groundwater SSSs have not

been developed based on the groundwater to ambient air pathway. The following Site media and potential human exposures (i.e., complete pathways) have been considered in the development of SSSs for the Vacant (Lawn Maintenance Only) scenario:

(1) Surface Soil – Future Condition:

- Dermal contact with surface soil by trespasser and lawn maintenance staff; and
- Incidental ingestion of surface soil by trespasser and lawn maintenance staff.

(2) Ambient Air – Future Condition:

- Inhalation of airborne particulate and vapors originating from surface soil by trespasser and lawn maintenance staff.

Descriptions of each of these potential exposure scenarios are presented in Section 4.2.

4.2 QUANTIFICATION OF EXPOSURE

To quantify exposure, potential exposure scenarios were developed using guidance presented in the following USEPA documents:

(i) USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

(ii) USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.

(iii) USEPA, 1997: Exposure Factors Handbook. Volume 1: General Factors. EPA/600/P-95/002Fa, August 1997.

(iv) USEPA, 2002c: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

(v) USEPA, 2004a: RAGs Volume 1, Human Health Evaluation Manual, Part E; Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

In instances where USEPA documents did not present necessary factors, or where more appropriate scientific data were not available, professional judgment was applied to develop conservative assumptions which are representative of the Reasonable Maximum Exposure (RME) and are protective of human health. As the current work is directed only to the development of SSSs for Site media, and not to the calculation of

hazard and risk, only RME assumptions are presented. The RME are conservative assumptions that generally utilize the 90th to 95th percentile assumptions, depending upon available data. For each land use scenario, the exposure assumptions are presented in the respective appendix, with the related data tables.

4.2.1 GENERIC ESTIMATION OF INTAKE

In a full HHRA, exposure estimates are calculated to reflect chemical concentration, contact rate, exposure time, and body weight in a term called "intake" or "dose". A generic equation for calculating chemical intake (USEPA, 1989) is:

$$I = \frac{C \times CR \times EF \times ED \times CF}{BW \times AT}$$

Where:

I = Chemical intake (mg/kg body weight/day);

C = Chemical concentration (e.g., mg/kg for soil);

CR = Contact rate (e.g., mg soil/day);

EF = Exposure frequency (days/year);

ED = Exposure duration (years);

CF = Conversion factors as appropriate (e.g., kg/mg);

BW = Body weight (kg); and

AT = Averaging time (period over which exposure is averaged, e.g., days).

For carcinogens, an averaging time (AT) of 70 years is used to prorate the total cumulative intake over a lifetime. For non-carcinogens, the averaging time is selected based on the toxic endpoint being assessed.

In the development of SSSs, this generic equation is combined with a target risk or target hazard level, and calculated in reverse to produce a target chemical concentration, or SSS, for the media of interest. The USEPA acceptable cancer risk range is 1E-06 to 1E-04, and acceptable hazard level is 1.0. Thus, for the purpose of developing human health based SSSs for the Site, a target cumulative cancer risk of 1.0E-05 and target cumulative hazard of 1.0 has been applied. The SSSs will be developed following USEPA RAGS Part B (USEPA, 1991b), and relevant updated documents.

4.2.2 EXPOSURE SCENARIO ASSUMPTIONS

Different exposure assumptions were developed for each receptor population evaluated in the HHRA process. Through the generic screening criteria process, COPCs have been identified in surface soil, soil, and groundwater. Based on the current and potential future land uses of the Site, three exposure scenarios, and thus, three sets of potential receptors, have been identified for the Site, as follows:

Scenario 1: Industrial Land Use	*Scenario 2: Recreational Land Use*	*Scenario 3: Vacant (Lawn Maintenance Only)*
Trespasser	Soccer Player	Trespasser
Industrial Worker	Golfer	Lawn Maintenance Staff
Construction/Utility Worker	Construction/Utility Worker	
	Golf Course Employee	

The exposure assumptions for each of these scenarios, and receptors, are presented below.

4.2.2.1 INDUSTRIAL LAND USE

The receptors for the Industrial Land Use scenario include a trespasser, industrial worker, and construction/utility worker. This scenario assumes that continued future industrial use of the Site does not involve any major re-development activities. The exposure assumptions applied to each Industrial Land Use receptor for each relevant media are provided in Appendix A, as indicated below:

Medium	*Receptor*	*Exposure Route*	*Appendix A Table Reference*
Surface Soil/ Ambient Air	Current/Future Trespasser	Incidental Ingestion Dermal Contact Inhalation	A.4.1
	Current/Future Industrial Worker	Incidental Ingestion Dermal Contact Inhalation	A.4.2
Soil (surface and subsurface)/ Ambient Air	Future Construction/Utility Worker	Incidental Ingestion Dermal Contact Inhalation	A.4.3
Indoor Air	Current/Future Industrial Worker	Inhalation	A.4.4

The exposure assumptions presented in Tables A.4.1 to A.4.4 of Appendix A that will be applied in the development of SSSs are summarized below:

Exposure Factor	*Units*	*Trespasser*	*Industrial Worker*	*Construction/ Utility Worker*
Soil Ingestion Rate (a)	mg/day	100	100	330
Ingestion Absorption Factor (b)	%/100	1	1	1
Skin Surface Area (a)	cm^2	3,688 (c)	3,300	3,300
Soil-Skin Adherence Factor (a)	mg/cm^2	0.4	0.2	0.3
Dermal Absorption Factor (d, e)	%/100	Chemical specific	Chemical specific	Chemical specific
Exposure Frequency	days/year	28 (f)	250 (e)	250 (a)
Fraction of Time Exposed	unitless	4/24 (f)	8/24 (g)	8/24 (g)
Exposure Duration	years	10 (h)	25 (e)	1 (a)
Body Weight (a)	kg	50 (c)	70	70
Carcinogenic Averaging Time (i)	days	25,550	25,550	25,550
Non-Carcinogenic Averaging Time (i)	days	3,650	9,125	365
Particulate Emission Factor (j)	m^3/kg	5.25E+08	5.25E+08	7.10E+06
Volatilization Factor (k)	m^3/kg	Chemical specific	Chemical specific	Chemical specific

Notes:

(a) USEPA, 2002c: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

(b) Professional Judgment: assumes 100 percent absorption for conservatism.

(c) USEPA, 1997: Exposure Factors Handbook. Volume 1: General Factors. EPA/600/P-95/002Fa. August 1997. Tables 6-6 and 6-7: skin surface area is the average of 13- to 14-year old mean total surface areas assuming 25 percent of total body area is exposed. Table 7-3: body weight is the average of 13-year old mean body weights.

(d) USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.

(e) USEPA, 2004a: RAGs Volume 1, Human Health Evaluation Manual, Part E; Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

(f) Professional Judgment: assumes adolescent will trespass for 4 hours per 24 hours, 1 day/week from April to October (6 months).

(g) Professional Judgment: assumes an 8-hour work day, thus 8 out of 24 hours spent at the Site.

(h) Professional Judgment: assumes a trespasser is a 9- through 18-year old, therefore the exposure duration is 10 years.

(i) USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

(j) For the particulate emission factor for the trespasser and industrial worker, see Table A.4.5 of Appendix A. For the particulate emission factor for the construction/utility worker, see Table A.4.6 of Appendix A.

(k) For the volatilization factors for the trespasser and industrial worker, see Table A.4.7 of Appendix A. For the volatilization factors for the construction/utility worker, see Table A.4.8 of Appendix A.

4.2.2.2 RECREATIONAL LAND USE

The recreational land use scenario is being developed based on the assumption that the Site will be redeveloped as either a soccer field or a golf course. The Site may alternatively be developed as baseball diamonds, or other recreational space. However, for the purpose of the current work, the development of the Site as either a soccer field or a golf course is considered and the receptors associated with these recreational land uses are included in the HHRA.

The receptors for the Recreational Land Use scenario include a child soccer player, a child golfer, an adult golfer, a golf course employee, and a construction/utility worker. This scenario assumes that converting the Site into a soccer field or golf course would not involve any major subsurface excavation activities. The exposure assumptions applied to each Recreational Land Use receptor for each relevant media are provided in Appendix B, as indicated below:

Medium	*Receptor*	*Route*	*Appendix B Table Reference*
Surface Soil/ Ambient Air	Future Child Soccer Player	Incidental Ingestion Dermal Contact Inhalation	B.4.1
	Future Child Golfer	Incidental Ingestion Dermal Contact Inhalation	B.4.2
	Future Adult Golfer	Incidental Ingestion Dermal Contact Inhalation	B.4.3
	Future Golf Course Employee	Incidental Ingestion Dermal Contact Inhalation	B.4.4
Soil (surface and subsurface)/ Ambient Air	Future Construction/Utility Worker	Incidental Ingestion Dermal Contact Inhalation	B.4.5
Indoor Air	Future Golf Course Employee	Inhalation	B.4.6

Soccer player and golfer exposure to indoor air may also occur under this land use scenario; however, indoor air exposure has only been evaluated for the golf course employee as this receptor will experience the greatest potential exposure and will thus be most sensitive to this medium.

The exposure assumptions presented in Tables B.4.1 to B.4.6 of Appendix B that will be applied in the development of SSSs are summarized below:

Exposure Factor	*Units*	*Child Soccer Player*	*Child Golfer*	*Adult Golfer*	*Golf Course Employee*	*Construction/ Utility Worker*
Soil Ingestion Rate (a)	mg/day	200	200	100	100	330
Ingestion Absorption Factor (b)	%/100	1	1	1	1	1
Skin Surface Area (a)	cm^2	2,938 (c)	2,938 (c)	3,300	3,300	3,300
Soil-Skin Adherence Factor (a)	mg/cm^2	0.3 (r)	0.2	0.2	0.2	0.3
Dermal Absorption Factor (d, e)	%/100	Chemical specific	Chemical specific	Chemical specific	Chemical specific	Chemical specific
Exposure Frequency	days/year	54 (f)	52 (g)	130 (h)	217 (i)	250 (a)
Fraction of Time Exposed	unitless	2/24 (j)	5/24 (k)	5/24 (k)	8/24 (l)	8/24 (l)
Exposure Duration	years	11 (m)	11 (m)	30 (n)	25 (d)	1 (a)
Body Weight (a)	kg	39 (c)	39 (c)	70	70	70
Carcinogenic Averaging Time (o)	days	25,550	25,550	25,550	25,550	25,550
Non-Carcinogenic Averaging Time (o)	days	4,015	4,015	10,950	9,125	365
Particulate Emission Factor (p)	m^3/kg	5.25E+08	5.25E+08	5.25E+08	5.25E+08	7.10E+06
Volatilization Factor (q)	m^3/kg	Chemical specific	Chemical specific	Chemical specific	Chemical specific	Chemical specific

Notes:

(a) USEPA, 2002c: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

(b) Professional Judgment: assumes 100 percent absorption for conservatism.

(c) USEPA, 1997: Exposure Factors Handbook. Volume 1: General Factors. EPA/600/P-95/002Fa. August 1997. Tables 6-6 and 6-7: skin surface area is the average of 10-to 11-year old mean total surface areas assuming 25 percent of total body area is exposed. Table 7-3: body weight is the average of 10- to 11-year old mean body weights.

(d) USEPA, 2004a: RAGS Volume 1, Human Health Evaluation Manual, Part E; Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

(e) USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.

(f) Professional Judgment: assumes child soccer player plays twice a week from May to October (27 weeks).

(g) Professional Judgment: assumes child golfer golfs 1 times per week from February to June (21 weeks) and September to November (13 weeks), and 2 times per week from July to August (9 weeks).

(h) Professional Judgment: assumes adult golfer golfs 3 times per week for 10 months of the year.

(i) Professional Judgment: assumes golf course employee works 5 days a week for 10 months of the year.

(j) Professional Judgment: assumes soccer player spends 2 hours per day (i.e. 2 out of 24 hours) playing soccer.

(k) Professional Judgment: conservatively assumes 5 hours per day (i.e., 5 out of 24 hours) spent at the golf course.

(l) Professional Judgment: assumes an 8-hour work day (i.e., 8 out of 24 hours spent working).

(m) Professional Judgment: assumes child soccer player/golfer is a 6- through 16-year old, therefore the exposure duration is 11 years.

(n) Professional Judgment: conservatively assumes adult golfer resides in the same area for 30 years, and frequents the same golf course over this time period.

(o) USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

(p) For the particulate emission factor for the child soccer player, child golfer, adult golfer, and golf course employee, see Table B.4.7 of Appendix B. For the particulate emission factor for the construction/utility worker, see Table B.4.8 of Appendix B.

(q) For the volatilization factors for the child soccer player, child golfer, adult golfer, and golf course employee, see Table B.4.9 of Appendix B. For the volatilization factors for the construction/utility worker, see Table B.4.10 of Appendix B.

(r) Soil to skin adherence factor is for Soccer Player #1 in moist conditions.

4.2.2.3 VACANT (LAWN MAINTENANCE ONLY)

The receptors for the Vacant (Lawn Maintenance Only) scenario include a trespasser and a person conducting lawn maintenance (i.e., mowing the lawn). This exposure scenario assumes all Site buildings are dismantled and the Site is left vacant. The only activity at the Site is occasional lawn mowing. The exposure assumptions applied to each Vacant (Lawn Maintenance Only) receptor for each relevant media are provided in Appendix C, as indicated below:

Medium	*Receptor*	*Route*	*Appendix C Table Reference*
Surface Soil/ Ambient Air	Future Trespasser	Incidental Ingestion Dermal Contact Inhalation	C.4.1
	Future Lawn Maintenance Staff	Incidental Ingestion Dermal Contact Inhalation	C.4.2

The exposure assumptions presented in Tables C.4.1 to C.4.2 of Appendix C that will be applied in the development of SSSs are summarized below:

Exposure Factor	*Units*	*Trespasser*	*Lawn Maintenance Staff*
Soil Ingestion Rate (a)	mg/day	100	100
Ingestion Absorption Factor (b)	%/100	1	1
Skin Surface Area	cm^2	3,688 (c)	3,300 (a)
Soil-Skin Adherence Factor (a)	mg/cm^2	0.4	0.2
Dermal Absorption Factor (d, e)	%/100	Chemical specific	Chemical specific
Exposure Frequency	days/year	28 (f)	35 (g)
Fraction Time Exposed	unitless	4/24 (f)	4/24 (h)
Exposure Duration	years	10 (i)	25 (d)
Body Weight	kg	50 (c)	70 (a)
Carcinogenic Averaging Time (j)	days	25,550	25,550
Non-Carcinogenic Averaging Time (j)	days	3,650	9,125
Particulate Emission Factor (k)	m^3/kg	5.25E+08	5.25E+08
Volatilization Factor (l)	m^3/kg	Chemical specific	Chemical specific

Notes:

(a) USEPA, 2002c: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

(b) Professional Judgment: assumes 100 percent absorption for conservatism.

(c) USEPA, 1997: Exposure Factors Handbook. Volume 1: General Factors. EPA/600/P-95/002Fa. August. Tables 6-6 and 6-7: skin surface area is the average of 13- to 14-year old mean total surface areas assuming 25 percent of total body area is exposed. Table 7-3: body weight is the average of 13-year old mean body weights.

(d) USEPA, 2004a: RAGs Volume 1, Human Health Evaluation Manual, Part E; Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

(e) USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.

(f) Professional Judgment: assumes adolescent will trespass for 4 hours per 24 hours, 1 day/week from April to October.

(g) Professional Judgment: assumes lawn is mowed once per week for 8 months of the year.

(h) Professional Judgment: assumes 4 hours is spent at the Site mowing the lawn per visit.

(i) Professional Judgment: assumes a trespasser is a 9- through 18-year old, thus the exposure duration is 10 years.

(j) USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

(k) For the particulate emission factor for the trespasser and lawn maintenance staff, see Table C.4.3 of Appendix C.

(l) For the volatilization factors for the trespasser and lawn maintenance staff, see Table C.4.4 of Appendix C.

4.3 DERIVATION OF NON-CARCINOGENIC STANDARD FOR LEAD

The best available quantitative tool for determining risks associated with non-residential adult exposures to lead-impacted soil is primarily based on the USEPA report titled: "Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil" (dated January 2003).

The derivation of risk-based SSSs for lead in soil at any site is largely dependent on the present and expected future land use of the site. Under the Industrial Land Use scenario, soil SSSs were developed for the industrial worker and the construction/utility worker. SSSs were not developed for the trespasser, as the SSSs for the industrial worker and/or construction/utility worker would be protective of the trespassers infrequent exposure to Site COPCs. Under the Recreational Land Use scenario, SSSs were developed based on the adult golfer, golf course employee, and the construction/utility worker. SSSs were not developed for the child golfer or child soccer player, as the SSSs developed for the adult golfer would be protective of the child exposures. SSSs were not developed for the Vacant (Lawn Maintenance Only) scenario as exposure to Site soil is expected to be very limited. The soil SSSs for lead for all of the aforementioned receptors were developed using the TRW Adult Exposure Equation Model.

4.3.1 ADULT EXPOSURE EQUATION

The TRW has indicated that the Adult Exposure Equation is a suitable and appropriate model for assessing adult exposures to lead in soils. The Adult Exposure Equation recommended for use by the TRW is as follows:

$$SSS = \frac{(PbB_{adult,central,goal} - PbB_{adult,0}) \bullet AT}{(BKSF \bullet IR_s \bullet AF_s \bullet EF_s)}$$

Where:

SSS = Site-Specific Standard for lead (µg/g);

$PbB_{adult,central,goal}$ = Goal for central estimate of blood lead concentration (µg/dL) in adults (i.e., women of childbearing age) that have Site exposures.

The goal is intended to ensure that $PbB_{95fetal}$ does not exceed 10 µg/dL;

$PbB_{adult,0}$	=	Typical lead concentration (µg/g) (appropriate average concentration for individual);
AT	=	Averaging Time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures;
$BKSF$	=	Biokinetic Slope Factor (µg/dL blood lead increase per µg/day lead uptake);
IR_s	=	Ingestion Rate of soil (g/day);
EF_s	=	Exposure Frequency for contact with assessed soils (days/yr); and
AF_s	=	Absolute Absorption Fraction of lead in soil.

The basis for the SSS calculation is the relationship between the soil lead concentration and the blood lead concentration in the developing fetus of adult women that have Site exposures. The relationship between the blood lead concentration in adult women and the corresponding 95th percentile fetal blood lead concentration ($PbB_{95,\ fetal}$), assuming that $PbB_{adult,\ centrall}$ reflects the geometric mean of a lognormal distribution of blood lead concentrations in women of child-bearing age, can be described by the following equation:

$$PbB_{adult,central,goal} = \frac{PbB_{95\ fetal}}{GSD_{i,adult}^{1.645} \bullet R_{fetal\ /\ maternal}}$$

Where:

$PbB_{95,\ fetal}$	=	95th percentile target blood lead (PbB) concentration in the fetus (µg/dL);
$R_{fetal\ /\ maternal}$	=	mean ratio of fetal to maternal PbB;
$GSD_{i,adult}$	=	individual Geometric Standard Deviation, an exponent of 1.645 represents the standard normal deviate used to calculate the 95th percentile from a lognormal distribution of blood lead concentration.

4.3.2 ADULT EXPOSURE EQUATION INPUT PARAMETERS

The basis for selection of input parameters for the above model is discussed below.

- 95th Percentile Blood Lead (PbB) Concentration in the Fetus ($PbB_{95fetal}$ in µg/dL):

  USEPA has also applied a value of 10 µg/dL as a target level that is protective for fetuses of pregnant women. Therefore, the value of 10 µg/dL was used in the modeling.

- Mean Ratio of Fetal to Maternal PbB ($R_{fetal/maternal}$):

  Various studies have estimated an average fetal-to-maternal PbB ratio of 0.9 based on a weight of evidence approach. This value has also been used by USEPA in applying the Adult Exposure Model. Therefore, the value of 0.9 for was used in the modeling.

- Individual Geometric Standard Deviation ($GSD_{i,adult}$):

  This parameter is used to assess variability in blood lead concentrations among different individuals. Few data are available regarding GSD values reflecting individual variability. Instead, GSD values reflecting community variability (which would be expected to be greater than individual variability) are frequently applied to estimate individual variability. A value for GSD of 2.18 was selected for use in this modeling based on the TRW Lead guidance assuming a heterogeneous population. A value for GSD of 2.11 was therefore conservatively applied in the modeling, consistent with the estimated GSD of blood lead concentration in U.S. women, aged 17-45 (all regions) (USEPA, 2002d);

- Baseline PbB Value ($PbB_{adult,0}$):

  This parameter is specific to the population in the area of interest. Therefore, published reference data were used to determine a representative value. A value of 1.53 µg/dL, corresponding to the estimated geometric mean blood lead concentration in U.S. women aged 17-45 (all regions), was chosen for this input parameter based on TRW Lead guidance (USEPA, 2002d);

- Biokinetic Slope Factor (BKSF in µg/dL per µg/day):

  The TRW adopted a BKSF of 0.4, derived for the baseline human health risk assessment for the California Gulch Superfund Site. Therefore, the default value of 0.4 for the parameter BKSF was used in the modeling (USEPA, 2003);

- Soil Absolute Absorption Fraction of Lead (AF_s):

  The TRW uses 12 percent (12%) as the absorbed fraction of lead from soil and dust for adults, based on an absorption factor for soluble lead of 0.20 and a relative bioavailability of 0.6 (soil/soluble).

- Soil Ingestion Rate (IRs in g/day):

  A soil ingestion rate of 0.1 g/day was applied for the industrial worker, adult golfer, and golf course employee, and a soil ingestion rate of 0.33 g/day was applied for the construction/utility worker (USEPA, 2002c).

- Soil Exposure Frequency (EFs in days/yr):

  For the future adult golfer, an exposure frequency of 130 days/year, or 3 days per week for 10 months of the year, was used as the average exposure in the modeling. For the future golf course employee, an exposure frequency of 217 days/year, or five work days per week for 10 months of the year, was used as the average exposure in the modeling. For the current/future industrial worker and the future construction/utility worker, an exposure frequency of 250 days/year was applied as the average exposure in the modeling (USEPA, 2002c); and

- Averaging Time (AT in days):

  The TRW applies a default value of 365 days/year based on the average time spent at work by both full-time and part-time workers which were applied for the golfers and outdoor employees.

The derivations of SSSs for lead in soil that are protective of ingestion exposure by industrial workers and construction/utility workers under the Industrial Land Use scenario, and adult golfers, golf course employees, and construction/utility workers under the Recreational Land Use scenario are presented in Tables A.7.7 and B.7.9, respectively. As indicated in Tables A.8.1, A.8.2, B.8.1, and B.8.2, the arithmetic mean lead concentrations in surface soil and soil are below the lead SSSs for all receptors and all exposure scenarios.

5.0 TOXICITY ASSESSMENT

The toxicity assessment weighs the available evidence regarding the potential for a particular COPC to cause adverse effects in exposed individuals and estimates the extent of exposure and possible severity of adverse effects. To develop toxicity values, two steps are taken: hazard identification and dose-response assessment. The hazard identification determines the potential adverse effects associated with exposure to a COPC. In the dose-response assessment, numerical toxicity values are determined or selected from the available toxicity data.

In the selection of toxicity values, preference has been given to the most recently developed values because these would incorporate the most recent toxicological information and would provide the best basis upon which to assess potential health hazards/risks. Toxicity values were primarily obtained from the USEPA IRIS (Integrated Risk Information System) database, Health Effects Assessment Summary Table (HEAST), peer-reviewed toxicity values from the Region III Risk-Based Concentration (RBC) Table, and NCEA provisional data as presented on the USEPA Region IX PRG table. Note that for tetrachloroethene (PCE) and trichloroethene (TCE), the current provisional toxicity data are under review and have not been accepted by USEPA. For this reason, SSSs for PCE and TCE will be developed, where appropriate, based on both the formerly accepted toxicity data for these compounds, and the current provisional toxicity data.

Note that toxicity data were selected for all identified COPCs for inclusion in the HHRA, although mercury and chlorobenzenes are expected to be the primary chemicals of concern in the HHRA.

5.1 TOXICITY INFORMATION FOR NON-CARCINOGENIC HAZARDS

For substances suspected to cause non-carcinogenic chronic effects, the health criteria are usually expressed as chronic intake levels below which no adverse effects are expected. In other words, there is a level of exposure to a chemical below which no toxic effects are expected. In contrast to the toxicological model used to assess carcinogenic risk, which assumes no concentration threshold, the non-carcinogenic dose-response model postulates a "threshold". The chronic intake levels are referred to as Reference Doses (RfDs) [in units of mg/(kg-day)] for the ingestion and dermal exposure routes, and Reference Concentrations (RfCs) (in units of mg/m^3) for the inhalation exposure route.

In this risk assessment, chronic RfDs and RfCs are used as the toxicity values for non-carcinogenic health effects. A chronic RfD or RfC is an estimate (with an uncertainty spanning an order of magnitude or greater) of a daily exposure level for the human population, including sensitive sub-populations, which poses no appreciable risk of deleterious effects over a lifetime of exposure. Uncertainty factors are incorporated into the RfDs and RfCs to account for extrapolations from animal toxicity data, data quality, and to protect sensitive sub-populations. The basis of a RfD or RfC is usually the highest dose or concentration administered to laboratory animals that did not cause observable adverse effects after chronic (usually lifetime) exposure. This is called the No-Observed Adverse Effect Level (NOAEL). The NOAEL is then divided by an uncertainty factor, and sometimes an additional modifying factor, to obtain the RfD or RfC. In general, an uncertainty factor of 10 is used to account for interspecies variation and another factor of 10 is used to account for sensitive human populations. Additional factors of 10 are included in the uncertainty factor if the RfD or RfC is based on the Lowest-Observed Adverse Effect Level (LOAEL) instead of the NOAEL, or if data inadequacies are present (e.g., the experiment for which the RfD or RfC was derived had less than lifetime exposure). The LOAEL is the dose level administered to laboratory animals that causes the lowest adverse effect (i.e., liver toxicity – although this is species and chemical-specific) after chronic exposure.

A summary of the RfDs used to estimate non-carcinogenic human health effects for oral and dermal exposure routes, and the RfCs used to estimate non-carcinogenic human health effects for the inhalation exposure route, for all three exposure scenarios are presented in the tables referenced below:

Scenario	*Toxicity Data*	*Exposure Route*	*Appendix*	*Appendix Table Reference*
Industrial Land Use	RfD	Ingestion Dermal contact	A	A.5.1
	RfC	Inhalation	A	A.5.2
Recreational Land Use	RfD	Ingestion Dermal contact	B	B.5.1
	RfC	Inhalation	B	B.5.2
Vacant (Lawn Maintenance Only)	RfD	Ingestion Dermal contact	C	C.5.1
	RfC	Inhalation	C	C.5.2

Note that lead was also identified as a COPC in Site surface soil and soil, although toxicity data have not been presented for lead in the aforementioned tables. The best available method for determining hazards associated with non-residential adult exposures to lead-impacted soil is based on the adult lead exposure equation as presented in the USEPA document "Recommendations of the Technical Review Workgroup (TRW) for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil" (USEPA, 2003). As such, the Adult Lead Model presented in USEPA (2003) has been applied to develop SSSs for lead in Site surface soil and soil.

5.2 TOXICITY INFORMATION FOR CARCINOGENIC RISKS

Cancer Slope Factors (CSFs) and Unit Risk Factors (URFs) are quantitative risk estimates of carcinogenic potency. Slope factors relate the lifetime probability of excess cancers to the lifetime average exposure dose of a substance. CSFs and URFs are estimated using mathematical extrapolation models, most commonly the linearized multistage (LMS) model, and are presented as risk per mg/(kg-day) (i.e., mg carcinogen per kg body weight per day) and risk per $\mu g/m^3$. These models assume low dose-response linearity and thus may not be appropriate for some suspect carcinogens, in particular those that function as promoters. As well, the body's natural repair processes and defense mechanisms may decrease cancer risk at low exposure levels. Thus, the risks at lower exposure levels are likely overestimated using the LMS model. When adequate human epidemiology data are available, maximum likelihood estimates (MLEs) of model parameters are used to generate a CSF or URF. When only animal data are available, the CSF or URF is derived from the largest possible linear slope that is consistent with the data (within the upper 95 percent confidence limit). In other words, the true risk to humans, while not identifiable, is not likely to exceed the upper-bound estimate. This is a conservative estimate, and in some cases a linear slope of zero may be as appropriate for the data (i.e., no carcinogenic risk).

Known or suspect human carcinogens have been evaluated and identified by the Carcinogen Assessment Group using the USEPA Weight-of-Evidence approach for carcinogenicity classification (HEAST, 1997). The USEPA classification is based on an evaluation of the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human and animal studies as follows:

Group A - Known Human Carcinogen (sufficient evidence of carcinogenicity in humans);

Group B - Probable Human Carcinogen (B1 – limited evidence of carcinogenicity in humans; B2 – sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans);

Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data);

Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence); and

Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in animal studies).

The COPCs were classified utilizing the USEPA system. A summary of the CSFs used to estimate the risk of cancer for oral and dermal exposure routes, and the URFs used to estimate the risk of cancer for the inhalation exposure route, for all three exposure scenarios are presented in the tables referenced below:

Scenario	*Toxicity Data*	*Exposure Route*	*Appendix*	*Appendix Table Reference*
Industrial Land Use	CSF	Ingestion Dermal contact	A	A.6.1
	URF	Inhalation	A	A.6.2
Recreational Land Use	CSF	Ingestion Dermal contact	B	B.6.1
	URF	Inhalation	B	B.6.2
Vacant (Lawn Maintenance Only)	CSF	Ingestion Dermal contact	C	C.6.1
	URF	Inhalation	C	C.6.2

The CSFs and URFs have been adjusted consistent with USEPA (2005) guidance.

5.3 SURROGATE TOXICITY DATA

A number of COPCs lack inhalation toxicity data, including 1,3-dichlorobenzene, acetone, cis-1,2-dichloroethene, 2-chlorophenol, 2-methylnaphthalene, acetophenone, anthracene, benzaldehyde, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene. The development of SSSs for these COPCs based on the indoor air inhalation exposure pathway would not be possible in the absence of appropriate toxicity data. In an effort

to account for inhalation exposure to these COPCs, a route-to-route extrapolation of toxicity data has been applied (i.e., oral toxicity data has been applied as inhalation toxicity data). This route-to-route extrapolation was only being performed for the indoor air inhalation scenario.

One COPC identified for the soil to indoor air pathway, phenanthrene, lacks any toxicity data. Toxicity data for naphthalene has been applied as surrogate data. Naphthalene provides the most conservative toxicity data for a non-carcinogenic polycyclic aromatic hydrocarbon. A summary of the toxicity data applied to estimate human health effects related to exposure to phenanthrene in the two scenarios in which it was identified as a COPC are presented in the tables referenced below:

Scenario	*Toxicity Data*	*Exposure Route*	*Appendix*	*Appendix Table Reference*
Industrial Land Use	RfD and RfC	Ingestion Dermal contact	A	A.5.3
	CSF and URF	Inhalation	A	A.6.3
Recreational Land Use	RfD and RfC	Ingestion Dermal contact	B	B.5.3
	CSF and URF	Inhalation	B	B.6.3

6.0 DERIVATION OF SITE-SPECIFIC STANDARDS

To assist risk managers in arriving at a final property use decision for the Site, Site-Specific Standards (SSSs) were developed for all COPCs identified at the Site. The following Sections 6.1, 6.2, and 6.3 present the SSSs for receptors under Industrial Land Use, Recreational Land Use, and Vacant scenarios, respectively.

The assumptions utilized in the derivation of the SSSs were previously presented in Section 4.0. In the development of SSSs, the target risk and hazard levels were utilized to back calculate soil and groundwater concentrations that are protective of human health for all receptors.

The SSSs, when compared to maximum concentrations, can be applied to provide a basis for comparing potential health risks related to different potential land use scenarios for the Site. The comparison can also be used in the development of appropriate risk management measures, as necessary. While development of SSSs does not indicate that cleanup is required, these values serve as additional information for risk managers to consider when weighing the different land development options and or cleanup options.

In order for risk managers to arrive at a final land usage decision at the Site, the available information must be weighed to arrive at a final decision regarding active remediation, management controls, etc. To assist risk managers in arriving at such a decision, SSSs were developed for all Site COPCs. The SSSs were developed for each COPC by conducting the RA process in reverse. In other words, the HQ formula was solved for the exposure concentration term by setting the HI to a specified target HI level. SSSs were developed for a target HQs of 1.0 and a target risk of 1.0E-05. Subsequently, the lower of the hazard and risk SSS was selected as the final SSS for each COPC in the various media.

6.1 INDUSTRIAL LAND USE SCENARIO

Section 6.1 presents the derivations of SSSs for each exposure scenario under an Industrial Land Use scenario, as follows:

- Trespasser surface soil exposure pathway – Section 6.1.1;
- Industrial worker surface soil exposure pathway – Section 6.1.2;
- Construction/utility worker surface and subsurface soil exposure pathway – Section 6.1.3;
- Soil to indoor air exposure pathway – Section 6.1.4; and

- Groundwater to indoor air exposure pathway – Section 6.1.5.

6.1.1 TRESPASSER EXPOSURE TO SURFACE SOIL

Table A.7.1 of Appendix A presents the calculation of the SSSs for Site COPCs for the trespasser exposure to surface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations found in Site surface soil.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
Cyclohexane	3.6E+05	2.7E-02	0 (0%)
Benzo(a)pyrene	7.1E-01	1.0E+00	8 (8.2%)
Aluminum	5.5E+06	2.0E+04	0 (0%)
Arsenic	2.1E+01	1.1E+02	1 (0.9%)
Cobalt	1.0E+05	1.8E+02	0 (0%)
Copper	2.3E+05	6.3E+03	0 (0%)
Iron	4.0E+06	1.3E+05	0 (0%)
Lead	NV	1.1E+02 (1)	0 (0%)
Manganese	2.7E+04	4.2E+03	0 (0%)
Mercury	5.8E+02	9.1E+03	9 (5.8%)
Aroclor-1260	7.4E+00	4.4E+00	0 (0%)

Note:
NV: No value.
(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum surface soil concentrations for benzo(a)pyrene, arsenic, and mercury exceeded the corresponding surface soil SSSs.

6.1.2 INDUSTRIAL WORKER EXPOSURE TO SURFACE SOIL

Table A.7.2 of Appendix A presents the calculation of the SSSs for Site COPCs for the industrial worker exposure to surface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the

maximum surface soil concentrations. The derivation of the SSS for lead in Site soil is presented separately in Table A.7.7 of Appendix A.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
Cyclohexane	3.2E+04	2.7E-02	0 (0%)
Benzo(a)pyrene	7.0E-02	1.0E+00	94 (96.9%)
Aluminum	8.8E+05	2.0E+04	0 (0%)
Arsenic	1.6E+00	1.1E+02	90 (84.9%)
Cobalt	2.3E+03	1.8E+02	0 (0%)
Copper	3.8E+04	6.3E+03	0 (0%)
Iron	6.7E+05	1.3E+05	0 (0%)
Lead (1)	5.2E+02	1.1E+02 (2)	0 (0%)
Manganese	7.2E+03	4.2E+03	0 (0%)
Mercury	6.1E+01	9.1E+03	27 (17.3%)
Aroclor-1260	7.4E-01	4.4E+00	0 (0%)

Note:

(1) Refer to Table A.7.7 of Appendix A for derivation of SSS for lead.

(2) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface soil concentrations for benzo(a)pyrene, arsenic, and mercury exceeded the corresponding surface soil SSSs.

6.1.3 CONSTRUCTION/UTILITY WORKER EXPOSURE TO SURFACE AND SUBSURFACE SOIL

Table A.7.3 of Appendix A presents the calculation of the SSSs for Site COPCs for the construction/utility worker exposure to surface and subsurface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface and subsurface soil SSSs to the maximum surface and subsurface soil concentrations. The derivation of the SSS for lead in Site soil is presented separately in Table A.7.7 of Appendix A.

The SSSs for the construction/utility worker exposure to surface and subsurface soil and the maximum surface and subsurface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
1,2,4-Trichlorobenzene	1.5E+02	1.1E+03	3 (2.1%)
1,4-Dichlorobenzene	1.3E+02	2.0E+03	5 (3.5%)
Benzene	2.4E+01	4.5E+02	4 (2.7%)
Cyclohexane	5.4E+03	3.4E-02	0 (0%)
Methyl cyclohexane	5.8E+03	5.4E-02	0 (0%)
Vinyl chloride	9.5E+00	2.9E+03	7 (6.1%)
Benzo(a)pyrene	2.1E+00	1.0E+00	0 (0%)
Bis(2-Ethylhexyl)phthalate	1.2E+03	1.3E+03	1 (0.7%)
Hexachlorobenzene	7.7E+00	8.2E+00	7 (4.5%)
Aluminum	1.0E+05	2.3E+04	0 (0%)
Arsenic	1.3E+01	1.1E+02	25 (11.2%)
Cobalt	5.6E+02	1.8E+02	0 (0%)
Copper	1.2E+04	6.3E+03	0 (0%)
Iron	2.1E+05	1.3E+05	0 (0%)
Lead (1)	1.6E+02	7.4E+01 (2)	0 (0%)
Manganese	1.1E+03	4.2E+03	2 (0.9%)
Mercury	1.1E+01	9.1E+03	118 (36.7%)
Aroclor-1260	7.6E+00	4.4E+00	0 (0%)

Note:

(1) Refer to Table A.7.7 of Appendix A for derivation of SSS for lead.

(2) Arithmetic mean lead concentration in Site surface and subsurface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface and subsurface soil concentrations for 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, vinyl chloride, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, manganese, and mercury exceeded the corresponding surface and subsurface soil SSSs.

6.1.4 SOIL TO INDOOR AIR EXPOSURE PATHWAY

Table A.7.5 of Appendix A presents the derivation of the SSSs for the soil to indoor air exposure pathway under the Industrial Land Use scenario, and compares the soil to indoor air SSSs to the maximum soil concentrations. Table A.7.4 presents the derivation

of the risk-based target indoor air concentrations used to develop these SSSs. The potential indoor air concentrations for an indoor worker were calculated using the Johnson & Ettinger (J&E) Model (USEPA, 2004b) and measured soil concentrations. Appendix D presents the methodology and assumptions used to estimate the soil gas attenuation factors and soil to indoor air SSSs for each potentially impacted Land Use scenario.

The soil to indoor air SSSs and maximum soil concentrations are summarized below:

COPC	SSS (µg/g)	Maximum Soil Concentration (µg/g)	Number of Samples > PSS (%)
1,2,4-Trichlorobenzene	2.7E+02	1.1E+03	3 (2.1%)
1,2-Dichlorobenzene	1.8E+03	1.1E+03	0 (0%)
1,3-Dichlorobenzene	1.8E+03	7.7E+01	0 (0%)
1,4-Dichlorobenzene	3.2E+00	2.0E+03	17 (12.0%)
2-Butanone	2.6E+04	3.1E-02	0 (0%)
Acetone	1.5E+04	1.7E-01	0 (0%)
Benzene	9.0E-02	4.5E+02	26 (17.8%)
Carbon Disulfide	6.3E-03	5.0E-03	0 (0%)
Chlorobenzene	8.7E+01	5.6E+02	4 (2.7%)
Chloroform (Trichloromethane)	2.9E-02	8.9E-01	3 (2.1%)
Cyclohexane	1.4E+02	3.4E-02	0 (0%)
Methyl cyclohexane	7.7E+01	5.4E-02	0 (0%)
Methylene chloride	1.2E+00	9.5E-02	0 (0%)
Tetrachloroethene (former)	1.1E+00	1.9E+00	11 (7.5%)
Tetrachloroethene (current)	8.7E-02	1.9E+00	18 (12.3%)
Vinyl chloride	1.3E-02	2.9E+03	34 (29.6%)
Xylenes (total)	1.8E+02	8.0E-03	0 (0%)
2-Methylnaphthalene	3.2E+03	2.3E+00	0 (0%)
Acetophenone	2.9E+04	1.2E+00	0 (0%)
Anthracene	1.9E+07	2.1E-01	0 (0%)
Benzaldehyde	1.5E+04	6.9E-01	0 (0%)
Benzo(b)fluoranthene	1.3E+04	2.0E+00	0 (0%)
Chrysene	4.1E+05	9.3E-01	0 (0%)
Fluoranthene	7.1E+07	1.5E+00	0 (0%)
Hexachlorobenzene	5.7E+00	8.2E+00	1 (1%)
Naphthalene	4.4E+02	5.7E-01	0 (0%)
Nitrobenzene	2.2E+02	9.6E+00	0 (0%)
Phenanthrene	1.5E+05	1.1E+00	0 (0%)
Pyrene	1.7E+07	1.6E+00	0 (0%)
Mercury	2.7E+01	9.1E+03	78 (24.2%)

As summarized in the above table, the maximum detected soil concentrations for 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform, tetrachloroethene (derived under both former and current toxicity data), vinyl chloride, hexachlorobenzene, and mercury exceeded the corresponding soil SSSs.

6.1.5 GROUNDWATER TO INDOOR AIR EXPOSURE PATHWAY

Table A.7.6 of Appendix A presents the derivation of the SSSs for the groundwater to indoor air exposure pathway under the Industrial Land Use scenario, and compares the groundwater-to-indoor air SSSs to the maximum groundwater concentrations. As for the soil to indoor air exposure pathway, Table A.7.4 of Appendix A presents the derivation of the risk-based target indoor air concentrations used to develop these SSSs. Appendix D presents the methodology and assumptions used to estimate the soil gas attenuation factors and groundwater to indoor air SSSs for each potentially impacted Land Use scenario.

The groundwater to indoor air pathway-specific SSSs and maximum groundwater concentrations are summarized below:

COPC	SSS (µg/L)	Maximum Groundwater Concentration (µg/L)	Number of Samples > PSS (%)
1,1-Dichloroethene	6.4E+05	4.1E+01	0 (0%)
1,2,4-Dichlorobenzene	1.7E+05	4.2E+03	0 (0%)
1,2-Dichlorobenzene	4.2E+06	2.5E+04	0 (0%)
1,3-Dichlorobenzene	1.6E+06	2.5E+03	0 (0%)
1,4-Dichlorobenzene	8.4E+03	4.5E+04	19 (8.3%)
Benzene	3.1E+03	9.8E+04	28 (12.2%)
Carbon tetrachloride	6.6E+02	6.0E+02	0 (0%)
Chlorobenzene	7.6E+05	2.3E+05	0 (0%)
Chloroform	1.1E+03	1.5E+02	0 (0%)
cis-1,2-Dichloroethene	3.5E+05	2.4E+01	0 (0%)
Cyclohexane	4.4E+06	1.7E+02	0 (0%)
Methylene chloride	6.8E+04	7.9E+03	0 (0%)
Tetrachloroethene (former)	2.8E+04	3.7E+02	0 (0%)
Tetrachloroethene (current)	2.6E+03	3.7E+02	0 (0%)
Toluene	4.3E+07	2.0E+02	0 (0%)
Trichloroethene (former)	1.1E+04	1.6E+01	0 (0%)
Trichloroethene (current)	1.8E+02	1.6E+01	0 (0%)
Vinyl chloride	1.6E+03	4.0E+03	7 (3.0%)
2-Chlorophenol	1.5E+06	3.4E+02	0 (0%)
Hexachloroethane	1.1E+05	2.8E+01	0 (0%)
Naphthalene	2.0E+05	4.1E+01	0 (0%)
Mercury	4.7E+03	3.1E+02	0 (0%)

As summarized in the above table, the maximum detected groundwater concentrations for 1,4-dichlorobenzene, benzene, and vinyl chloride exceeded the corresponding groundwater SSSs.

6.2 RECREATIONAL LAND USE SCENARIO

Section 6.2 presents the derivations of SSSs for each exposure scenario under a Recreational Land Use scenario, as follows:

- Child soccer player surface soil exposure pathway – Section 6.2.1;
- Child golfer surface soil exposure pathway – Section 6.2.2;

- Adult golfer surface soil exposure pathway – Section 6.2.3;
- Golf course employee surface soil exposure pathway – Section 6.2.4;
- Construction/utility worker surface and subsurface soil exposure pathway – Section 6.2.5;
- Soil to indoor air exposure pathway – Section 6.2.6; and
- Groundwater to indoor air exposure pathway – Section 6.2.7.

6.2.1 CHILD SOCCER PLAYER EXPOSURE TO SURFACE SOIL

Table B.7.1 of Appendix B presents the calculation of the SSSs for Site COPCs for the child soccer player exposure to surface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	SSS (µg/g)	Maximum Surface Soil Concentration (µg/g)	Number of Samples > PSS (%)
1,2,4-Trichlorobenzene	5.7E+03	1.3E+02	0 (0%)
1,4-Dichlorobenzene	2.6E+02	1.0E+02	0 (0%)
Cyclohexane	3.9E+05	2.7E-02	0 (0%)
Benzo(a)anthracene	2.4E+00	8.3E-01	0 (0%)
Benzo(a)pyrene	2.4E-01	1.0E+00	80 (82.5%)
Benzo(b)fluoranthene	2.4E+00	2.0E+00	0 (0%)
Hexachlorobenzene	3.3E+00	6.2E-01	0 (0%)
Indeno(1,2,3-cd)pyrene	2.4E+00	4.5E-01	0 (0%)
Aluminum	1.2E+06	2.0E+04	0 (0%)
Antimony	2.8E+02	1.0E+01	0 (0%)
Arsenic	4.9E+00	1.1E+02	16 (15.1%)
Beryllium	3.6E+02	6.9E+01	0 (0%)
Cobalt	2.4E+04	1.8E+02	0 (0%)
Copper	5.0E+04	6.3E+03	0 (0%)
Iron	8.8E+05	1.3E+05	0 (0%)
Lead	NV	1.1E+02 (1)	0 (0%)
Manganese	1.2E+04	4.2E+03	0 (0%)
Mercury	2.7E+02	9.1E+03	13 (8.2%)
Nickel	1.2E+04	6.7E+02	0 (0%)
Thallium	8.8E+01	7.2E-01	0 (0%)
Vanadium	4.9E+02	4.5E+01	0 (0%)
Zinc	3.8E+05	2.9E+04	0 (0%)
Aroclor-1260	2.6E+00	4.4E+00	1 (10%)

Note:

NV: No value.

(1) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1.

As summarized in the above table, maximum detected surface soil concentrations for benzo(a)pyrene, arsenic, mercury, and Aroclor-1260 exceeded the corresponding surface soil SSSs.

6.2.2 CHILD GOLFER EXPOSURE TO SURFACE SOIL

Table B.7.2 of Appendix B presents the calculation of the SSSs for Site COPCs for the child golfer exposure to surface soil through dermal contact, incidental ingestion, and

inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations. For each COPC, two risk-based surface soil concentrations were initially developed: one protective of carcinogenic health impacts, and a second protective on non-carcinogenic health impacts. The risk-based surface soil concentration applied as the SSS was the lower of these two concentrations.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
1,2,4-Trichlorobenzene	3.4E+03	1.3E+02	0 (0%)
1,4-Dichlorobenzene	2.0E+02	1.0E+02	0 (0%)
Cyclohexane	1.6E+05	2.7E-02	0 (0%)
Benzo(a)anthracene	2.9E+00	8.3E-01	0 (0%)
Benzo(a)pyrene	2.9E-01	1.0E+00	79 (81.4%)
Benzo(b)fluoranthene	2.9E+00	2.0E+00	0 (0%)
Hexachlorobenzene	3.7E+00	6.2E-01	0 (0%)
Indeno(1,2,3-cd)pyrene	2.9E+00	4.5E-01	0 (0%)
Aluminum	1.3E+06	2.0E+04	0 (0%)
Antimony	3.4E+02	1.0E+01	0 (0%)
Arsenic	5.3E+00	1.1E+02	12 (11.3%)
Beryllium	5.2E+02	6.9E+01	0 (0%)
Cobalt	2.5E+04	1.8E+02	0 (0%)
Copper	5.3E+04	6.3E+03	0 (0%)
Iron	9.2E+05	1.3E+05	0 (0%)
Lead	NV	1.1E+02 (1)	0 (0%)
Manganese	1.5E+04	4.2E+03	0 (0%)
Mercury	2.0E+02	9.1E+03	13 (8.2%)
Nickel	1.6E+04	6.7E+02	0 (0%)
Thallium	9.2E+01	7.2E-01	0 (0%)
Vanadium	6.4E+02	4.5E+01	0 (0%)
Zinc	4.0E+05	2.9E+04	0 (0%)
Aroclor-1260	3.1E+00	4.4E+00	1 (10%)

Note:

NV: No value.

(1) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1

As summarized in the above table, maximum detected surface soil concentrations for benzo(a)pyrene, arsenic, mercury, and Aroclor-1260 exceeded the corresponding surface soil SSSs.

6.2.3 ADULT GOLFER EXPOSURE TO SURFACE SOIL

Table B.7.3 of Appendix B presents the calculation of the SSSs for Site COPCs for the adult golfer exposure to surface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations. The derivation of the SSS for lead in Site surface soil is presented separately in Table B.7.9 of Appendix B.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	SSS (µg/g)	Maximum Surface Soil Concentration (µg/g)	Number of Samples > PSS (%)
1,2,4-Trichlorobenzene	2.6E+03	1.3E+02	0 (0%)
1,4-Dichlorobenzene	6.8E+01	1.0E+02	1 (1.5%)
Cyclohexane	1.1E+05	2.7E-02	0 (0%)
Benzo(a)anthracene	3.4E+00	8.3E-01	0 (0%)
Benzo(a)pyrene	3.4E-01	1.0E+00	79 (81.4%)
Benzo(b)fluoranthene	3.4E+00	2.0E+00	0 (0%)
Hexachlorobenzene	1.4E+00	6.2E-01	0 (0%)
Indeno(1,2,3-cd)pyrene	3.4E+00	4.5E-01	0 (0%)
Aluminum	1.8E+06	2.0E+04	0 (0%)
Antimony	3.4E+02	1.0E+01	0 (0%)
Arsenic	2.6E+00	1.1E+02	59 (55.7%)
Beryllium	3.8E+02	6.9E+01	0 (0%)
Cobalt	5.9E+03	1.8E+02	0 (0%)
Copper	7.4E+04	6.3E+03	0 (0%)
Iron	1.3E+06	1.3E+05	0 (0%)
Lead (1)	1.0E+03	1.1E+02 (2)	0 (0%)
Manganese	1.4E+04	4.2E+03	0 (0%)
Mercury	1.8E+02	9.1E+03	13 (8.2%)
Nickel	1.5E+04	6.7E+02	0 (0%)
Thallium	1.3E+02	7.2E-01	0 (0%)
Vanadium	5.6E+02	4.5E+01	0 (0%)
Zinc	5.5E+05	2.9E+04	0 (0%)
Aroclor-1260	1.2E+00	4.4E+00	2 (20%)

Note:

(1) Refer to Table B.7.9 of Appendix B for derivation of SSS for lead.

(2) Arithmetic mean lead concentration for Site surface soil, as presented in Table A.3.1.

As summarized in the above table, maximum detected surface soil concentrations for 1,4-dichlorobenzene, benzo(a)pyrene, arsenic, mercury, and Aroclor-1260 exceeded the corresponding surface soil SSSs.

6.2.4 GOLF COURSE EMPLOYEE EXPOSURE TO SURFACE SOIL

Table B.7.4 of Appendix B presents the calculation of the SSSs for Site COPCs for the golf course employee exposure to surface soil through dermal contact, incidental ingestion,

and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations. The derivation of the SSS for lead in Site surface soil is presented separately in Table B.7.9 of Appendix B.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
Cyclohexane	3.7E+04	2.7E-02	0 (0%)
Benzo(a)pyrene	2.4E-01	1.0E+00	80 (82.5%)
Aluminum	1.0E+06	2.0E+04	0 (0%)
Arsenic	1.8E+00	1.1E+02	78 (73.6%)
Cobalt	2.7E+03	1.8E+02	0 (0%)
Copper	4.4E+04	6.3E+03	0 (0%)
Iron	7.7E+05	1.3E+05	0 (0%)
Lead	6.0E+02	1.1E+02 (2)	0 (0%)
Manganese	8.3E+03	4.2E+03	0 (0%)
Mercury	7.0E+01	9.1E+03	24 (15.4%)
Aroclor-1260	8.6E-01	4.4E+00	3 (30%)

Note:

(1) Refer to Table B.7.9 of Appendix B for derivation of SSS for lead.

(2) Arithmetic mean lead concentration for Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface soil concentrations of benzo(a)pyrene, arsenic, mercury, and Aroclor-1260 exceeded the corresponding surface soil SSSs.

6.2.5 CONSTRUCTION/UTILITY WORKER EXPOSURE TO SURFACE AND SUBSURFACE SOIL

Table B.7.5 of Appendix B presents the calculation of the SSSs for Site COPCs for the construction/utility worker exposure to surface and subsurface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface and subsurface soil SSSs to the maximum surface and subsurface soil concentrations, under a Recreational Land Use scenario. The derivation of the SSS for lead in Site soil is presented separately in Table B.7.9 of Appendix B.

The SSSs for the construction/utility worker exposure to surface and subsurface soil and the maximum surface and subsurface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
1,2,4-Trichlorobenzene	1.5E+02	1.1E+03	3 (2.1%)
1,4-Dichlorobenzene	1.3E+02	2.0E+03	5 (3.5%)
Benzene	2.4E+01	4.5E+02	4 (2.7%)
Cyclohexane	5.4E+03	3.4E-02	0 (0%)
Methyl cyclohexane	5.8E+03	5.4E-02	0 (0%)
Vinyl chloride	9.5E+00	2.9E+03	7 (6.1%)
Benzo(a)pyrene	2.1E+00	1.0E+00	0 (0%)
Bis(2-Ethylhexyl)phthalate	1.2E+03	1.3E+03	1 (0.7%)
Hexachlorobenzene	7.7E+00	8.2E+00	7 (4.5%)
Aluminum	1.0E+05	2.3E+04	0 (0%)
Arsenic	1.3E+01	1.1E+02	25 (11.2%)
Cobalt	5.6E+02	1.8E+02	0 (0%)
Copper	1.2E+04	6.3E+03	0 (0%)
Iron	2.1E+05	1.3E+05	0 (0%)
Lead	1.6E+02	7.4E+01 (2)	0 (0%)
Manganese	1.1E+03	4.2E+03	2 (0.9%)
Mercury	1.1E+01	9.1E+03	118 (36.7%)
Aroclor-1260	7.6E+00	4.4E+00	0 (0%)

Note:

(1) Refer to Table B.7.9 of Appendix B for derivation of SSS for lead.

(2) Arithmetic mean lead concentration for Site surface and subsurface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface and subsurface soil concentrations for 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, vinyl chloride, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, manganese, and mercury exceeded the corresponding surface and subsurface soil SSSs.

6.2.6 SOIL TO INDOOR AIR EXPOSURE PATHWAY

Table B.7.7 of Appendix B presents the derivation of the SSSs for the soil to indoor air exposure pathway under the Recreational Land Use scenario, and compares the soil to indoor air SSSs to the maximum soil concentrations. Table B.7.6 presents the derivation

of the risk-based target indoor air concentrations used to develop these SSSs. The applied soil gas attenuation factors were calculated using the Johnson & Ettinger (J&E) Model (USEPA, 2004b). Appendix D presents the methodology and assumptions used to estimate the soil gas attenuation factors and soil to indoor air SSSs for each potentially impacted Land Use scenario.

The soil to indoor air SSSs and maximum soil concentrations are summarized below:

COPC	SSS (µg/g)	Maximum Soil Concentration (µg/g)	Number of Samples > PSS (%)
1,2,4-Trichlorobenzene	1.5E+02	1.1E+03	3 (2.1%)
1,2-Dichlorobenzene	1.0E+03	1.1E+03	1 (1%)
1,3-Dichlorobenzene	1.0E+03	7.7E+01	0 (0%)
1,4-Dichlorobenzene	1.8E+00	2.0E+03	22 (15.5%)
2-Butanone	1.5E+04	3.1E-02	0 (0%)
Acetone	8.4E+03	1.7E-01	0 (0%)
Benzene	5.2E-02	4.5E+02	28 (19.2%)
Carbon Disulfide	1.4E+01	5.0E-03	0 (0%)
Chlorobenzene	5.0E+01	5.6E+02	7 (4.8%)
Chloroform (Trichloromethane)	1.7E-02	8.9E-01	4 (3.4%)
Cyclohexane	7.9E+01	3.4E-02	0 (0%)
Methyl cyclohexane	4.4E+01	5.4E-02	0 (0%)
Methylene chloride	6.8E-01	9.5E-02	0 (0%)
Tetrachloroethene (former)	6.2E-01	1.9E+00	16 (11.0%)
Tetrachloroethene (current)	5.0E-02	1.9E+00	24 (16.4%)
Vinyl chloride	7.7E-03	2.9E-03	76 (66.1%)
Xylenes (total)	1.0E+02	8.0E-03	0 (0%)
2-Methylnaphthalene	1.8E+03	2.3E+00	0 (0%)
Acetophenone	1.7E+04	1.2E+00	0 (0%)
Anthracene	1.1E+07	2.1E-01	0 (0%)
Benzaldehyde	8.5E+03	6.9E-01	0 (0%)
Benzo(b)fluoranthene	7.5E+03	2.0E+00	0 (0%)
Chrysene	2.3E+05	9.3E-01	0 (0%)
Fluoranthene	4.1E+07	1.5E+00	0 (0%)
Hexachlorobenzene	3.3E+00	8.2E+00	1 (1%)
Naphthalene	2.5E+02	5.7E-01	0 (0%)
Nitrobenzene	1.3E+02	9.6E+00	0 (0%)
Phenanthrene	8.6E+04	1.1E+00	0 (0%)
Pyrene	1.0E+07	1.6E+00	0 (0%)
Mercury	1.5E+01	9.1E+03	99 (30.7%)

As summarized in the above table, the maximum detected soil concentrations for 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform, tetrachloroethene (derived under both former and current toxicity data), vinyl chloride, hexachlorobenzene, and mercury exceeded the corresponding soil SSSs.

6.2.7 GROUNDWATER TO INDOOR AIR EXPOSURE PATHWAY

Table B.7.8 of Appendix B presents the derivation of the SSSs for the groundwater to indoor air exposure pathway under the Recreational Land Use scenario, and compares the groundwater-to-indoor air SSSs to the maximum groundwater concentrations. Table B.7.6 presents the derivation of the target risk-based indoor air concentrations used to develop these SSSs. Appendix D presents the methodology and assumptions used to estimate the soil gas attenuation factors and groundwater to indoor air SSSs for each potentially impacted Land Use scenario.

The groundwater to indoor air pathway-specific SSSs and maximum groundwater concentrations are summarized below:

COPC	SSS (µg/L)	Maximum Groundwater Concentration (µg/L)	Number of Samples > PSS (%)
1,1-Dichloroethene	3.6E+05	4.1E+01	0 (0%)
1,2,4-Dichlorobenzene	9.6E+04	4.2E+03	0 (0%)
1,2-Dichlorobenzene	2.4E+06	2.5E+04	0 (0%)
1,3-Dichlorobenzene	9.3E+05	2.5E+03	0 (0%)
1,4-Dichlorobenzene	4.8E+03	4.5E+04	29 (12.6%)
Benzene	1.8E+03	9.8E+04	34 (14.8%)
Carbon tetrachloride	3.7E+02	6.0E+02	8 (3.5%)
Chlorobenzene	4.3E+05	2.3E+05	0 (0%)
Chloroform	6.5E+02	1.5E+02	0 (0%)
cis-1,2-Dichloroethene	2.0E+05	2.4E+01	0 (0%)
Cyclohexane	2.5E+06	1.7E+02	0 (0%)
Methylene chloride	3.8E+04	7.9E+03	0 (0%)
Tetrachloroethene (former)	1.6E+04	3.7E+02	0 (0%)
Tetrachloroethene (current)	1.5E+03	3.7E+02	0 (0%)
Toluene	2.5E+07	2.0E+02	0 (0%)
Trichloroethene (former)	6.4E+03	1.6E+01	0 (0%)
Trichloroethene (current)	1.0E+02	1.6E+01	0 (0%)
Vinyl chloride	9.0E+02	4.0E+03	7 (3.0%)
2-Chlorophenol	8.2E+05	3.4E+02	0 (0%)
Hexachloroethane	6.1E+04	2.8E+01	0 (0%)
Naphthalene	1.2E+05	4.1E+01	0 (0%)
Mercury	2.7E+03	3.1E+02	0 (0%)

As summarized in the above table, the maximum detected groundwater concentrations for 1,4-dichlorobenzene, benzene, carbon tetrachloride, and vinyl chloride exceeded the corresponding groundwater SSSs.

6.3 VACANT SCENARIO

Section 6.3 presents the derivations of SSSs for each exposure pathway under a Vacant scenario, as follows:

- Trespasser surface soil exposure pathway – Section 6.3.1; and
- Lawn maintenance staff surface soil exposure pathway – Section 6.3.2.

6.3.1 TRESPASSER EXPOSURE TO SURFACE SOIL

Table C.7.1 of Appendix C presents the calculation of the SSSs for Site COPCs for the trespasser exposure to surface soil under a Vacant Land Use scenario. Trespasser exposure could potentially occur through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate. Table C.7.1 also compares the surface soil SSSs to the maximum surface soil concentrations.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
Cyclohexane	3.6E+05	2.7E-02	0 (0%)
Benzo(a)pyrene	7.1E-01	1.0E+00	7 (7.2%)
Aluminum	5.5E+06	2.0E+04	0 (0%)
Arsenic	2.1E+01	1.1E+02	1 (0.9%)
Cobalt	1.0E+05	1.8E+02	0 (0%)
Copper	2.3E+05	6.3E+03	0 (0%)
Iron	4.0E+06	1.3E+05	0 (0%)
Lead	NV	1.1E+02 (1)	0 (0%)
Manganese	2.7E+04	4.2E+03	0 (0%)
Mercury	5.8E+02	9.1E+03	9 (5.7%)
Aroclor-1260	7.4E+00	4.4E+00	0 (0%)

Note:
NV: No value.
(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, maximum detected surface soil concentrations for benzo(a)pyrene, arsenic, and mercury exceeded the corresponding surface soil SSSs.

6.3.2 LAWN MAINTENANCE STAFF EXPOSURE TO SURFACE SOIL

Table C.7.2 of Appendix C presents the calculation of the SSSs for Site COPCs for the lawn maintenance staff exposure to surface soil through dermal contact, incidental ingestion, and inhalation of vapor and/or particulate, and compares the surface soil SSSs to the maximum surface soil concentrations.

The surface soil SSSs and maximum surface soil concentrations are summarized below:

COPC	*SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Number of Samples > PSS (%)*
Cyclohexane	4.5E+05	2.7E-02	0 (0%)
Benzo(a)pyrene	1.5E+00	1.0E+00	0 (0%)
Aluminum	6.6E+06	2.0E+04	0 (0%)
Arsenic	1.1E+01	1.1E+02	2 (1.9%)
Cobalt	3.3E+04	1.8E+02	0 (0%)
Copper	2.7E+05	6.3E+03	0 (0%)
Iron	4.8E+06	1.3E+05	0 (0%)
Lead	NV	1.1E+02 (1)	0 (0%)
Manganese	5.3E+04	4.2E+03	0 (0%)
Mercury	7.2E+02	9.1E+03	6 (3.8%)
Aroclor-1260	5.3E+00	4.4E+00	0 (0%)

Note:

NV: No value.

(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, maximum detected surface soil concentrations for arsenic and mercury exceeded the corresponding surface soil SSSs.

6.4 QUALITATIVE INTERPRETATION OF HEALTH RISKS

All receptors could be exposed to volatile COPCs within vapors that volatilize from soil and groundwater to soil gas, and migrate through the undisturbed ground surface to ambient air. However, VOC vapors emitted to ambient air from soil gas will be immediately dispersed and diluted in the atmosphere to negligible levels. Thus, the potential for inhalation exposure to volatile COPCs derived from the soil and groundwater to soil gas emitted to ambient air is considered insignificant, and SSSs were not quantitatively derived for this pathway.

6.5 UNCERTAINTY ANALYSIS

The purpose of this section is to provide a summary and discussion regarding the uncertainties associated with the HHRA evaluation. The various uncertainties are discussed below in the following sections.

6.5.1 EXPOSURE SCENARIO ASSUMPTIONS

This section evaluates the uncertainty associated with the primary exposure scenario assumptions such as land use and frequency of exposure. Because the assumptions used in the scenarios are often not objectively based but rather are subjective estimates based on judgment, conservatism, and experience applied to available data, the tendency is to select conservative, health-protective values to guard against under-estimating exposure (and associated risks). This leads to a general over-estimation of exposure. When each individual exposure is over-estimated, the net effect is compounded. That is, the total exposure is over-estimated to an even greater degree than the individual exposures. Exposure scenarios are, therefore, conservative in nature, and thereby provide the necessary safety factor for protection of human health.

The intent of the HHRA was to derive SSSs protective of human health. In order to accomplish this goal, a series of standardized USEPA exposure assumptions were utilized, where available and applicable. In the absence of available or applicable exposure assumptions, professional judgment was used to establish necessary assumptions protective of human health.

The major uncertainties regarding the physical exposure scenarios used in the HHRA are summarized as follows:

(i) the actual frequency of trespassing entry to the Site is unknown. As a result, professional judgment was used to conservatively estimate media exposure on Site;

(ii) the COPC concentrations attached to particles in ambient air are modeled (for construction/utility worker exposure) based on conservative assumptions for input parameters, such as soil properties and meteorological conditions, that will likely result in an over-estimation of the risks;

(iii) SSS exceedances are inherently uncertain because COPC concentrations are based on maximum concentrations, and assumed to remain constant over time. This assumption may not have a large effect on the estimated concentrations of

inorganics; however, it could have a major effect on the SSS exceedances of organics, as the concentrations of organics will decrease over time due to degradation and remediation processes. The assumption that the measured concentrations are equivalent during sampling and over the duration of exposure will overestimate the number of exceedances of the SSSs; and

(iv) for most COPCs, the HHRA assumes that 100 percent absorption occurs after oral ingestion. Actual absorption rates from ingested contaminants may vary from 5 to 100 percent due to the tendency for strong adsorption of the COPCs to the ingested soil and sediment, which would reduce or prevent uptake into the body. Thus, assumption of 100 percent absorption of ingested COPCs leads to an overestimate of the SSS.

6.5.2 DOSE RESPONSE

One of the major uncertainties in deriving SSSs is the application of published toxicity information. Factors introducing uncertainty associated with toxicity value application are as follows:

(i) applicability of animal toxicity data - chemicals may be assumed to be human carcinogens based on animal studies even when there is limited or no available evidence that the chemical is a human carcinogen;

(ii) differences in chemical concentrations - CSFs are derived from high concentration animal studies and therefore may not be applicable to low concentration exposures;

(iii) assumptions in toxicity values - CSFs are developed in a conservative manner;

(iv) application of oral toxicity values to derive inhalation toxicity values by route-to-route extrapolation may not be appropriate for some of the COPCs. As a result, the SSSs derived for these exposure pathways may be under or over estimated; and

(v) assumptions in toxicity values (Non-carcinogenic Hazard) - RfDs are also established with conservative safety factors compared to actual studies.

6.5.3 SYNERGISTIC, ADDITIVE, AND ANTAGONISTIC EFFECTS

Receptor exposure to a mixture of chemicals can in some cases lead to synergistic, additive, or antagonistic health effects. Synergistic effects occur when chemicals interact

in the receptor and cause an effect significantly greater than the sum of effects of the individual chemicals. There is no apparent scientific basis to suspect that the COPCs identified at the Site will have synergistic effects. Potential synergistic effects were not evaluated in the HHRA, and thus if these are occurring, then the calculated SSSs may be underestimated. Alternatively, chemicals may interact in the receptor in such a way as to cause an overall effect that is less than the sum of effects of the individual chemicals. These potential antagonistic effects were not evaluated in the HHRA, and thus, if they are occurring, the calculated SSSs may be overestimated.

7.0 CONCLUSIONS/RECOMMENDATIONS

The purpose of the HHRA was to develop Site-specific Standards (SSSs) for the portion of the Site indicated on Figure 2.2. Although a variety of Solid Waste Management Units (SWMU) and areas of concern (Areas) have previously been identified within this portion of the Site (CRA, 2006), the Site was treated as one large exposure unit. Three different exposure scenarios were considered in the development of human health based SSSs, based on the current and potential future land uses of the Site. The exposure scenarios included Industrial Land Use, Recreational Land Use, and Vacant (Lawn Maintenance Only). The recreational land use scenario was developed based on the assumption that the Site would be redeveloped as either a soccer field or as a golf course, although it may alternatively be developed as some other type of recreational space. The following potential human receptors may be exposed to Site media under the given exposure scenarios:

Scenario 1: Industrial Land Use	***Scenario 2: Recreational Land Use***	***Scenario 3: Vacant (Lawn Maintenance Only)***
Trespasser	Soccer Player	Trespasser
Industrial Worker	Golfer	Lawn Maintenance Staff
Construction/Utility Worker	Golf Course Employee	
	Construction/Utility Worker	

Site COPCs were selected according to USEPA RAGS Part A (USEPA, 1989) and, to the extent practical, chemicals were screened against the RBCs developed by USEPA Region III (USEPA, 2007b). The SSSs were developed following USEPA RAGS Part B methodology (USEPA, 1991b), and the exposure assumptions and toxicity data outlined in Sections 4.0 and 5.0, respectively. Note that groundwater SSSs were not developed for construction/utility worker exposure during ground intrusive activities, as the concurrent Corrective Measures Study will include Institutional Controls (ICs), health and safety procedures, engineering controls, or active remedies, that will limit this exposure.

The human health based SSSs for the Site were developed based on a target cancer risk of 1.0E-05 and target hazard of 1.0.

7.1 RECOMMENDED SSSs

SSSs were developed for potential human receptor exposures to soil and groundwater COPCs under three alternate land use scenarios: i) Industrial; ii) Recreational; and iii) Vacant. The human receptors under the Industrial Land Use scenario included a trespasser, industrial worker, and construction/utility worker. The human receptors under the Recreational Land Use scenario included a child soccer player, child golfer, adult golfer, golf course employee, and a construction/utility worker. The human receptors under the Vacant scenario included a trespasser and lawn maintenance staff.

The SSSs were calculated for potentially complete human exposure pathways to meet the carcinogenic risk target of 1.0×10^{-5}, and the non-carcinogenic hazard level of 1.0. The final SSS for each COPC for each land use scenario was established as the lower of the exposure pathway-specific SSSs. The final SSSs were compared against the maximum detected/detection limit analytical results for each COPC in soil and groundwater at the Site. The Site SSSs for each land use scenario are selected to be protective of human receptors at the Site. The rationale for the selection and development of the proposed SSSs is described below.

7.1.1 DEVELOPMENT OF SITE-SPECIFIC STANDARDS – INDUSTRIAL LAND USE SCENARIO

Development of Surface Soil Site-Specific Standards

The SSSs for COPCs in surface soil at the Site under an Industrial Land Use scenario are summarized in Table A.8.1 of Appendix A. The human receptors and exposure pathways considered in the development of the surface soil SSSs are:

- Trespasser incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil; and
- Industrial worker incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil.

The proposed SSS for each COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Surface Soil SSS (µg/g)*[1]	*Maximum Surface Soil Concentration (µg/g)* [2]	*Basis of Proposed SSS*
Cyclohexane	3.2E+04	2.7E-02	Industrial Worker
Benzo(a)pyrene	7.0E-02	**1.0E+00**	Industrial Worker
Aluminum	8.9E+05	2.0E+04	Industrial Worker
Arsenic	1.6E+00	**1.1E+02**	Industrial Worker
Cobalt	2.3E+03	1.8E+02	Industrial Worker
Copper	3.8E+04	6.3E+03	Industrial Worker
Iron	6.7E+05	1.3E+05	Industrial Worker
Lead	5.2E+02	1.1E+02 (1)	Industrial Worker
Manganese	7.2E+03	4.2E+03	Industrial Worker
Mercury	6.1E+01	**9.1E+03**	Industrial Worker
Aroclor-1260	7.4E-01	**4.4E+00**	Industrial Worker

Note:

(1) Arithmetic mean lead concentration for Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface soil COPC concentrations exceeded the calculated surface soil SSSs for benzo(a)pyrene, arsenic, mercury, and Aroclor-1260.

Development of Soil Site-Specific Standards

The SSSs for COPCs in soil at the Site under an Industrial Land Use scenario are summarized in Table A.8.2 of Appendix A. The human receptors and exposure pathways considered in the development of the soil SSSs are:

- Industrial worker inhalation exposure to COPCs in Site soil migrating to indoor air; and
- Construction/utility worker incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within soil.

The proposed soil SSS for each COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Soil SSS (µg/g)*	*Maximum Soil Concentration (µg/g)*	*Basis of Proposed SSS*
1,2,4-Trichlorobenzene	1.5E+02	**1.1E+03**	Construction/ Utility Worker
1,2-Dichlorobenzene	1.8E+03	1.1E+03	Indoor Air
1,3-Dichlorobenzene	1.8E+03	7.7E+01	Indoor Air
1,4-Dichlorobenzene	3.2E+00	**2.0E+03**	Indoor Air
2-Butanone	2.8E+04	3.1E-02	Indoor Air
Acetone	1.5E+04	1.7E-01	Indoor Air
Benzene	9.0E-02	**4.5E+02**	Indoor Air
Carbon Disulfide	6.3E-03	5.0E-03	Indoor Air
Chlorobenzene	8.7E+01	**5.6E+02**	Indoor Air
Chloroform	2.9E-02	**8.9E-01**	Indoor Air
Cyclohexane	1.4E+02	3.4E-02	Indoor Air
Methyl cyclohexane	7.7E+01	5.4E-02	Indoor Air
Methylene chloride	1.2E+00	9.5E-02	Indoor Air
Tetrachloroethene (former)	1.1E+00	**1.9E+00**	Indoor Air
Tetrachloroethene (current)	8.7E-02	**1.9E+00**	Indoor Air
Vinyl Chloride	1.3E-02	**2.9E+03**	Indoor Air
Xylenes (total)	1.8E+02	8.0E-03	Indoor Air
2-Methylnaphthalene	3.2E+03	2.3E+00	Indoor Air
Acetophenone	2.9E+04	1.2E+00	Indoor Air
Anthracene	1.9E+07	2.1E-01	Indoor Air
Benzaldehyde	1.5E+04	6.9E-01	Indoor Air
Benzo(a)pyrene	2.1E+00	1.0E+00	Construction/ Utility Worker
Benzo(b)fluoranthene	1.3E+04	2.0E+00	Indoor Air
Bis(2-ethylhexyl)phthalate	1.2E+03	**1.3E+03**	Construction/ Utility Worker
Chrysene	4.1E+05	9.3E-01	Indoor Air
Fluoranthene	7.1E+07	1.5E+00	Indoor Air
Hexachlorobenzene	5.7E+00	**8.2E+00**	Indoor Air
Naphthalene	4.4E+02	5.7E-01	Indoor Air
Nitrobenzene	2.2E+02	9.6E+00	Indoor Air
Phenanthrene	1.5E+05	1.1E+00	Indoor Air
Pyrene	1.7E+07	1.6E+00	Indoor Air
Aluminum	1.0E+05	2.3E+04	Construction/ Utility Worker
Arsenic	1.3E+01	**1.1E+02**	Construction/ Utility Worker
Cobalt	5.6E+02	1.8E+02	Construction/ Utility Worker
Copper	1.2E+04	6.3E+03	Construction/ Utility Worker
Iron	2.1E+05	1.3E+05	Construction/ Utility Worker
Lead	1.6E+02	7.4E+01 (1)	Construction/ Utility Worker
Manganese	1.1E+03	**4.2E+03**	Construction/ Utility Worker
Mercury	1.1E+01	**9.1E+03**	Construction/ Utility Worker
Aroclor-1260	7.6E+00	4.4E+00	Construction/ Utility Worker

Note:

(1) Arithmetic mean lead concentration for Site surface and subsurface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected soil COPC concentrations exceeded the calculated soil SSSs for 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform (trichloromethane), tetrachloroethene (under current and former toxicity data), vinyl chloride, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, manganese, and mercury. This indicates that risk management measures will be required to address these exceedances should the Site be developed for Industrial Land use.

Development of Groundwater Site-Specific Standards

The selection of the SSSs for COPCs in Site groundwater is presented in Table A.8.3 of Appendix A. The human receptors and exposure pathways considered in the development of the groundwater SSSs are:

- Industrial worker inhalation exposure to groundwater COPCs migrating to indoor air.

The calculated groundwater SSS for each COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Groundwater SSS (µg/L)*	*Maximum Groundwater Concentration (µg/L)*	*Basis of Proposed SSS*
1,1-Dichloroethene	6.4E+05	4.1E+01	Indoor Air
1,2,4-Trichlorobenzene	1.7E+05	4.2E+03	Indoor Air
1,2-Dichlorobenzene	4.2E+06	2.5E+04	Indoor Air
1,3-Dichlorobenzene	1.7E+06	2.5E+03	Indoor Air
1,4-Dichlorobenzene	8.4E+03	**4.5E+04**	Indoor Air
Benzene	3.1E+03	**9.8E+04**	Indoor Air
Carbon Tetrachloride	6.6E+02	6.0E+02	Indoor Air
Chlorobenzene	7.6E+05	2.3E+05	Indoor Air
Chloroform	1.1E+03	1.5E+02	Indoor Air
cis-1,2-Dichloroethene	3.5E+05	2.4E+01	Indoor Air
Cyclohexane	4.4E+06	1.7E+02	Indoor Air
Methylene chloride	6.8E+04	7.9E+03	Indoor Air
Tetrachloroethene (former)	2.8E+04	3.7E+02	Indoor Air
Tetrachloroethene (current)	2.6E+03	3.7E+02	Indoor Air
Toluene	4.3E+07	2.0E+02	Indoor Air
Trichloroethene (former)	1.1E+04	1.6E+01	Indoor Air
Trichloroethene (current)	1.8E+02	1.6E+01	Indoor Air
Vinyl Chloride	1.6E+03	**4.0E+03**	Indoor Air
2-Chlorophenol	1.5E+06	3.4E+02	Indoor Air
Hexachloroethane	1.1E+05	2.8E+01	Indoor Air
Naphthalene	2.0E+05	4.1E+01	Indoor Air
Mercury	4.7E+03	3.1E+02	Indoor Air

As summarized in the above table, the calculated groundwater SSSs for 1,4-dichlorobenzene, benzene, and vinyl chloride exceed the maximum detected concentrations.

7.1.2 DEVELOPMENT OF SITE-SPECIFIC STANDARDS – RECREATIONAL LAND USE SCENARIO

Development of Surface Soil Site-Specific Standards

The proposed SSSs for COPCs in surface soil at the Site under a Recreational Land Use scenario are summarized in Table B.8.1 of Appendix B. The human receptors and exposure pathways considered in the development of the surface soil SSSs are:

- Child soccer player incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil;
- Child golfer incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil;
- Adult golfer incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil; and
- Golf course employee incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil.

The surface soil SSS for each COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Surface Soil SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Basis of Proposed SSS*
1,2,4-Trichlorobenzene	2.6E+03	1.3E+02	Adult Golfer
1,4-Dichlorobenzene	6.8E+01	**1.0E+02**	Adult Golfer
Cyclohexane	3.7E+04	2.7E-02	Golf Course Employee
Benzo(a)anthracene	2.4E+00	8.3E-01	Child Soccer Player
Benzo(a)pyrene	2.4E-01	**1.0E+00**	Child Soccer Player
Benzo(b)fluoranthene	2.4E+00	2.0E+00	Child Soccer Player
Hexachlorobenzene	1.4E+00	6.2E-01	Adult Golfer
Indeno(1,2,3-cd)pyrene	2.4E+00	4.5E-01	Child Soccer Player
Aluminum	1.0E+06	2.0E+04	Golf Course Employee
Antimony	2.8E+02	1.0E+01	Child Soccer Player
Arsenic	1.8E+00	**1.1E+02**	Golf Course Employee
Beryllium	3.6E+02	6.9E+01	Child Soccer Player
Cobalt	2.7E+03	1.8E+02	Golf Course Employee
Copper	4.4E+04	6.3E+03	Golf Course Employee
Iron	7.7E+05	1.3E+05	Golf Course Employee
Lead	6.0E+02	1.1E+02 (1)	Golf Course Employee
Manganese	8.3E+03	4.2E+03	Golf Course Employee
Mercury	7.0E+01	**9.1E+03**	Golf Course Employee
Nickel	1.2E+04	6.7E+02	Child Soccer Player
Thallium	8.8E+01	7.2E-01	Child Soccer Player
Vanadium	4.9E+02	4.5E+01	Child Soccer Player
Zinc	3.8E+05	2.9E+04	Child Soccer Player
Aroclor-1260	8.6E-01	**4.4E+00**	Golf Course Employee

Note:

(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected surface soil COPC concentrations exceeded the calculated soil PSSs for 1,4-dichlorobenzene, benzo(a)pyrene, arsenic, mercury, and Aroclor-1260.

Development of Soil Site-Specific Standards

The proposed SSSs for COPCs in soil at the Site under a Recreational Land Use scenario are summarized in Table B.8.2 of Appendix B. The human receptors and exposure pathways considered in the development of the soil SSSs are:

- Construction/utility worker inhalation exposure to COPCs in Site soil; and
- Golf course employee inhalation exposure to COPCs in Site soil migrating to indoor air.

The proposed SSS for each soil COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Soil SSS (µg/g)*	*Maximum Soil Concentration (µg/g)*	*Basis of Proposed SSS*
1,2,4-Trichlorobenzene	1.5E+02	**1.1E+03**	Construction/ Utility Worker
1,2-Dichlorobenzene	1.0E+03	**1.1E+03**	Indoor Air
1,3-Dichlorobenzene	1.0E+03	7.7E+01	Indoor Air
1,4-Dichlorobenzene	1.8E+00	**2.0E+03**	Indoor Air
2-Butanone	1.5E+04	3.1E-02	Indoor Air
Acetone	8.4E+03	1.7E-01	Indoor Air
Benzene	5.2E-02	**4.5E+02**	Indoor Air
Carbon Disulfide	1.4E+01	5.0E-03	Indoor Air
Chlorobenzene	5.0E+01	**5.6E+02**	Indoor Air
Chloroform	1.7E-02	**8.9E-01**	Indoor Air
Cyclohexane	7.9E+01	3.4E-02	Indoor Air
Methyl cyclohexane	4.4E+01	5.4E-02	Indoor Air
Methylene chloride	6.8E-01	9.5E-02	Indoor Air
Tetrachloroethene (former)	6.2E-01	**1.9E+00**	Indoor Air
Tetrachloroethene (current)	5.0E-02	**1.9E+00**	Indoor Air
Vinyl Chloride	7.7E-03	**2.9E+03**	Indoor Air
Xylenes (total)	1.0E+02	8.0E-03	Indoor Air
2-Methylnaphthalene	1.8E+03	2.3E+00	Indoor Air
Acetophenone	1.7E+04	1.2E+00	Indoor Air
Anthracene	1.1E+07	2.1E-01	Indoor Air
Benzaldehyde	8.5E+03	6.9E-01	Indoor Air
Benzo(a)pyrene	2.1E+00	1.0E+00	Construction/ Utility Worker
Benzo(b)fluoranthene	7.5E+03	2.0E+00	Indoor Air
Bis(2-ethylhexyl)phthalate	1.2E+03	**1.3E+03**	Construction/ Utility Worker
Chrysene	2.3E+05	9.3E-01	Indoor Air
Fluoranthene	4.1E+07	1.5E+00	Indoor Air
Hexachlorobenzene	3.3E+00	**8.2E+00**	Construction/ Utility Worker
Naphthalene	2.5E+02	5.7E-01	Indoor Air
Nitrobenzene	1.3E+02	9.6E+00	Indoor Air
Phenanthrene	8.6E+04	1.1E+00	Indoor Air
Pyrene	1.0E+07	1.6E+00	Indoor Air
Aluminum	1.0E+05	2.3E+04	Construction/ Utility Worker
Arsenic	1.3E+01	**1.1E+02**	Construction/ Utility Worker
Cobalt	5.6E+02	1.8E+02	Construction/ Utility Worker
Copper	1.2E+04	6.3E+03	Construction/ Utility Worker
Iron	2.1E+05	1.3E+05	Construction/ Utility Worker
Lead	1.6E+02	7.4E+01 (1)	Construction/ Utility Worker
Manganese	1.1E+03	**4.2E+03**	Construction/ Utility Worker
Mercury	1.1E+01	**9.1E+03**	Construction/ Utility Worker
Aroclor-1260	7.6E+00	4.4E+00	Construction/ Utility Worker

Note:
NV: No value.

(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected soil COPC concentrations exceeded the calculated soil PSSs for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform (trichloromethane), tetrachloroethene (under current and former toxicity data), vinyl chloride, bis(2-ethylhexyl)phthalate, hexachlorobenzene, arsenic, manganese, and mercury.

Development of Site-Specific Groundwater Standards

The selection of the proposed SSSs for COPCs in Site groundwater is presented in Table B.8.3 of Appendix B. The human receptor and exposure pathway considered in the development of the groundwater SSSs is the industrial worker inhalation exposure to groundwater COPCs migrating to indoor air.

The calculated SSS for each COPC is therefore based on this receptor-specific SSSs, as summarized in the following table:

COPC	*Groundwater SSS (µg/L)*	*Maximum Groundwater Concentration (µg/L)*	*Basis of Proposed SSS*
1,1-Dichloroethene	3.6E+05	4.1E+01	Indoor Air
1,2,4-Trichlorobenzene	9.6E+04	4.2E+03	Indoor Air
1,2-Dichlorobenzene	2.4E+06	2.5E+04	Indoor Air
1,3-Dichlorobenzene	9.3E+05	2.5E+03	Indoor Air
1,4-Dichlorobenzene	4.8E+03	**4.5E+04**	Indoor Air
Benzene	1.8E+03	**9.8E+04**	Indoor Air
Carbon Tetrachloride	3.7E+02	**6.0E+02**	Indoor Air
Chlorobenzene	4.3E+05	2.3E+05	Indoor Air
Chloroform	6.5E+02	1.5E+02	Indoor Air
cis-1,2-Dichloroethene	2.0E+05	2.4E+01	Indoor Air
Cyclohexane	2.5E+06	1.7E+02	Indoor Air
Methylene chloride	3.8E+04	7.9E+03	Indoor Air
Tetrachloroethene (former)	1.6E+04	3.7E+02	Indoor Air
Tetrachloroethene (current)	1.5E+03	3.7E+02	Indoor Air
Toluene	2.4E+07	2.0E+02	Indoor Air
Trichloroethene (former)	6.4E+03	1.6E+01	Indoor Air
Trichloroethene (current)	1.0E+02	1.6E+01	Indoor Air
Vinyl Chloride	9.0E+02	**4.0E+03**	Indoor Air
2-Chlorophenol	8.2E+05	3.4E+02	Indoor Air
Hexachloroethane	6.1E+04	2.8E+01	Indoor Air
Naphthalene	1.2E+05	4.1E+01	Indoor Air
Mercury	2.7E+03	3.1E+02	Indoor Air

As summarized in the above table, the calculated groundwater SSSs for 1,4-dichlorobenzene, benzene, carbon tetrachloride, and vinyl chloride exceed the maximum detected concentrations/detection limits.

7.1.3 DEVELOPMENT OF SITE-SPECIFIC STANDARDS – VACANT (LAWN MAINTENANCE ONLY) SCENARIO

Development of Site-Specific Surface Soil Standards

The proposed SSSs for COPCs in surface soil at the Site under a Vacant (Lawn Maintenance Only) scenario are summarized in Table C.8.1 of Appendix C. The human receptors and exposure pathways considered in the development of the soil SSSs are:

- Trespasser incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil; and
- Lawn maintenance staff incidental ingestion, dermal contact, and ambient air inhalation exposure to COPCs within surface soil.

The proposed SSS for each surface soil COPC is based on the lower of these receptor-specific SSSs, as summarized below:

COPC	*Surface Soil SSS (µg/g)*	*Maximum Surface Soil Concentration (µg/g)*	*Basis of Proposed SSS*
Cyclohexane	3.6E+05	2.7E-02	Trespasser
Benzo(a)pyrene	7.1E-01	**1.0E+00**	Trespasser
Aluminum	5.5E+06	2.0E+04	Trespasser
Arsenic	1.1E+01	**1.1E+02**	Lawn Maintenance Staff
Cobalt	3.3E+04	1.8E+02	Lawn Maintenance Staff
Copper	2.3E+05	6.3E+03	Trespasser
Iron	4.0E+06	1.3E+05	Trespasser
Lead	NV	1.1E+02 (1)	--
Manganese	2.7E+04	4.2E+03	Trespasser
Mercury	5.8E+02	**9.1E+03**	Trespasser
Aroclor-1260	5.3E+00	4.4E+00	Lawn Maintenance Staff

Note:
NV: No value.

(1) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1.

As summarized in the above table, the maximum detected soil COPC concentrations for benzo(a)pyrene, arsenic, and mercury exceeded the calculated surface soil SSSs.

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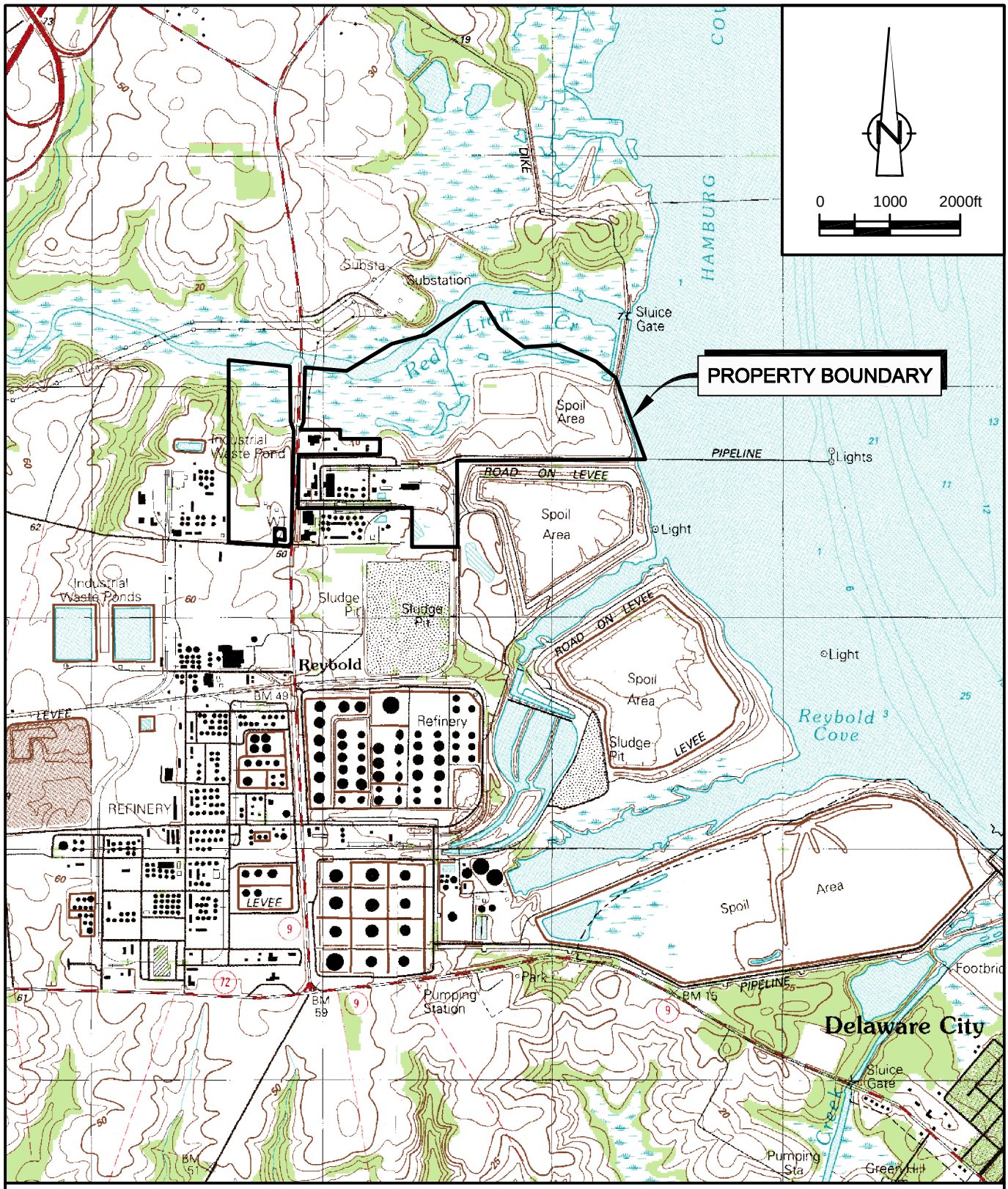
FIGURES



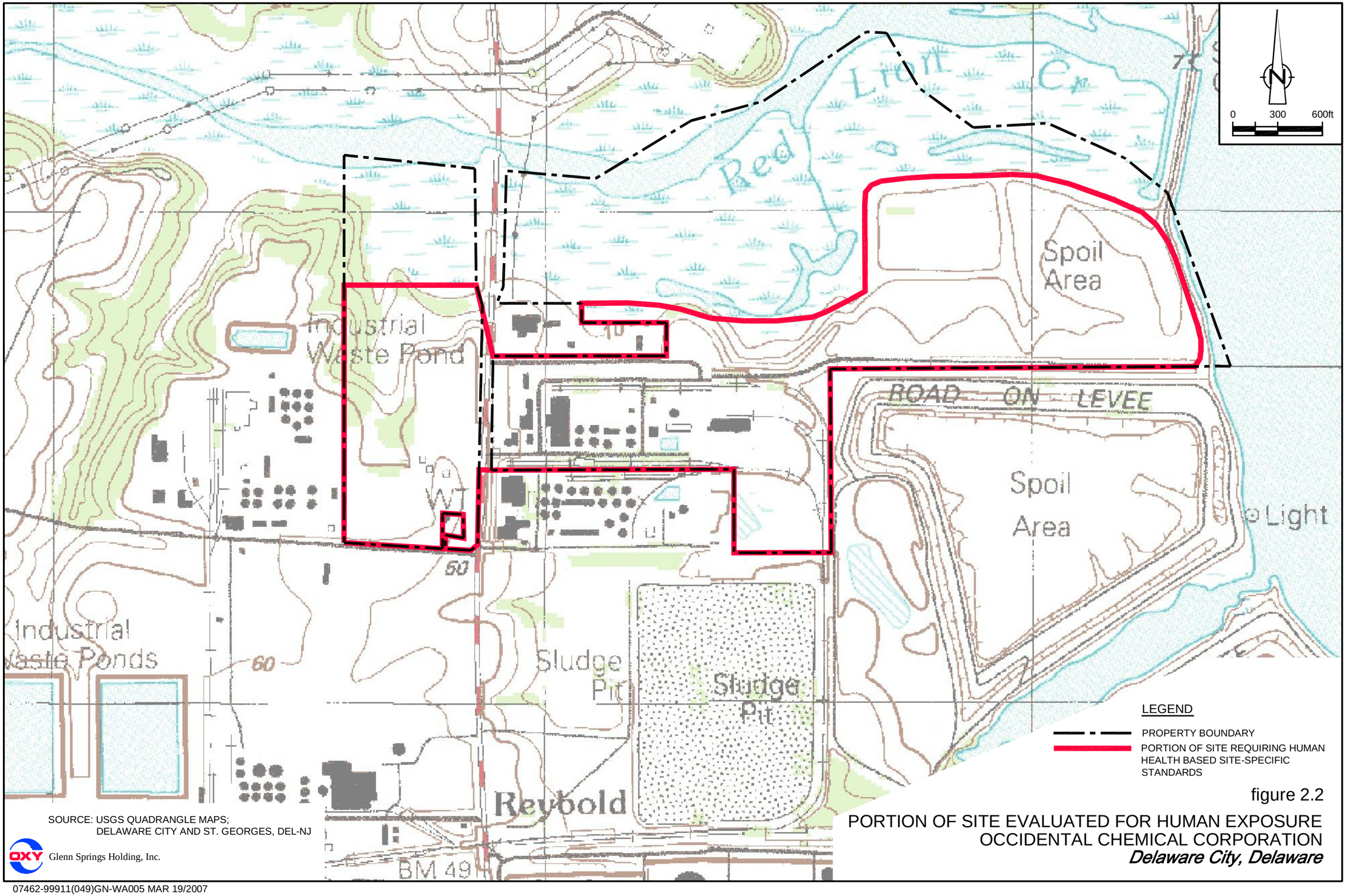
SOURCE: USGS QUADRANGLE MAPS;
DELAWARE CITY AND ST. GEORGES, DEL-NJ

Glenn Springs Holding, Inc.

figure 2.1

TOPOGRAPHY OF SITE AREA MAP
OCCIDENTAL CHEMICAL CORPORATION
Delaware City, Delaware

07462-99911(049)GN-WA004 MAR 19/2007



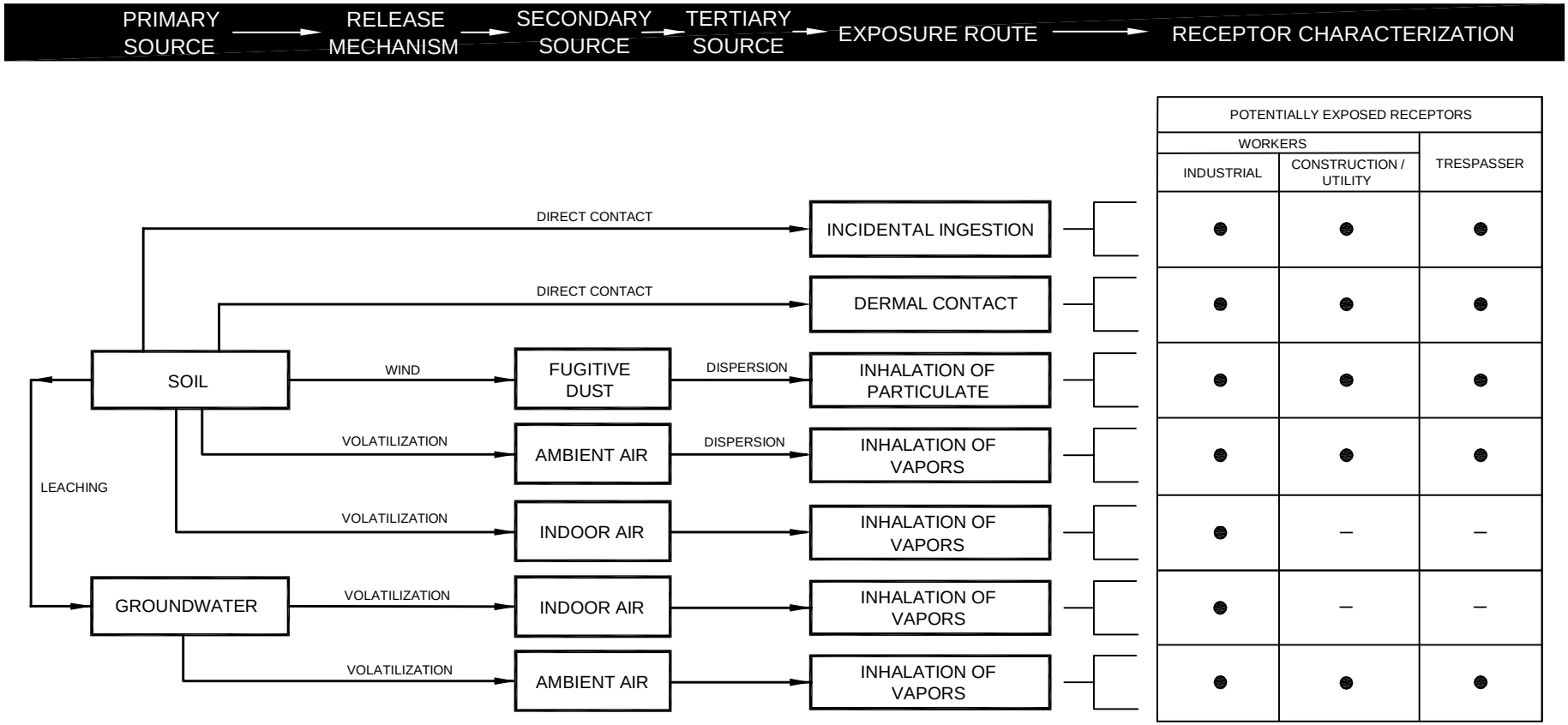
SOURCE: USGS QUADRANGLE MAPS;
DELAWARE CITY AND ST. GEORGES, DEL-NJ

Glenn Springs Holding, Inc.

figure 2.2

PORTION OF SITE EVALUATED FOR HUMAN EXPOSURE
OCCIDENTAL CHEMICAL CORPORATION
Delaware City, Delaware

07462-99911(049)GN-WA005 MAR 19/2007



LEGEND

● POTENTIALLY COMPLETE EXPOSURE PATHWAY

— INCOMPLETE EXPOSURE PATHWAY

figure 3.1

CONCEPTUAL SITE MODEL
INDUSTRIAL LAND USE SCENARIO
OCCIDENTAL CHEMICAL CORPORATION
Delaware City, Delaware

Glenn Springs Holding, Inc.

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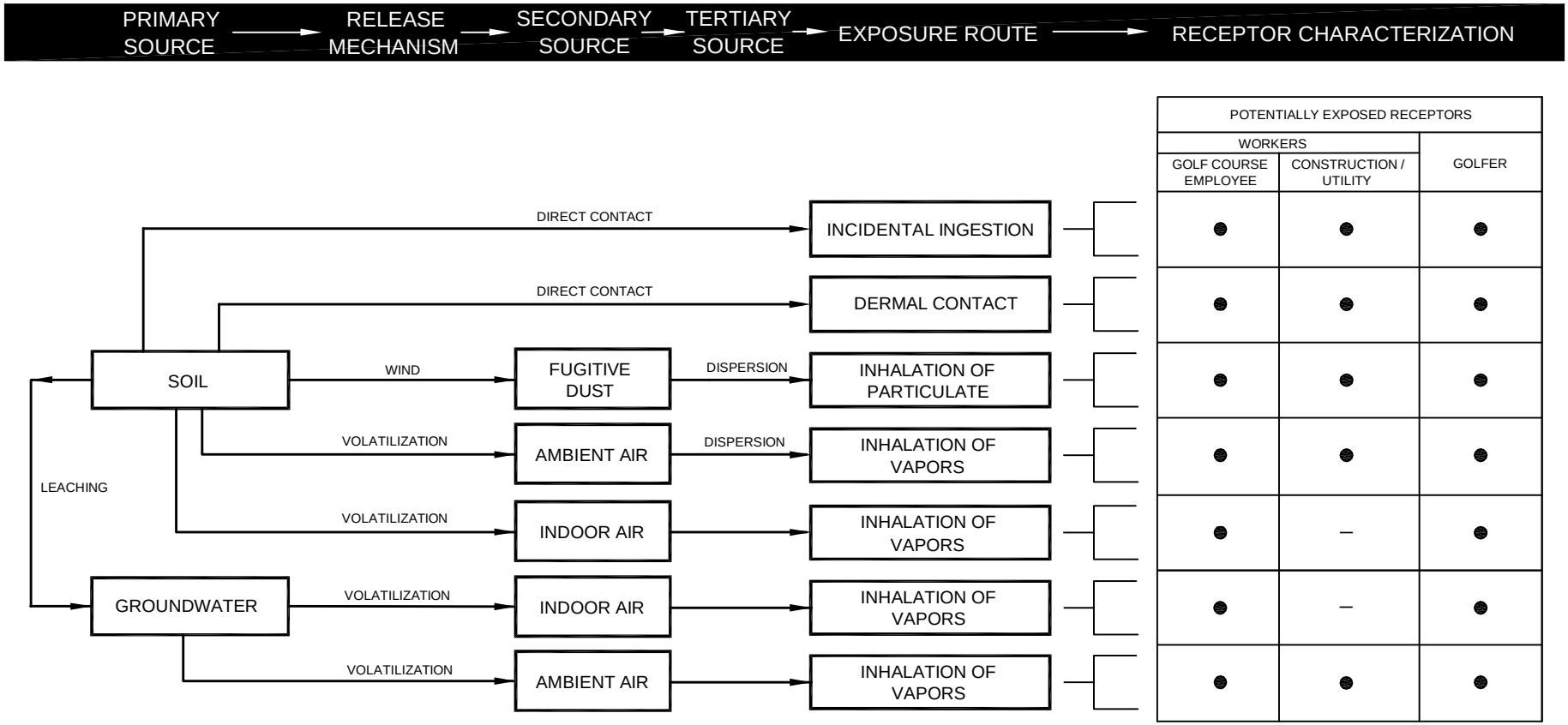

LEGEND

● POTENTIALLY COMPLETE EXPOSURE PATHWAY

— INCOMPLETE EXPOSURE PATHWAY

figure 3.2

CONCEPTUAL SITE MODEL
RECREATIONAL LAND USE (GOLF COURSE) SCENARIO
OCCIDENTAL CHEMICAL CORPORATION
Delaware City, Delaware

Glenn Springs Holding, Inc.

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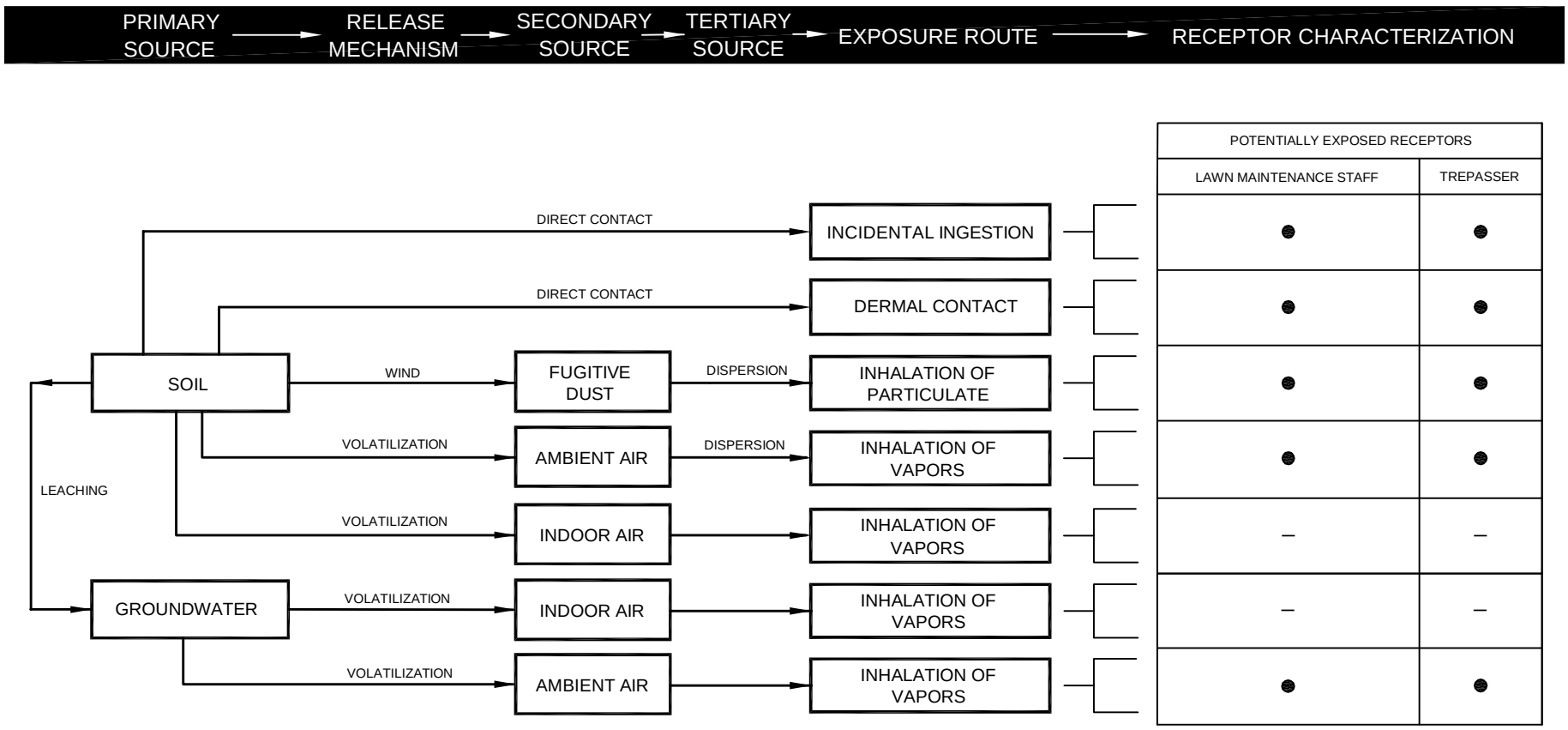

LEGEND

● POTENTIALLY COMPLETE EXPOSURE PATHWAY

— INCOMPLETE EXPOSURE PATHWAY

figure 3.3

CONCEPTUAL SITE MODEL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OCCIDENTAL CHEMICAL CORPORATION
Delaware City, Delaware

Glenn Springs Holding, Inc.

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TABLES

TABLE 3.1

DERIVATION OF MERCURY STANDARD FOR SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	*RfC inhalation (mg/m^3)*	*VF (m^3/kg)*	*Industrial Worker THQ Adult ($\mu g/g$)*	*Site-Specific Soil Standard SSS_{ss} (1) ($\mu g/g$)*
Metals				
Mercury	3.00E-04	2.52E+04	3.31E+01	3.31E+01

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table A.2.1.

Industrial Worker Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS_{ss}	calculated
Target Hazard Level (unitless)	THQ	1
Reference Concentration (mg/m^3)	RfC	chemical-specific
Exposure Time (unitless)	ET	8/24
Exposure Frequency (days/year)	EF	250
Exposure Duration (years)	ED	25
Conversion Factor (kg/mg)	CF	1.0E-06
Averaging Time - noncarc. (days)	ATnc	9,125
Volatilization Factor (m^3/kg)	VF	chemical-specific

Exposure Equations

Non-Carcinogenic Endpoints:

$$SSS_{ss} = \frac{THQ \times ATnc}{ET \times EF \times ED \times (1/RfC) \times (1/VF)}$$

TABLE 3.2

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	*Units*	*Industrial Worker* Mercury
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	2.52E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	58.17
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	1.46E-05
	T	=	exposure interval	USEPA, 2002	s	7.88E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2002 (Default)	g/cm^3	1.5

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	58.17
	"A"	=	constant	USEPA, 2002 (1)	unitless	9.9253
	Area	=	areal extent of the site or contamination	USEPA, 2002 (Default)	acres	0.5
	"B"	=	constant	USEPA, 2002 (1)	unitless	18.6636
	"C"	=	constant	USEPA, 2002 (1)	unitless	211.8862

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units	
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	1.46E-05
	Θ_a	=	air-filled porosity	USEPA, 2002 (Default)	unitless	0.284
	Θ_w	=	water-filled porosity	USEPA, 2002 (Default)	unitless	0.150
	n	=	total soil porosity	USEPA, 2002 (Default)	unitless	4.34E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2002 (Default)	g/cm^3	1.5
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002	unitless	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002	cm^2/s	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002	cm^2/s	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002 (2)	cm^3/g	5.20E+01

Notes:
(1) Based on Zone 7 - Huntington, West Virginia.
(2) Default value for mercury at pH 6.8, as specified in USEPA (2002).

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APPENDIX A

EXPOSURE ASSUMPTIONS FOR THE DEVELOPMENT OF SITE-SPECIFIC STANDARDS – INDUSTRIAL LAND USE

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TABLE A.1.1

SELECTION OF EXPOSURE PATHWAY SCENARIOS
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe	*Medium*	*Exposure Medium*	*Exposure Point*	*Receptor Population*	*Receptor Age*	*Exposure Route*	*Type of Analysis*	*Rationale for Selection or Exclusion of Exposure Pathway*
Current/ Future:	Surface Soil (0 to 2 ft bgs)	Surface Soil	Direct Contact	Trespasser	Adolescent	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while trespassing.
		Ambient Air	Direct Contact	Trespasser	Adolescent	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while trespassing.
		Surface Soil	Direct Contact	Industrial Worker	Adult	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while working outside.
		Ambient Air	Direct Contact	Industrial Worker	Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while working outside.
	Soil (0 to 15 ft bgs)	Indoor Air	Direct Contact	Industrial Worker	Adult	Inhalation of Vapors	Quant	Potential exposure to indoor air while working indoors.
	Groundwater	Indoor Air	Direct Contact	Industrial Worker	Adult	Inhalation of Vapors	Quant	Potential exposure to indoor air while working indoors.
		Ambient Air	Direct Contact	Trespasser	Adolescent	Inhalation of Vapors	Qual	Potential exposure to ambient air while trespassing.
			Direct Contact	Industrial Worker	Adult	Inhalation of Vapors	Qual	Potential exposure to ambient air while working outside.
Future:	Soil (0 to 15 ft bgs)	Soil	Direct Contact	Construction Worker	Adult	Ingestion Dermal	Quant	Potential exposure to contaminated soil during ground intrusive activities.
		Ambient Air	Direct Contact	Construction Worker	Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air during ground intrusive activities.

TABLE A.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.003	K	130		mg/kg	SB-13; SC Pipeline Area; 0-2 ftbgs (08/18/98)	26/65	0.0008 - 2.7	130	1000	N	N/A	N/A		BSC
95-50-1	1,2-Dichlorobenzene	0.0066		79		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	25/65	0.0009 - 2.7	79	9200	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.11	J	0.11	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.11	31	C	N/A	N/A		BSC
541-73-1	1,3-Dichlorobenzene	0.0062		5.2		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	13/65	0.0008 - 2.7	5.2	310	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	100		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	26/65	0.0009 - 2.7	100	120	C	N/A	N/A		BSC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.022	J	mg/kg	SCPX-01-10; SC Pipeline Area; 1 ftbgs (05/18/04)	15/45	0.0009 - 2.7	0.022	61000	N	N/A	N/A		BSC
67-64-1	Acetone	0.007	B	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	30/45	0.006 - 2.7	0.17	92000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		1.3	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	9/51	0.0008 - 2.7	1.3	52	C	N/A	N/A		BSC
75-25-2	Bromoform	0.001		0.001		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.001	360	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/41	0.0008 - 2.7	0.27	140	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.0026	J	mg/kg	SCPX-04-10; SC Pipeline Area; 1 ftbgs (05/18/04)	2/35	0.0008 - 2.7	0.0026	10000	N	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	38		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	18/51	0.0009 - 2.7	38	2000	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.017	K	0.017	K	mg/kg	SCPX-04-14; SC Pipline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.017	1000	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.027	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	2/34	0.0008 - 2.7	0.027	--	N	N/A	N/A	X	AD
108-87-2	Methyl cyclohexane	0.016	K	0.016	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/34	0.0008 - 2.7	0.016	--	N	N/A	N/A		LDF
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	33/51	0.001 - .7	0.095	380	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.004	J	0.012	J	mg/kg	WB-18; Waste Lake 2; 0-2 ftbgs (08/18/98)	12/51	0.0008 - 2.7	0.012	5.3	C	N/A	N/A		BSC
108-88-3	Toluene	0.007	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.007	8200	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	0.0045	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.0045	4	C	N/A	N/A		LDF
	Semi-volatile Organic Compounds															
120-83-2	2,4-Dichlorophenol	0.45		0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	1/51	0.35 - 0.47	0.45	310	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.072	J	0.15	J	mg/kg	FLD-32; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	2/97	0.33 - 2.4	0.15	410	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.44		0.44		mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.35 - 0.47	0.44	410	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/87	0.33 - 2.4	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/34	0.36 - 0.47	1.2	10000	N	N/A	N/A		BSC
120-12-7	Anthracene	0.086	J	0.17	J	mg/kg	FLD-06; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	4/97	0.33 - 2.4	0.17	31000	N	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/34	0.35 - 0.42	0.69	10000	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	0.83	3.9	C	N/A	N/A		BSC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	22/97	0.33 - 2.4	1	0.39	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.065	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	2	3.9	C	N/A	N/A		BSC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	9/97	0.33 - 2.4	0.3	410 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	19/97	0.33 - 2.4	1.7	39	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1.3		mg/kg	OBSL-CAP-10;Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	27/51	0.35 - 0.42	1.3	200	C	N/A	N/A		BSC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	5/51	0.35 - 0.47	0.92	20000	N	N/A	N/A		BSC
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	27/97	0.33 - 2.2	0.93	390	C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.085	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	3/97	0.33 - 2.4	0.15	0.39	C	N/A	N/A		BSC
84-66-2	Diethyl phthalate	0.34	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	6/41	0.37 - 0.47	0.53	82000	N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12	J	0.32	J	mg/kg	OBSL-CAP-10; Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	2/51	0.35 - 0.47	0.32	10000 (7)	N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.04	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	32/97	0.33 - 2.2	1.5	4100	N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.051	J	0.62		mg/kg	WB-32; Waste Lake 2; 0-2 ftbgs (08/17/98)	6/65	0.35 - 0.47	0.62	1.8	C	N/A	N/A		BSC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	11/97	0.33 - 2.4	0.45	3.9	C	N/A	N/A		BSC
78-59-1	Isophorone	0.072	J	0.072	J	mg/kg	WB-19; Waste Lake 2; 0-2 ftbgs (08/20/98)	1/50	0.35 - 0.47	0.072	3000	C	N/A	N/A		BSC
91-20-3	Naphthalene	0.1	J	0.22	J	mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	2/97	0.33 - 2.4	0.22	2000	N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.1	J	3.1	K	mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	4/41	0.35 - 0.47	3.1	51	N	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	24/97	0.33 - 2.4	1.1	410 (6)	N	N/A	N/A		BSC
129-00-0	Pyrene	0.071	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/97	0.34 - 2.2	1.6	3100	N	N/A	N/A		BSC

TABLE A.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Metals															
7429-90-5	Aluminum	5120		20100	J	mg/kg	SC-4; SC Pipeline Area; 0-4 ftbgs (04/05/04)	54/54	--	20100	--	N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	10.4	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	41/59	0.18 - 5	10.4	41	N	N/A	N/A		BSC
7440-38-2	Arsenic	0.44		110		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	110	1.9	C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	14.9		520		mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	60/60	--	520	20000	N	N/A	N/A		BSC
7440-41-7	Beryllium	0.37		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	59/60	0.62	69.3	200	N	N/A	N/A		BSC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	39/60	0.013 - 0.62	6.4	100	N	N/A	N/A		BSC
7440-70-2	Calcium	146	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	30400	--	N	N/A	N/A		NUT
7440-47-3	Chromium Total	6.5		99		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	99	150000	N	N/A	N/A		BSC
7440-48-4	Cobalt	2.2	B	182		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	182	--	N	N/A	N/A	X	AD
7440-50-8	Copper	2.7		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	55/60	11 - 12	6300	4100	N	N/A	N/A	X	ASC
7439-89-6	Iron	6900		126000		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	126000	72000	N	N/A	N/A	X	ASC
7439-92-1	Lead	2.6		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	3410	800 (9)	N	N/A	N/A	X	ASC
7439-95-4	Magnesium	500		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	12100	--	N	N/A	N/A		NUT
7439-96-5	Manganese	40.6		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	106/106	--	4200	2000	N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	156/158	0.21 - 48	9131	3.31 (10)	N	N/A	N/A	X	ASC
7440-02-0	Nickel	4.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	674	2000	N	N/A	N/A		BSC
7440-09-7	Potassium	373	J	5590	J	mg/kg	PE-SBG-GRID 12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	5590	--	N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.2	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	38/106	0.18 - 0.62	3.2	510	N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	0.68	B	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	8/60	0.048 - 60	0.68	510	N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		8650		mg/kg	PE-SBG-GRID-12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	8650	--	N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		0.72	B	mg/kg	OBSL-CAP-5; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	12/60	0.19 - 180	0.72	7.2	N	N/A	N/A		BSC
7440-62-2	Vanadium	10.3	J	45		mg/kg	SCPX-02-17; Chlorine Pipeline Area; 1- ftbgs (05/19/04)	54/54	--	45	100	N	N/A	N/A		BSC
7440-66-6	Zinc	17.4		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	28800	31000	N	N/A	N/A		BSC

TABLE A.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	1.4 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-03R, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, PE-RTR-DIRT-FROM-BRINE-RR, PE-GTB-BUILDING 1, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SC-6, WL2-F1, WL2-F2, WL2-F3, WL2-F4, WL2-F5, WL2-F6, WL2-F7, WL2-F8, WL2-F9, WL2-F10, WL2-F11, WL2-F12, WL2-F13, WL2-F14, SS-07, SS-08, SS-09, SS-10, WB-04, WB-17, WB-28, WB-29, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, PE-WWTP, A, A/B, B, C, D.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Industrial Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.

TABLE A.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.002		1100	L	mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	51/142	0.0008 - 2.8	1100	1000	N	N/A	N/A	X	ASC
95-50-1	1,2-Dichlorobenzene	0.0025		1100		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	56/142	0.0009 - 2.8	1100	9200	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.0098	J	0.47		mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	4/117	0.0008 - 31	0.47	31	C	N/A	N/A		BSC
540-59-0	1,2-Dichloroethene (total)	0.013	J	0.013	J	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/63	0.005 - 31	0.013	--	N	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	0.0036		77		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	32/141	0.0008 - 2.8	77	310	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	2000		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	62/142	0.009 - 2.8	2000	120	C	N/A	N/A	X	ASC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.031	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	19/87	0.0008 - 2.7	0.031	61000	N	N/A	N/A		BSC
67-64-1	Acetone	0.002	JB	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	65/87	0.006 - 2.7	0.17	92000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		450		mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	34/146	0.0008 - 31	450	52	C	N/A	N/A	X	ASC
75-25-2	Bromoform	0.001		0.0034		mg/kg	SC-1; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/117	0.0008 - 31	0.0034	360	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/114	0.0008 - 62	0.27	140	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.005	J	mg/kg	WL1-5; Vicinity of Waste Lake 1; 15 ftbgs (02/18/02)	3/58	0.0008 - 4.1	0.005	10000	N	N/A	N/A		BSC
56-23-5	Carbon tetrachloride	0.011		0.041		mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	3/117	0.0008 - 31	0.041	22	C	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	560		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	69/146	0.0008 - 31	560	2000	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.004	J	0.89	J	mg/kg	WB-12; Old Brine Sludge LF; 8-10 ftbgs (09/23/93)	9/117	0.0008 - 31	0.89	1000	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.034	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	5/54	0.0008 - 10	0.034	--	N	N/A	N/A	X	AD
100-41-4	Ethylbenzene	0.03		0.03		mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.03	10000	N	N/A	N/A		BSC
108-87-2	Methyl cyclohexane	0.016	K	0.054	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	4/54	0.0008 - 12	0.054	--	N	N/A	N/A	X	AD
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-1; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	73/146	0.001 - 62	0.095	380	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.002	B	1.9		mg/kg	WB-12; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	41/146	0.0008 - 31	1.9	5.3	C	N/A	N/A		BSC
108-88-3	Toluene	0.002	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	4/117	0.0008 - 31	0.007	8200	N	N/A	N/A		BSC
156-60-5	trans-1,2-Dichloroethene	0.013	JP	0.013	JP	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/102	0.0008 - 31	0.013	2000	N	N/A	N/A		BSC
79-01-6	Trichloroethene	0.012	J	0.012	J	mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.012	7.2	C	N/A	N/A		BSC
75-69-4	Trichlorofluoromethane (CFC-11)	0.0111		0.0111		mg/kg	WB-04; Waste Lake 2; 10-12 ftbgs (10/18/93)	1/113	0.0008 - 31	0.0111	31000	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	2900		mg/kg	WB-11; Waste Lake 3; 12-14 ftbgs (09/22/93)	12/115	0.0008 - 28	2900	4	C	N/A	N/A	X	ASC
1330-20-7	Xylene (total)	0.002	J	0.008	J	mg/kg	WB-19; Waste Lake 2; 8-10 ftbgs (08/20/98)	5/87	0.0008 - 21	0.008	20000	N	N/A	N/A		BSC
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	0.06	J	0.07	J	mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	2/93	0.36 - 370	0.07	10000	N	N/A	N/A		BSC
120-83-2	2,4-Dichlorophenol	0.05	J	0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	6/141	0.35 - 370	0.45	310	N	N/A	N/A		BSC
95-57-8	2-Chlorophenol	0.36	J	1.1		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/138	0.35 - 370	1.1	510	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.062	J	2.3	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	16/213	0.33 - 370	2.3	410	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.2	J	2	J	mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/102	0.35 - 370	2	410	N	N/A	N/A		BSC
106-44-5	4-Methylphenol	0.074	J	0.25	J	mg/kg	WB-20; Waste Lake 2; 8-10 ftbgs (08/24/98)	13/121	0.35 - 370	0.25	510	N	N/A	N/A		BSC
83-32-9	Acenaphthene	0.059	J	0.22	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	6/221	0.33 - 370	0.22	6100	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/192	0.33 - 370	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/51	0.35 - 3.6	1.2	10000	N	N/A	N/A		BSC
120-12-7	Anthracene	0.054	J	0.21	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	12/223	0.33 - 370	0.21	31000	N	N/A	N/A		BSC
1912-24-9	Atrazine	0.17	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/04/05)	1/51	0.35 - 3.6	0.17	13	C	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/51	0.35 - 3.6	0.69	10000	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	35/223	0.33 - 370	0.83	3.9	C	N/A	N/A		BSC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/223	0.33 - 370	1	0.39	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.056	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	33/223	0.33 - 370	2	3.9	C	N/A	N/A		BSC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	20/223	0.33 - 370	0.3	410 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	33/223	0.33 - 370	1.7	39	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1300	J	mg/kg	WB-32; Waste Lake 2; 8-10 ftbgs (09/23/93)	61/139	0.35 - 120	1300	200	C	N/A	N/A	X	ASC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	7/142	0.35 - 370	0.92	20000	N	N/A	N/A		BSC

TABLE A.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Semi-volatile Organic Compounds (cont.'d)														
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	47/223	0.33 - 370	0.93	390 C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.056	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	6/223	0.33 - 370	0.15	0.39 C	N/A	N/A		BSC
84-66-2	Diethyl phthalate	0.08	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	11/113	0.35 - 370	0.53	82000 N	N/A	N/A		BSC
84-74-2	Di-n-butylphthalate	0.04	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/05/05)	10/113	0.35 - 370	0.17	10000 N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12		3.8		mg/kg	WB-22; Waste Lake 2; 2-4 ftbgs (08/19/98)	6/135	0.35 - 120	3.8	10000 (7) N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.038	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	56/223	0.33 - 370	1.5	4100 N	N/A	N/A		BSC
86-73-7	Fluorene	0.053	J	0.33	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	8/223	0.33 - 370	0.33	4100 N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.04	J	8.2	D	mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	11/154	0.35 - 370	8.2	1.8 C	N/A	N/A	X	ASC
87-68-3	Hexachlorobutadiene	0.1	J	0.41		mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	2/86	0.35 - 11	0.41	37 C	N/A	N/A		BSC
67-72-1	Hexachloroethane	0.2	J	0.63		mg/kg	PE-SCL-Sewer Compression Line; Process Line; 4 ftbgs (01/20/04)	2/94	0.35 - 11	0.63	200 C	N/A	N/A		BSC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/218	0.33 - 370	0.45	3.9 C	N/A	N/A		BSC
78-59-1	Isophorone	0.072	J	0.1	J	mg/kg	WB-23; Waste Lake 2; 4-6 ftbgs (08/20/98)	2/115	0.35 - 11	0.1	3000 C	N/A	N/A		BSC
91-20-3	Naphthalene	0.063	J	0.57		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	22/214	0.33 - 11	0.57	2000 N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.04	J	9.6		mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	11/95	0.35 - 11	9.6	51 N	N/A	N/A		BSC
86-30-6	N-Nitrosodiphenylamine	0.06	J	0.06	J	mg/kg	WB-24; Waste Lake 2; 4-6 ftbgs (08/24/98)	1/140	0.35 - 370	0.06	580 C	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	45/223	0.33 - 370	1.1	410 (6) N	N/A	N/A		BSC
108-95-2	Phenol	0.62	J	0.71		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/140	0.35 - 370	0.71	31000 N	N/A	N/A		BSC
129-00-0	Pyrene	0.045	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	59/223	0.34 - 370	1.6	3100 N	N/A	N/A		BSC
	Metals														
7429-90-5	Aluminum	1080		22700		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	22700	-- N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	23		mg/kg	WB-13; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	67/136	0.18 - 310	23	41 N	N/A	N/A		BSC
7440-38-2	Arsenic	0.34		110		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	1.2 - 1.8	110	1.9 C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	7.1		7500	J	mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	137/143	20 - 42	7500	20000 N	N/A	N/A		BSC
7440-41-7	Beryllium	0.15		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	108/143	0.5 - 1	69.3	200 N	N/A	N/A		BSC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	92/143	0.013 - 1	6.4	100 N	N/A	N/A		BSC
7440-70-2	Calcium	112	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	30400	-- N	N/A	N/A		NUT
7440-47-3	Chromium Total	2.5		121		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	224/224	--	121	150000 N	N/A	N/A		BSC
7440-48-4	Cobalt	1.6		182		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	182	-- N	N/A	N/A	X	AD
7440-50-8	Copper	1.8		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	118/143	11 - 21	6300	4100 N	N/A	N/A	X	ASC
7439-89-6	Iron	730		126000		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	126000	72000 N	N/A	N/A	X	ASC
7439-92-1	Lead	1.5		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	224/224	--	3410	800 (9) N	N/A	N/A	X	ASC
7439-95-4	Magnesium	136		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	12100	-- N	N/A	N/A		NUT
7439-96-5	Manganese	21.3		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	224/224	--	4200	2000 N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	307/322	0.018 - 48	9131	3.31 (10) N	N/A	N/A	X	ASC
7440-02-0	Nickel	3.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	3.5 - 4	674	2000 N	N/A	N/A		BSC
7440-09-7	Potassium	108		5600		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	5600	-- N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.3	L	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	78/224	0.18 - 4.8	3.3	510 N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	1.7		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	23/143	0.043 - 60	1.7	510 N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		18000		mg/kg	WB-03; Waste Lake 2; 6-8 ftbgs (10/18/93)	136/143	110 - 500	18000	-- N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		1		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98) WB-26; Waste Lake 2; 6-8 ftbgs (08/20/98)	24/143	0.19 - 180	1	7.2 N	N/A	N/A		BSC
7440-62-2	Vanadium	5.5		79.6	J	mg/kg	WB-15; Waste Lake 2; 8-105 ftbgs (08/25/98)	84/84	--	79.6	100 N	N/A	N/A		BSC
7440-66-6	Zinc	6.3		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	28800	31000 N	N/A	N/A		BSC

TABLE A.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	*Chemical*	*Minimum Concentration (1,2)*	*Minimum Qualifier*	*Maximum Concentration (1,2)*	*Maximum Qualifier*	*Units*	*Location of Maximum Concentration*	*Detection Frequency (2)*	*Range of Detection Limits (2)*	*Maximum Concentration Used for Screening (3)*	*Screening Toxicity Value (4)*	*Potential ARAR/TBC Value*	*Potential ARAR/TBC Source*	*COPC Flag*	*Rationale for Contaminant Deletion or Selection (5)*
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	1.4 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: KOH-DILUTION, LOADING-SCALE, SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, SCPX-04-14, SCPX-04-18, SB-03, WB-14A, A-67D, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, A-69, A-70, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, SB-02, WB-12, WB-13, WB-13T, PE-RTR-DIRT-FROM-BRINE-44, PE-GTB-GTW-EXCAVATION, PE-SCL-Sewer Compression Line, PE-BWC-1+00, PE-BWC-2+00, PE-BWC-3+00, PE-BWC-4+00, PE-BWC-5+00, PE-BWC-6+00, PE-BWC-7+00, PE-BWC-8+00, PE-BWC-9+50, PE-BWC-10+00, PE-BWC-11+45, PE-BWC-12+00, PE-BWC-13+00, PE-BWC-13+85, PE-BWC-14+60, PE-BWC-15+70, PE-BWC-18+00, PE-BWC-18+50, PE-BWC-19+00, PE-BWC-20+00, PE-BWC-21+00, PE-BWC-22+00, PE-BWC-23+00, PE-BWC-24+00, PE-BWC-25+00, PE-BWC-26+00, PE-BWC-27+40, PE-BWC-28+00, PE-BWC-29+00, PE-BWC-30+00, PE-BWC-31+00, PE-BWC-32+00, PE-GTB-BUILDING 1, Pipe Support Foundation, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, A-62S, SB-10, SB-11, SB-12, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SB-6, SB-8, SS-06, SB-01, SB-07, WL1-5, WL2-F1, WL2-F2, WL2-F3, WL2-F4, SS-07, SS-08, SS-09, SS-10, SB-04, SB-04A, SB-04B, SB-05, WB-03, WB-04, WB-05, WB-06, WB-07, WB-08, WB-09, WB-14-1998, WB-15, WB-16, WB-17, WB-18, WB-19, WB-20, WB-21, WB-22, WB-23, WB-24, WB-25, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, SB-08, SB-09, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, WB-11, PE-WWTP, A, A/B, B, C, D, E.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Industrial Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.
P = Greater than 25% difference between two GC columns.

TABLE A.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.002		1100	L	mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	51/142	0.0008 - 2.8	1100	--	N	N/A	N/A	X	VOC
95-50-1	1,2-Dichlorobenzene	0.0025		1100		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	56/142	0.0009 - 2.8	1100	--	N	N/A	N/A	X	VOC
107-06-2	1,2-Dichloroethane	0.0098	J	0.47		mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	4/117	0.0008 - 31	0.47	--	C	N/A	N/A		LDF
540-59-0	1,2-Dichloroethene (total)	0.013	J	0.013	J	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/63	0.005 - 31	0.013	--	N	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	0.0036		77		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	32/141	0.0008 - 2.8	77	--	N	N/A	N/A	X	VOC
106-46-7	1,4-Dichlorobenzene	0.0011	B	2000		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	62/142	0.009 - 2.8	2000	--	C	N/A	N/A	X	VOC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.031	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	19/87	0.0008 - 2.7	0.031	--	N	N/A	N/A	X	VOC
67-64-1	Acetone	0.002	JB	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	65/87	0.006 - 2.7	0.17	--	N	N/A	N/A	X	VOC
71-43-2	Benzene	0.0011		450		mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	34/146	0.0008 - 31	450	--	C	N/A	N/A	X	VOC
75-25-2	Bromoform	0.001		0.0034		mg/kg	SC-1; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/117	0.0008 - 31	0.0034	--	C	N/A	N/A		LDF
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/114	0.0008 - 62	0.27	--	N	N/A	N/A		LDF
75-15-0	Carbon disulfide	0.002	J	0.005	J	mg/kg	WL1-5; Vicinity of Waste Lake 1; 15 ftbgs (02/18/02)	3/58	0.0008 - 4.1	0.005	--	N	N/A	N/A	X	VOC
56-23-5	Carbon tetrachloride	0.011		0.041		mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	3/117	0.0008 - 31	0.041	--	C	N/A	N/A		LDF
108-90-7	Chlorobenzene	0.001	J	560		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	69/146	0.0008 - 31	560	--	N	N/A	N/A	X	VOC
67-66-3	Chloroform (Trichloromethane)	0.004	J	0.89	J	mg/kg	WB-12; Old Brine Sludge LF; 8-10 ftbgs (09/23/93)	9/117	0.0008 - 31	0.89	--	N	N/A	N/A	X	VOC
110-82-7	Cyclohexane	0.0052		0.034	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	5/54	0.0008 - 10	0.034	--	N	N/A	N/A	X	VOC
100-41-4	Ethylbenzene	0.03		0.03		mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.03	--	N	N/A	N/A		LDF
108-87-2	Methyl cyclohexane	0.016	K	0.054	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	4/54	0.0008 - 12	0.054	--	N	N/A	N/A	X	VOC
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-1; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	73/146	0.001 - 62	0.095	--	C	N/A	N/A	X	VOC
127-18-4	Tetrachloroethene	0.002	B	1.9		mg/kg	WB-12; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	41/146	0.0008 - 31	1.9	--	C	N/A	N/A	X	VOC
108-88-3	Toluene	0.002	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	4/117	0.0008 - 31	0.007	--	N	N/A	N/A		LDF
156-60-5	trans-1,2-Dichloroethene	0.013	JP	0.013	JP	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/102	0.0008 - 31	0.013	--	N	N/A	N/A		LDF
79-01-6	Trichloroethene	0.012	J	0.012	J	mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.012	--	C	N/A	N/A		LDF
75-69-4	Trichlorofluoromethane (CFC-11)	0.0111		0.0111		mg/kg	WB-04; Waste Lake 2; 10-12 ftbgs (10/18/93)	1/113	0.0008 - 31	0.0111	--	N	N/A	N/A		LDF
75-01-4	Vinyl chloride	0.0045	J	2900		mg/kg	WB-11; Waste Lake 3; 12-14 ftbgs (09/22/93)	12/115	0.0008 - 28	2900	--	C	N/A	N/A	X	VOC
1330-20-7	Xylene (total)	0.002	J	0.008	J	mg/kg	WB-19; Waste Lake 2; 8-10 ftbgs (08/20/98)	5/87	0.0008 - 21	0.008	--	N	N/A	N/A	X	VOC
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	0.06	J	0.07	J	mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	2/93	0.36 - 370	0.07	--	N	N/A	N/A		NVOC
120-83-2	2,4-Dichlorophenol	0.05	J	0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	6/141	0.35 - 370	0.45	--	N	N/A	N/A		NVOC
95-57-8	2-Chlorophenol	0.36	J	1.1		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/138	0.35 - 370	1.1	--	N	N/A	N/A		LDF
91-57-6	2-Methylnaphthalene	0.062	J	2.3	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	16/213	0.33 - 370	2.3	--	N	N/A	N/A	X	VOC
106-47-8	4-Chloroaniline	0.2	J	2	J	mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/102	0.35 - 370	2	--	N	N/A	N/A		NVOC
106-44-5	4-Methylphenol	0.074	J	0.25	J	mg/kg	WB-20; Waste Lake 2; 8-10 ftbgs (08/24/98)	13/121	0.35 - 370	0.25	--	N	N/A	N/A		NVOC
83-32-9	Acenaphthene	0.059	J	0.22	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	6/221	0.33 - 370	0.22	--	N	N/A	N/A		LDF
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/192	0.33 - 370	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/51	0.35 - 3.6	1.2	--	N	N/A	N/A	X	VOC
120-12-7	Anthracene	0.054	J	0.21	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	12/223	0.33 - 370	0.21	--	N	N/A	N/A	X	VOC
1912-24-9	Atrazine	0.17	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/04/05)	1/51	0.35 - 3.6	0.17	--	C	N/A	N/A		NVOC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/51	0.35 - 3.6	0.69	--	N	N/A	N/A	X	VOC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	35/223	0.33 - 370	0.83	--	C	N/A	N/A		NVOC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/223	0.33 - 370	1	--	C	N/A	N/A		NVOC
205-99-2	Benzo(b)fluoranthene	0.056	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	33/223	0.33 - 370	2	--	C	N/A	N/A	X	VOC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	20/223	0.33 - 370	0.3	--	N	N/A	N/A		NVOC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	33/223	0.33 - 370	1.7	--	C	N/A	N/A		NVOC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1300	J	mg/kg	WB-32; Waste Lake 2; 8-10 ftbgs (09/23/93)	61/139	0.35 - 120	1300	--	C	N/A	N/A		NVOC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	7/142	0.35 - 370	0.92	--	N	N/A	N/A		NVOC

TABLE A.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Semi-volatile Organic Compounds (cont.'d)															
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	47/223	0.33 - 370	0.93	--	C	N/A	N/A	X	VOC
53-70-3	Dibenz(a,h)anthracene	0.056	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	6/223	0.33 - 370	0.15	--	C	N/A	N/A		NVOC
84-66-2	Diethyl phthalate	0.08	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	11/113	0.35 - 370	0.53	--	N	N/A	N/A		NVOC
84-74-2	Di-n-butylphthalate	0.04	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/05/05)	10/113	0.35 - 370	0.17	--	N	N/A	N/A		NVOC
117-84-0	Di-n-octyl phthalate	0.12		3.8		mg/kg	WB-22; Waste Lake 2; 2-4 ftbgs (08/19/98)	6/135	0.35 - 120	3.8	--	N	N/A	N/A		LDF
206-44-0	Fluoranthene	0.038	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	56/223	0.33 - 370	1.5	--	N	N/A	N/A	X	VOC
86-73-7	Fluorene	0.053	J	0.33	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	8/223	0.33 - 370	0.33	--	N	N/A	N/A		LDF
118-74-1	Hexachlorobenzene	0.04	J	8.2	D	mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	11/154	0.35 - 370	8.2	--	C	N/A	N/A	X	VOC
87-68-3	Hexachlorobutadiene	0.1	J	0.41		mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	2/86	0.35 - 11	0.41	--	C	N/A	N/A		LDF
67-72-1	Hexachloroethane	0.2	J	0.63		mg/kg	PE-SCL-Sewer Compression Line; Process Line; 4 ftbgs (01/20/04)	2/94	0.35 - 11	0.63	--	C	N/A	N/A		LDF
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/218	0.33 - 370	0.45	--	C	N/A	N/A		NVOC
78-59-1	Isophorone	0.072	J	0.1	J	mg/kg	WB-23; Waste Lake 2; 4-6 ftbgs (08/20/98)	2/115	0.35 - 11	0.1	--	C	N/A	N/A		NVOC
91-20-3	Naphthalene	0.063	J	0.57		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	22/214	0.33 - 11	0.57	--	N	N/A	N/A	X	VOC
98-95-3	Nitrobenzene	0.04	J	9.6		mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	11/95	0.35 - 11	9.6	--	N	N/A	N/A	X	VOC
86-30-6	N-Nitrosodiphenylamine	0.06	J	0.06	J	mg/kg	WB-24; Waste Lake 2; 4-6 ftbgs (08/24/98)	1/140	0.35 - 370	0.06	--	C	N/A	N/A		NVOC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	45/223	0.33 - 370	1.1	--	N	N/A	N/A	X	VOC
108-95-2	Phenol	0.62	J	0.71		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/140	0.35 - 370	0.71	--	N	N/A	N/A		NVOC
129-00-0	Pyrene	0.045	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	59/223	0.34 - 370	1.6	--	N	N/A	N/A	X	VOC
	Metals															
7429-90-5	Aluminum	1080		22700		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	22700	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	0.19	L	23		mg/kg	WB-13; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	67/136	0.18 - 310	23	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	0.34		110		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	1.2 - 1.8	110	--	C	N/A	N/A		NVOC
7440-39-3	Barium	7.1		7500	J	mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	137/143	20 - 42	7500	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.15		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	108/143	0.5 - 1	69.3	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	92/143	0.013 - 1	6.4	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	112	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	30400	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	2.5		121		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	224/224	--	121	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.6		182		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	182	--	N	N/A	N/A		NVOC
7440-50-8	Copper	1.8		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	118/143	11 - 21	6300	--	N	N/A	N/A		NVOC
7439-89-6	Iron	730		126000		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	126000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.5		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	224/224	--	3410	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	136		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	12100	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	21.3		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	224/224	--	4200	--	N	N/A	N/A		NVOC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	307/322	0.018 - 48	9131	--	N	N/A	N/A	X	VOC
7440-02-0	Nickel	3.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	3.5 - 4	674	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	108		5600		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	5600	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	0.23	BN	3.3	L	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	78/224	0.18 - 4.8	3.3	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.066	L	1.7		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	23/143	0.043 - 60	1.7	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	17.4		18000		mg/kg	WB-03; Waste Lake 2; 6-8 ftbgs (10/18/93)	136/143	110 - 500	18000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	0.2		1		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98) WB-26; Waste Lake 2; 6-8 ftbgs (08/20/98)	24/143	0.19 - 180	1	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	5.5		79.6	J	mg/kg	WB-15; Waste Lake 2; 8-105 ftbgs (08/25/98)	84/84	--	79.6	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	6.3		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	28800	--	N	N/A	N/A		NVOC

TABLE A.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	*Chemical*	*Minimum Concentration (1,2)*	*Minimum Qualifier*	*Maximum Concentration (1,2)*	*Maximum Qualifier*	*Units*	*Location of Maximum Concentration*	*Detection Frequency (2)*	*Range of Detection Limits (2)*	*Maximum Concentration Used for Screening (3)*	*Screening Toxicity Value*	*Potential ARAR/TBC Value*	*Potential ARAR/TBC Source*	*COPC Flag*	*Rationale for Contaminant Deletion or Selection (4)*
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	-- C	N/A	N/A		NVOC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: KOH-DILUTION, LOADING-SCALE, SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, SCPX-04-14, SCPX-04-18, SB-03, WB-14A, A-67D, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, A-69, A-70, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, SB-02, WB-12, WB-13, WB-13T, PE-RTR-DIRT-FROM-BRINE-44, PE-GTB-GTW-EXCAVATION, PE-SCL-Sewer Compression Line, PE-BWC-1+00, PE-BWC-2+00, PE-BWC-3+00, PE-BWC-4+00, PE-BWC-5+00, PE-BWC-6+00, PE-BWC-7+00, PE-BWC-8+00, PE-BWC-9+50, PE-BWC-10+00, PE-BWC-11+45, PE-BWC-12+00, PE-BWC-13+00, PE-BWC-13+85, PE-BWC-14+60, PE-BWC-15+70, PE-BWC-18+00, PE-BWC-18+50, PE-BWC-19+00, PE-BWC-20+00, PE-BWC-21+00, PE-BWC-22+00, PE-BWC-23+00, PE-BWC-24+00, PE-BWC-25+00, PE-BWC-26+00, PE-BWC-27+40, PE-BWC-28+00, PE-BWC-29+00, PE-BWC-30+00, PE-BWC-31+00, PE-BWC-32+00, PE-GTB-BUILDING 1, Pipe Support Foundation, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, A-62S, SB-10, SB-11, SB-12, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SB-6, SB-8, SS-06, SB-01, SB-07, WL1-5, WL2-F1, WL2-F2, WL2-F3, WL2-F4, SS-07, SS-08, SS-09, SS-10, SB-04, SB-04A, SB-04B, SB-05, WB-03, WB-04, WB-05, WB-06, WB-07, WB-08, WB-09, WB-14-1998, WB-15, WB-16, WB-17, WB-18, WB-19, WB-20, WB-21, WB-22, WB-23, WB-24, WB-25, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, SB-08, SB-09, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, WB-11, PE-WWTP, A, A/B, B, C, D, E.

(3) Screening concentration is the maximum detected concentration.

(4) Rationale Codes
Selection Reason : Analyte considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway complete (VOC).
Deletion Reason : Not considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway incomplete (NVOC).
Low Detection Frequency, less than 5% (LDF)

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.
P = Greater than 25% difference between two GC columns.

TABLE A.2.4

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN OVERBURDEN/ WATER TABLE WELL GROUNDWATER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
71-55-6	1,1,1-Trichloroethane	1		4.9	K	µg/L	A-46; Vicinity of Process Area (03/16/05)	29/230	1 - 1200	4.9	310	N	N/A	N/A		BSC
79-34-5	1,1,2,2-Tetrachloroethane	2		2		µg/L	A-48; Process Area (06/24/05)	1/230	1 - 1200	2	3	C	N/A	N/A		BSC
75-34-3	1,1-Dichloroethane	1	K	2	K	µg/L	A-59S; Vicinity of Waste Lake 1 (10/13/05)	7/230	1 - 1200	2	220	N	N/A	N/A		BSC
							A-59S; Vicinity of Waste Lake 1 (12/08/05)									
							A-59S; Vicinity of Waste Lake 1 (02/24/06)									
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
75-35-4	1,1-Dichloroethene	1		41		µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	42/230	1 - 1200	41	19	N	N/A	N/A	X	ASC
120-82-1	1,2,4-Trichlorobenzene	1		4200		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	64/230	1 - 1200	4200	340	N	N/A	N/A	X	ASC
95-50-1	1,2-Dichlorobenzene	1		25000		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	109/230	1	25000	260	N	N/A	N/A	X	ASC
107-06-2	1,2-Dichloroethane	5.2		14		µg/L	A-39S; Vicinity of Waste Lake 1 (10/12/05)	2/230	1 - 1200	14	5 *	C	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	1		2500		µg/L	A-61S; Vicinity of Waste Lake 1 (12/08/05)	89/230	1 - 2000	2500	83	N	N/A	N/A	X	ASC
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
106-46-7	1,4-Dichlorobenzene	1	B	45000		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	119/230	1	45000	820	C	N/A	N/A	X	ASC
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
78-93-3	2-Butanone (Methyl Ethyl Ketone)	2	K	25		µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	4/230	5 - 6200	25	44000	N	N/A	N/A		BSC
591-78-6	2-Hexanone	1	J	1	J	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/230	5 - 6200	1	--	N	N/A	N/A		LDF
108-10-1	4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	7	J	7	J	µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	1/230	5 - 6200	7	1400	N	N/A	N/A		BSC
67-64-1	Acetone	3	J	1100	J	µg/L	A-69; Vicinity of Waste Lake 1 (10/14/05)	62/230	5 - 6200	1100	22000	N	N/A	N/A		BSC
							A-75; Vicinity of Waste Lake 1 (10/14/05)									
71-43-2	Benzene	1		98000		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	94/230	0.7	98000	5 *	C	N/A	N/A	X	ASC
75-27-4	Bromodichloromethane	3.1		3.1		µg/L	A-49; Vicinity of Process Area (05/19/06)	1/230	1 - 1200	3.1	2.1	C	N/A	N/A		LDF
75-15-0	Carbon disulfide	1	K	15		µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	10/230	1 - 1200	15	56	N	N/A	N/A		BSC
56-23-5	Carbon tetrachloride	1		600		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	54/230	1 - 1200	600	5 *	C	N/A	N/A	X	ASC
108-90-7	Chlorobenzene	1		230000		µg/L	A-37S; Vicinity of Waste Lake 1 (10/13/05)	119/230	1	230000	39	N	N/A	N/A	X	ASC
75-00-3	Chloroethane	1		19	K	µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	4/230	1 - 1200	19	2800	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	1		150	J	µg/L	A-27S; Vicinity of Process Area (05/24/06)	97/230	1 - 1200	150	80 *	C	N/A	N/A	X	ASC
74-87-3	Chloromethane (Methyl Chloride)	3	J	6	J	µg/L	A-37S; Vicinity of Waste Lake 1 (02/23/06)	1/230	1 - 1200	6	6.7	C	N/A	N/A		BSC
156-59-2	cis-1,2-Dichloroethene	1	J	24		µg/L	A-48; Process Area (06/24/05)	37/230	1 - 1200	24	21	N	N/A	N/A	X	ASC
110-82-7	Cyclohexane	1		170			A-37S; Vicinity of Waste Lake 1 (12/08/05)	25/230	1 - 1200	170	--	N	N/A	N/A	X	AD
100-41-4	Ethylbenzene	1		4.8		µg/L	A-50; Vicinity of Process Area (03/16/05)	7/230	1 - 1200	4.8	700 *	N	N/A	N/A		LDF
108-87-2	Methylcyclohexane	2	K	39	K		A-61S; Vicinity of Waste Lake 1 (02/24/06)	18/230	1 - 1200	39	71	N	N/A	N/A		BSC
1634-04-4	Methyl Tert Butyl Ether	1		10		µg/L	A-67S; Vicinity of Process Area/ Vicinity of Chlorine Pipeline (10/12/05)	21/230	1 - 1200	10	12000	C	N/A	N/A		BSC
75-09-2	Methylene chloride	1		7900		µg/L	A-37S; Vicinity of Waste Lake 1 (08/31/06)	22/230	1 - 1200	7900	58	C	N/A	N/A	X	ASC
127-18-4	Tetrachloroethene	1		370		µg/L	A-48; Process Area (06/24/05)	128/230	1 - 2000	370	5 *	C	N/A	N/A	X	ASC
108-88-3	Toluene	1	K	200		µg/L	R-110; Vicinity of Waste Lake 1 (12/08/05)	47/230	1 - 1200	200	150	N	N/A	N/A	X	ASC
156-60-5	trans-1,2-Dichloroethene	1	J	9		µg/L	A-37S; Vicinity of Waste Lake 1 (12/08/05)	8/230	1 - 1200	9	18	N	N/A	N/A		BSC
79-01-6	Trichloroethene	1	B	16		µg/L	A-37S; Vicinity of Waste Lake 1 (12/08/05)	69/230	1 - 1200	16	5 *	C	N/A	N/A	X	ASC
75-01-4	Vinyl chloride	1		4000		µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	64/230	1 - 2000	4000	2 *	C	N/A	N/A	X	ASC
1330-20-7	Xylene (total)	2	K	19		µg/L	A-50; Vicinity of Process Area (03/16/05)	12/230	1 - 1200	19	2200 (6)	N	N/A	N/A		BSC

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OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN OVERBURDEN/WATER TABLE WELL GROUNDWATER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	1	J	2	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	2/75	25 - 250	2	--	N	N/A	N/A		NVOC
88-06-2	2,4,6-Trichlorophenol	1	J	2	K	µg/L	A-37S; Vicinity of Waste Lake 1 (10/13/05)	2/75	10 - 100	2	--	C	N/A	N/A		NVOC
120-83-2	2,4-Dichlorophenol	1	J	39	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	14/75	10 - 100	39	--	N	N/A	N/A		NVOC
95-57-8	2-Chlorophenol	4	J	340	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	13/75	10 - 100	340	110	N	N/A	N/A	X	ASC
91-57-6	2-Methylnaphthalene	2	J	2	J	µg/L	A-27D; Vicinity of Process Area (10/12/05)	1/76	10 - 100	2	330	N	N/A	N/A		BSC
95-48-7	2-Methylphenol	63		95		µg/L	A-75; Vicinity of Waste Lake 1 (08/30/06)	2/75	10 - 100	95	--	N	N/A	N/A		NVOC
106-44-5	4-Methylphenol	5	J	130	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	4/75	10 - 100	130	--	N	N/A	N/A		NVOC
98-86-2	Acetophenone	10		52		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	4/76	10 - 100	52	80000	N	N/A	N/A		BSC
1912-24-9	Atrazine	1	L	5	J	µg/L	A-23; Old/ New Brine Sludge LF (08/24/06)	8/76	10 - 100	5	--	C	N/A	N/A		NTX
100-52-7	Benzaldehyde	2	K	2	K	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/76	10 - 100	2	36000	N	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	1	J	3	J	µg/L	A-27S; Vicinity of Process Area (10/12/05)	13/76	10 - 100	3	--	C	N/A	N/A		NVOC
105-60-2	Caprolactam	1	J	1	J	µg/L	A-76; Waste Lake 1/ Vicinity of Waste Lake 1 (10/12/05) R-110; Vicinity of Waste Lake 1 (10/13/05)	2/76	10 - 100	1	--	N	N/A	N/A		LDF
84-66-2	Diethyl phthalate	8	J	34	J	µg/L	A-62S; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/13/05)	3/76	10 - 100	34	--	N	N/A	N/A		NVOC
84-74-2	Di-n-butylphthalate	1	B	3	J	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	12/76	10 - 100	3	--	N	N/A	N/A		NVOC
87-68-3	Hexachlorobutadiene	1	J	4	J	µg/L	A-44; Vicinity of Process Area (08/28/06)	2/76	10 - 100	4	0.33	C	N/A	N/A		LDF
67-72-1	Hexachloroethane	2	J	28		µg/L	A-27D; Vicinity of Process Area (08/28/06)	5/76	10 - 100	28	3.8	C	N/A	N/A	X	ASC
78-59-1	Isophorone	1	J	1	J	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/76	10 - 100	1	--	C	N/A	N/A		NVOC
91-20-3	Naphthalene	1	J	41		µg/L	A-75; Vicinity of Waste Lake 1 (08/30/06)	16/76	10 - 100	41	15	N	N/A	N/A	X	ASC
98-95-3	Nitrobenzene	2	J	2	J	µg/L	A-69; Vicinity of Waste Lake 1 (08/31/06)	1/76	10 - 100	2	200	N	N/A	N/A		BSC
108-95-2	Phenol	4	J	620	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	13/75	10 - 100	620	--	N	N/A	N/A		NVOC
	Metals															
7429-90-5	Aluminum	9.5	B	11500		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	133/139	9.9 - 12.4	11500	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	2.3		8	J	µg/L	A-7A; New Brine Sludge LF (08/24/06)	14/139	2.1 - 5.8	8	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	1.8	B	1560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	59/139	1.7 - 5.6	1560	--	C	N/A	N/A		NVOC
7440-39-3	Barium	4.4		1400		µg/L	A-32OB; Waste Lake 2 (06/23/05)	138/139	6.4	1400	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.1		2	B	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	47/139	0.1 - 17.1	2	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.16	B	11.8		µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	76/139	0.12 - 0.65	11.8	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	606	B	461000		µg/L	A-35D; Process Area (06/24/05)	161/161	--	461000	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	0.55	J	183		µg/L	A-27D; Vicinity of Process Area (08/28/06)	93/139	0.34 - 2.4	183	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.2	J	361		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	87/139	1.1 - 3	361	--	N	N/A	N/A		NVOC
7440-50-8	Copper	1		22.6		µg/L	R-110; Vicinity of Waste Lake 1 (02/23/06)	84/139	0.96 - 1.6	22.6	--	N	N/A	N/A		NVOC
7439-89-6	Iron	11.1		293000		µg/L	A-55; Waste Lake 1 (06/24/05)	127/139	4.3 - 17.8	293000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.4		32.5		µg/L	A-55; Waste Lake 1 (06/24/05)	31/139	1.1 - 15.2	32.5	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	12.1	B	259000		µg/L	A-32OB; Waste Lake 2 (06/23/05)	139/139	--	259000	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	2.9	J	57100		µg/L	A-29S; Waste Lake 2 (06/23/05) A-59S; Vicinity of Waste Lake 1 (06/17/05)	171/171	--	57100	--	N	N/A	N/A		NVOC
7439-97-6	Mercury	0.1		309	K	µg/L	A-34S; Process Area (06/24/05)	143/211	0.1	309	0.068	N	N/A	N/A	X	ASC
7440-02-0	Nickel	1.4	J	66.6		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	94/139	1 - 6.6	66.6	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	1370	B	2430000		µg/L	A-40D; Process Area (06/24/05)	173/173	--	2430000	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	2		17.4		µg/L	A-57; Waste Lake 1 (06/24/05)	53/139	1.7 - 5.4	17.4	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.47	J	8.8	J	µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	30/139	0.38 - 3.6	8.8	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	11100		9150000		µg/L	A-47; Vicinity of Waste Lake 1 (02/23/06)	172/172	--	9150000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	1.8		14.2		µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	32/139	1.7 - 5	14.2	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	1.8		4560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	43/139	1.3 - 5.4	4560	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	3.2	B	1060		µg/L	A-76; Waste Lake 1/ Vicinity of Waste Lake 1 (09/06/06)	138/139	2.1	1060	--	N	N/A	N/A		NVOC

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OXYCHEM
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Scenario Timeframe: Current/ Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Dissolved Metals															
7429-90-5	Aluminum	8	B	8540		µg/L	A-47; Vicinity of Waste Lake 1 (03/17/05)	104/161	6.5 - 12.4	8540	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	2.2		8.9		µg/L	A-29S; Waste Lake 2 (06/23/05)	10/161	2.1 - 5.8	8.9	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	1.7		1560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	86/161	1.7 - 5.6	1560	--	C	N/A	N/A		NVOC
7440-39-3	Barium	3.8	B	1210		µg/L	A-32OB; Waste Lake 2 (06/23/05)	160/161	6.4	1210	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.1		1.8	B	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	49/161	0.1 - 17.1	1.8	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.13	B	182	J	µg/L	A-33D; Waste Lake 3/ Vicinity of Chlorine Pipeline (08/25/06)	68/161	0.12 - 0.65	182	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	650	B	290000		µg/L	A-35D; Process Area (06/24/05)	161/161	--	290000	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	0.39	B	186		µg/L	A-27D; Vicinity of Process Area (08/28/06)	93/161	0.34 - 2.4	186	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.3	J	366		µg/L	A-39D; Vicinity of Waste Lake 1 (03/16/05)	89/161	1.2 - 3	366	--	N	N/A	N/A		NVOC
7440-50-8	Copper	0.97	B	39	J	µg/L	A-68S; Vicinity of Process Area/ Vicinity of Chlorine Pipeline (08/29/06)	91/161	0.9 - 1.6	39	--	N	N/A	N/A		NVOC
7439-89-6	Iron	4.2	B	262000		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	142/161	6.3 - 17.8	262000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.2	J	21.3		µg/L	A-29S; Waste Lake 2 (06/23/05)	25/162	1.1 - 15.2	21.3	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	11.4	B	237000		µg/L	A-32OB; Waste Lake 2 (06/23/05)	161/161	--	237000	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	0.93	J	59500		µg/L	A-29S; Waste Lake 2 (06/23/05)	184/185	1.2	59500	--	N	N/A	N/A		NVOC
7487-94-7	Mercury	0.1		272		µg/L	A-34S; Process Area (06/24/05)	132/225	0.1	272	0.068	N	N/A	N/A	X	ASC
7440-02-0	Nickel	1.4		64.5		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	113/161	1 - 6.6	64.5	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	1490		2550000		µg/L	A-40D; Process Area (06/24/05)	187/187	--	2550000	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	2.1		22.4		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	85/161	1.7 - 5.4	22.4	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.46	J	3.2	J	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	39/161	0.38 - 3.6	3.2	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	21300		8880000		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	185/185	--	8880000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	1.8		8.7		µg/L	A-39D; Vicinity of Waste Lake 1 (02/23/06)	40/161	1.7 - 31	8.7	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	1.3		4560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	35/161	1 - 5.4	4560	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	1.2		489		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	152/161	2.1	489	--	N	N/A	N/A		NVOC
	Gas															
--	Ethane	0.5	J	15		µg/L	A-62S; Waste Lake 3/ Vicinity of Chlorine Pipeline (02/22/06)	36/156	1	15	--	--	N/A	N/A		NTX
--	Ethene	0.8	J	3400		µg/L	A-37S; Vicinity of Waste Lake 1 (02/23/06)	24/156	1 - 260	3400	--	--	N/A	N/A		NTX
--	Methane	1		100000		µg/L	A-32D; Waste lake 2 (06/23/05)	127/156	1	100000	--	--	N/A	N/A		NTX

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: A-6A, A-7A, A-11A, A-12, A-13, A-14, A-15, A-16, A-23, A-24, A-25D, A-26D, A-26OB, A-26S, A-27D, A-27S, A-29D, A-29OB, A-29S, A-30OB, A-31OB, A-32D, A-32OB, A-32S, A-33D, A-33S, A-34D, A-34S, A-35D, A-35S, A-36D, A-36S, A-37S, A-39D, A-39OB, A-39S, A-40D, A-44, A-45, A-46, A-47, A-48, A-49, A-50, A-51, A-53, A-55, A-57, A-59S, A-60S, A-61S, A-62D, A-62S, A-66D, A-66S, A-67D, A-67S, A-68D, A-68S, A-69, A-70, A-71, A-75, A-76, B-5, R-110, R-112.

(3) Screening concentration is the maximum detected concentration.

(4) Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils, USEPA, Table 2c: Generic Screening Levels and Summary Sheet, Target Groundwater Concentration Corresponding to Target Indoor Air Concentration, November 20, 2002. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1. The parameters marked with an * are based on the Maximum Contaminant Levels (MCLs).

(5) Rationale Codes

Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)

Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Not considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway incomplete (NVOC).
No Toxicity Data (NTX)

(6) The lowest criterion from each isomer (p-xylene) substituted.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.

TABLE A.3.1
SUMMARY OF LEAD ARITHMETIC MEANS
OXYCHEM
DELAWARE CITY, DELAWARE

Medium	*Units*	*Lead Arithmetic Mean*
Surface Soil (0-2 ftbgs)	mg/kg	106
Soil (0-15 ftbgs)	mg/kg	73.9

TABLE A.4.1

EXPOSURE ASSUMPTIONS FOR CURRENT/FUTURE TRESPASSER EXPOSURE TO SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	100	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	BW	Body Weight	kg	50	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (4)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,688	USEPA, 1997 (5)
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	BW	Body Weight	kg	50	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.4	USEPA, 2004
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (6)
Inhalation	FT	Fraction of Time Exposed	unitless	4/24	Professional Judgement (7)
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table A.4.5
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table A.4.7

Notes:
(1) Professional Judgement; adolescent will trespass for 1 day/week from April to October, for a total of 28 days (RME).
(2) Trespasser is a 9 through 18 year old therefore the exposure duration is 10 years.
(3) Body weight is the average of 13 yr old mean body weights, Table 7-3 of Exposure Factor Handbook, Volume 1.
(4) Professional Judgement; assumed 100% absorption for conservatism.
(5) Skin surface area is the average of 13-14 yr old mean total surface areas assuming 25% of total body area is exposed, Tables 6-6 and 6-7 of Exposure Factor Handbook, Volume 1.
(6) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(7) Professional Judgement; adolescent will trespass for 4 hours.

References:
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 1997: Exposure Factors Handbook. Volume. 1: General Factors. EPA/600/P-95/002Fa. August 1997.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE A.4.2

EXPOSURE ASSUMPTIONS FOR CURRENT/FUTURE INDUSTRIAL WORKER EXPOSURE TO SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/ Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	100	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2004
	ED	Exposure Duration	years	25	USEPA, 2004
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (1)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,300	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2004
	ED	Exposure Duration	years	25	USEPA, 2004
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (2)
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgement (3)
	EF	Exposure Frequency	days/year	250	USEPA, 2004
	ED	Exposure Duration	years	25	USEPA, 2004
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table A.4.5
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table A.4.7

Notes:
(1) Professional Judgement; assumed 100% absorption for conservatism.
(2) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(3) Professional Judgment; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

References:
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE A.4.3

EXPOSURE ASSUMPTIONS FOR FUTURE CONSTRUCTION/UTILITY WORKER EXPOSURE TO SURFACE AND SUBSURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Soil/ Ambient Air
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	330	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (1)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,300	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.3	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (2)
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgement (3)
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	7.10E+06	Refer to Table A.4.6
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table A.4.8

Notes:
(1) Professional Judgement; assumed 100% absorption for conservatism.
(2) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(3) Professional Judgment; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

References:
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE A.4.4

EXPOSURE ASSUMPTIONS FOR CURRENT/FUTURE INDUSTRIAL WORKER EXPOSURE TO INDOOR AIR
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Current/Future
Medium: Soil or Groundwater
Exposure Medium: Indoor Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgment (1)
	EF	Exposure Frequency	days/year	250	USEPA, 2004
	ED	Exposure Duration	years	25	USEPA, 2004
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989

Notes:

(1) Professional Judgment; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE A.4.5

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

PEF: Soil-to-Air Particulate Emission Factor

$$PEF = Q/C_{wind} \times \frac{3600}{0.036 \times (1 - V) \times \left(U_m / U_t\right)^3 \times F(x)}$$

				Reference	*Units*	*Value*
Where:	PEF	=	soil-to-air particulate emission factor	Equation 4-8, USEPA, 2002	m^3/kg	5.25E+08
	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	V	=	fraction of vegetative cover	USEPA, 2002	unitless	0.5
	U_m	=	mean annual windspeed	USEPA, 2002	m/s	4.69
	U_t	=	equivalent threshold value of windspeed at 7 m	USEPA, 2002	m/s	11.32
	F(x)	=	function dependent on U_m/U_t	USEPA, 2002	unitless	0.194

Q/C_{wind}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{wind} = A \times \exp\frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	"A"	=	constant	USEPA, 2002 (1)	unitless	14.0111
	Area	=	areal extent of the site or contamination	(2)	acres	146
	"B"	=	constant	USEPA, 2002 (1)	unitless	19.6154
	"C"	=	constant	USEPA, 2002 (1)	unitless	225.3397

Notes:

(1) Based on Zone 8 - Philadelphia, Pennsylvania.

(2) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

Reference:

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE A.4.6

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SURFACE AND SUBSURFACE SOIL EXPOSURE - FUTURE CONSTRUCTION/UTILITY WORKER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$PEF_{SC} = Q/C_{sr} \times 1/F_D \times [(T \times A_R) / (556 \times ((W/3)^{0.4} \times ((365\ d/y - p) / 365\ d/y) \times VKT)]$$

$$Q/C_{sr} = A \times EXP [(\ln A_s - B)^2 / C]$$

INPUT PARAMETERS	*VALUE*	*REFERENCE*
PEF_{sc}/ subchronic road particulate emission factor (m^3/kg) =	**7.10E+06**	Equation 5-5, USEPA, 2002
Q/C_{sr}/ inverse of ratio of the 1-h geometric mean air concentration =	13.04	Equation 5-6, USEPA, 2002
A/ constant (unitless) =	12.9351	USEPA, 2002
B/ constant (unitless) =	5.7383	USEPA, 2002
C/ constant (unitless) =	71.7711	USEPA, 2002
A_s/ areal extent of site surface soil contamination (acres) =	146	Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs)
F_D/ dispersion correction factor (unitless) =	0.185	USEPA, 2002
T/ total time over which construction occurs (s) =	3.15E+07	USEPA, 2002 (site-specific, within a 1 year construction campaign)
A_R/ surface area of contaminated road segment (m^2) =	4,687	USEPA, 2002 ($A_R = L_R*W_R*0.092903\ m^2/ft^2$)
L_R - length of road segment (ft) =	2522	USEPA, 2002
W_R - width of road segment (ft) =	20	USEPA, 2002
W/ mean vehicle weight (tons) =	8	USEPA, 2002, Assumes 20 two-ton cars and 10 twenty-ton trucks (W = (20*2+10*20)/30)
p/ number of days with at least 0.01 inches of precipitation (days/yr) =	130	USEPA, 2002
VKT/ sum of fleet vehicle kilometres travelled during the exposure duration (km) =	2,768	Assuming that the area is configured as a square with the unpaved construction access road segment dividing the square evenly, the road length would be equal to the square root of 590,841 m^2, also equal to 769 m or 0.769 km. Assuming that each vehicle travels the length of the road once per day, 5 days per week for a total of 120 days, (30*0.769*120).

Reference:

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE A4.7

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

			Reference	Units	Trespasser: Cyclohexane	Trespasser: Mercury
Where:	VF	= soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m³/kg	7.65E+02	3.71E+04
	Q/C_{vol}	= inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23
	D_A	= apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	2.01E-03	8.58E-07
	T	= exposure interval	USEPA, 2002	s	3.15E+08	3.15E+08
	ρ_{db}	= soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	= inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23
	"A"	= constant	USEPA, 2002 (2)	unitless	14.0111	14.0111
	Area	= areal extent of the site or contamination	(3)	acres	146	146
	"B"	= constant	USEPA, 2002 (2)	unitless	19.6154	19.6154
	"C"	= constant	USEPA, 2002 (2)	unitless	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

				Units		
Where:	D_A	= apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	2.01E-03	8.58E-07
	Θ_a	= air-filled porosity	(4)	unitless	0.109	0.109
	Θ_w	= water-filled porosity	(5)	unitless	0.166	0.166
	n	= total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01
	ρ_{db}	= soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66
	H'	= dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	8.20E+00	4.67E-01
	D_i	= diffusivity in air	USEPA, 2002; USEPA, 2004b	cm²/s	8.00E-02	3.07E-02
	D_w	= diffusivity in water	USEPA, 2002; USEPA, 2004b	cm²/s	9.00E-06	6.30E-06
	K_d	= soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	9.60E-01	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

				Units		
Where:	K_d	= soil-water partition coefficient	USEPA, 2002 (7)	cm³/g	9.60E-01	8.20E+01
	K_{oc}	= soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	1.60E+02	--
	f_{oc}	= organic content of soil	USEPA, 2002	g/g	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.
(2) Based on Zone 8 - Philadelphia, Pennsylvania.
(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(6) Average porosity of a sand soil applied.
(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE A4.7

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

			Reference	Units	Industrial Worker: Cyclohexane	Industrial Worker: Mercury
Where:	VF	= soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	1.21E+03	5.86E+04
	Q/C_{vol}	= inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	D_A	= apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	T	= exposure interval	USEPA, 2002	s	7.88E+08	7.88E+08
	ρ_{db}	= soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	= inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	"A"	= constant	USEPA, 2002 (2)	unitless	14.0111	14.0111
	Area	= areal extent of the site or contamination	(3)	acres	146	146
	"B"	= constant	USEPA, 2002 (2)	unitless	19.6154	19.6154
	"C"	= constant	USEPA, 2002 (2)	unitless	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

				Units		
Where:	D_A	= apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	Θ_a	= air-filled porosity	(4)	unitless	0.109	0.109
	Θ_w	= water-filled porosity	(5)	unitless	0.166	0.166
	n	= total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01
	ρ_{db}	= soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66
	H'	= dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	8.20E+00	4.67E-01
	D_i	= diffusivity in air	USEPA, 2002; USEPA, 2004b	cm^2/s	8.00E-02	3.07E-02
	D_w	= diffusivity in water	USEPA, 2002; USEPA, 2004b	cm^2/s	9.00E-06	6.30E-06
	K_d	= soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	9.60E-01	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

				Units		
Where:	K_d	= soil-water partition coefficient	USEPA, 2002 (7)	cm^3/g	9.60E-01	8.20E+01
	K_{oc}	= soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.60E+02	--
	f_{oc}	= organic content of soil	USEPA, 2002	g/g	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.
(2) Based on Zone 8 - Philadelphia, Pennsylvania.
(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(6) Average porosity of a sand soil applied.
(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE A.4.8

DERIVATION OF VOLATILIZATION FACTOR FOR SOIL - CONSTRUCTION/UTILITY WORKER INHALATION EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$VF = (Q/C_{sa}) \times 1/F_D \times ((3.14 \times D_A \times T)^{1/2}) \times 10^{-4} / (2 \times \rho_b \times D_A)$$

$$D_A = ((\Theta_a^{10/3} \times D_i \times H + \Theta_w^{10/3} \times D_w) / n^2)/(\rho_b \times K_d + \Theta_w + \Theta_a \times H)$$

$$Q/C_{sa} = A \times EXP [(\ln A_c - B)^2 / C]$$

INPUT PARAMETERS	*REFERENCE*	*Chemical of Concern*			
		1,2,4-Trichlorobenzene	1,4-Dichlorobenzene	Benzene	Cyclohexane
VF/ volatilization factor (m^3/kg) =	Equation 5-14, USEPA, 2002	**1.02E+04**	**3.08E+03**	**6.33E+02**	**2.05E+02**
D_A/ apparent diffusivity (cm^2/s) =	Equation 5-14, USEPA, 2002	8.10E-07	8.89E-06	2.11E-04	2.01E-03
Q/C_{sa}/ inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3) =	Equation 5-15, USEPA, 2002	5.67	5.67	5.67	5.67
A/ constant (unitless) =	USEPA, 2002	2.4538	2.4538	2.4538	2.4538
B/ constant (unitless) =	USEPA, 2002	17.566	17.566	17.566	17.566
C/ constant (unitless) =	USEPA, 2002	189.0426	189.0426	189.0426	189.0426
A_s/ areal extent of site surface soil contamination (acres) =	(1)	146	146	146	146
F_D/ dispersion correction factor (unitless) =	USEPA, 2002	0.185	0.185	0.185	0.185
Θ_a/ air-filled soil porosity (L_{air}/L_{soil}) =	(2)	0.109	0.109	0.109	0.109
Di/ diffusivity in air (cm^2/s) =	USEPA, 2002; USEPA, 2004b	3.00E-02	6.90E-02	8.80E-02	8.00E-02
H/ dimensionless Henry's law constant =	USEPA, 2002; USEPA, 2004b	5.82E-02	9.96E-02	2.28E-01	8.20E+00
Θ_w/ water-filled soil porosity (L_{water}/L_{soil}) =	(3)	0.166	0.166	0.166	0.166
D_w/ diffusivity in water (cm^2/s) =	USEPA, 2002; USEPA, 2004b	8.23E-06	7.90E-06	9.80E-06	9.00E-06
n/ total soil porosity (L_{pore}/L_{soil}) =	Fetter, 2001: Table 3.4 (4)	0.275	0.275	0.275	0.275
ρ_b/ dry soil bulk density (g/cm^3) =	USEPA, 2004a (5)	1.66	1.66	1.66	1.66
Kd/ soil-water partition coefficient (cm^3/g) =	USEPA, 2002 (Kd = Koc x foc) (6)	1.07E+01	3.70E+00	3.53E-01	9.60E-01
Koc/ soil organic carbon-water partition coefficient (cm^3/g) =	USEPA, 2002; USEPA, 2004b	1.78E+03	6.17E+02	5.89E+01	1.60E+02
foc/ organic carbon content of soil (g/g) =	USEPA, 2002	0.006	0.006	0.006	0.006
T/ exposure interval (s) =	USEPA, 2002	31536000	31536000	31536000	31536000
Conversion Factor/ 10^{-4} (m^2/cm^2) =	USEPA, 2002	1.00E-04	1.00E-04	1.00E-04	1.00E-04

Notes:

(1) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(2) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(3) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$,
where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(4) Average porosity of a sand soil applied.
(5) Default dry bulk density for sand soils applied.
(6) Value for mercury is based on pH 7.

References:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
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USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE A.4.8

DERIVATION OF VOLATILIZATION FACTOR FOR SOIL - CONSTRUCTION/UTILITY WORKER INHALATION EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$VF = (Q/C_{sa}) \times 1/F_D \times ((3.14 \times D_A \times T)^{1/2}) \times 10^{-4} / (2 \times \rho_b \times D_A)$$

$$D_a = ((\Theta_a^{10/3} \times D_i \times H + \Theta_w^{10/3} \times D_w) / n^2)/(\rho_b \times K_d + \Theta_w + \Theta_a \times H)$$

$$Q/C_{sa} = A \times EXP [(\ln A_c - B)^2 / C]$$

INPUT PARAMETERS	*REFERENCE*	Methyl cyclohexane	Vinyl chloride	Hexachlorobenzene	Mercury
VF/ volatilization factor (m^3/kg) =	Equation 5-14, USEPA, 2002	**4.45E+02**	**2.04E+02**	**4.38E+04**	**9.92E+03**
D_A/ apparent diffusivity (cm^2/s) =	Equation 5-14, USEPA, 2002	4.27E-04	2.03E-03	4.39E-08	8.58E-07
Q/C_{sa}/ inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3) =	Equation 5-15, USEPA, 2002	5.67	5.67	5.67	5.67
A/ constant (unitless) =	USEPA, 2002	2.4538	2.4538	2.4538	2.4538
B/ constant (unitless) =	USEPA, 2002	17.566	17.566	17.566	17.566
C/ constant (unitless) =	USEPA, 2002	189.0426	189.0426	189.0426	189.0426
A_s/ areal extent of site surface soil contamination (acres) =	(1)	146	146	146	146
F_D/ dispersion correction factor (unitless) =	USEPA, 2002	0.185	0.185	0.185	0.185
Θ_a/ air-filled soil porosity (L_{air}/L_{soil}) =	(2)	0.109	0.109	0.109	0.109
Di/ diffusivity in air (cm^2/s) =	USEPA, 2002; USEPA, 2004b	7.00E-02	1.06E-01	5.42E-02	3.07E-02
H/ dimensionless Henry's law constant =	USEPA, 2002; USEPA, 2004b	1.80E+01	1.11E+00	5.41E-02	4.67E-01
Θ_w/ water-filled soil porosity (L_{water}/L_{soil}) =	(3)	0.166	0.166	0.166	0.166
D_w/ diffusivity in water (cm^2/s) =	USEPA, 2002; USEPA, 2004b	9.00E-06	1.23E-05	5.91E-06	6.30E-06
n/ total soil porosity (L_{pore}/L_{soil}) =	Fetter, 2001: Table 3.4 (4)	0.275	0.275	0.275	0.275
ρ_b/ dry soil bulk density (g/cm^3) =	USEPA, 2004a (5)	1.66	1.66	1.66	1.66
Kd/ soil-water partition coefficient (cm^3/g) =	USEPA, 2002 (Kd = Koc x foc) (6)	1.32E+01	1.12E-01	3.30E+02	8.20E+01
Koc/ soil organic carbon-water partition coefficient (cm^3/g) =	USEPA, 2002; USEPA, 2004b	2.20E+03	1.86E+01	5.50E+04	--
foc/ organic carbon content of soil (g/g) =	USEPA, 2002	0.006	0.006	0.006	0.006
T/ exposure interval (s) =	USEPA, 2002	31536000	31536000	31536000	31536000
Conversion Factor/ 10^{-4} (m^2/cm^2) =	USEPA, 2002	1.00E-04	1.00E-04	1.00E-04	1.00E-04

Notes:

(1) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(2) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(3) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$,
where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(4) Average porosity of a sand soil applied.
(5) Default dry bulk density for sand soils applied.
(6) Value for mercury is based on pH 7.

References:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE A.5.1

NON-CANCER TOXICITY DATA - ORAL/DERMAL ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal RfD (2)*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (3) (MM/DD/YY)*
VOCs										
1,1-Dichloroethene	chronic	5.00E-02	mg/kg-d	100%	5.00E-02	mg/kg-d	liver	100	IRIS	04/16/08
1,2,4-Trichlorobenzene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	adrenal weights	1000	IRIS	04/16/08
1,2-Dichlorobenzene	chronic	9.00E-02	mg/kg-d	100%	9.00E-02	mg/kg-d	no effects	1000	IRIS	04/16/08
1,3-Dichlorobenzene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
1,4-Dichlorobenzene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
2-Butanone	chronic	6.00E-01	mg/kg-d	100%	6.00E-01	mg/kg-d	developmental toxicity	1000	IRIS	04/16/08
Acetone	chronic	9.00E-01	mg/kg-d	100%	9.00E-01	mg/kg-d	liver	1000	IRIS	04/16/08
Benzene	chronic	4.00E-03	mg/kg-d	100%	4.00E-03	mg/kg-d	blood system	300	IRIS	04/16/08
Carbon disulfide	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	developmental toxicity	100	IRIS	04/16/08
Carbon tetrachloride	chronic	7.00E-04	mg/kg-d	100%	7.00E-04	mg/kg-d	liver	1000	IRIS	04/16/08
Chlorobenzene	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Chloroform	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
cis-1,2-Dichloroethene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	blood system	3000	HEAST	07/01/97
Cyclohexane	chronic	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	chronic	--	--	--	--	--	--	--	--	--
Methylene chloride	chronic	6.00E-02	mg/kg-d	100%	6.00E-02	mg/kg-d	liver	100	IRIS	04/16/08
Tetrachloroethene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Toluene	chronic	8.00E-02	mg/kg-d	100%	8.00E-02	mg/kg-d	kidney	3000	IRIS	04/16/08
Trichloroethene (former)	chronic	6.00E-03	mg/kg-d	100%	6.00E-03	mg/kg-d	--	--	R9-PRGb	10/01/99
Trichloroethene (current)	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	--	--	R9-PRGa	10/01/04
Vinyl chloride	chronic	3.00E-03	mg/kg-d	100%	3.00E-03	mg/kg-d	liver	30	IRIS	04/16/08
Xylenes (total)	chronic	2.00E-01	mg/kg-d	100%	2.00E-01	mg/kg-d	body weight	1000	IRIS	04/16/08
SVOCs										
2-Chlorophenol	chronic	5.00E-03	mg/kg-d	100%	5.00E-03	mg/kg-d	reproductive effects	1000	IRIS	04/16/08
2-Methylnaphthalene	chronic	4.00E-03	mg/kg-d	100%	4.00E-03	mg/kg-d	respiratory system	3000	IRIS	04/16/08
Acetophenone	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	general toxicity	3000	IRIS	04/16/08
Anthracene	chronic	3.00E-01	mg/kg-d	100%	3.00E-01	mg/kg-d	no effects	3000	IRIS	04/16/08
Benzaldehyde	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	kidney	1000	IRIS	04/16/08
Benzo(a)pyrene	chronic	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	chronic	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Chrysene	chronic	--	--	--	--	--	--	--	--	--
Fluoranthene	chronic	4.00E-02	mg/kg-d	100%	4.00E-02	mg/kg-d	liver	3000	IRIS	04/16/08
Hexachlorobenzene	chronic	8.00E-04	mg/kg-d	100%	8.00E-04	mg/kg-d	liver	100	IRIS	04/16/08
Hexachloroethane	chronic	1.00E-03	mg/kg-d	100%	1.00E-03	mg/kg-d	kidney	1000	IRIS	04/16/08
Naphthalene	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	body weight	3000	IRIS	04/16/08
Nitrobenzene	chronic	5.00E-04	mg/kg-d	100%	5.00E-04	mg/kg-d	liver	10000	IRIS	04/16/08
Phenanthrene	chronic	--	--	--	--	--	--	--	--	--
Pyrene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	kidney	3000	IRIS	04/16/08

TABLE A.5.1

NON-CANCER TOXICITY DATA - ORAL/DERMAL ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal RfD (2)*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (3) (MM/DD/YY)*
Metals										
Aluminum	chronic	1.00E+00	mg/kg-d	100%	1.00E+00	mg/kg-d	--	--	R9-PRGa	10/01/04
Arsenic	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	skin discoloration	3	IRIS	04/16/08
Cobalt	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
Copper	chronic	4.00E-02	mg/kg-d	100%	4.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
Iron	chronic	7.00E-01	mg/kg-d	100%	7.00E-01	mg/kg-d	--	--	R3-RBC	10/16/07
Lead	chronic	--	--	--	--	--	--	--	--	--
Manganese	chronic	2.00E-02	mg/kg-d	4%	8.00E-04	mg/kg-d	central nervous system	6	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	autoimmune system	1000	IRIS	04/16/08
PCBs										
Aroclor-1260	chronic	--	--	--	--	--	--	--	--	--

Notes:

-- = Not Available

N/A = Not Applicable

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended by USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal RfD = Oral RfD x (ABS_{GI}/100), consistent with Equation 4.3 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.
Region III Risk-Based Concentrations (R3-RBC) Table, October 16, 2007. USEPA peer-reviewed value.

TABLE A.5.2

NON-CANCER TOXICITY DATA -- INHALATION ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Value Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfC:RfD: Target Organ*	*Dates (1) (MM/DD/YY)*
VOCs							
1,1-Dichloroethene	chronic	2.00E-01	mg/m^3	liver	30	IRIS	04/16/08
1,2,4-Trichlorobenzene	chronic	3.50E-03	mg/m^3	--	--	R9-PRGa	10/01/04
1,2-Dichlorobenzene	chronic	2.00E-01	mg/m^3	body weight	1000	HEAST	07/01/97
1,3-Dichlorobenzene	--	--	--	--	--	--	--
1,4-Dichlorobenzene	chronic	8.00E-01	mg/m^3	liver	100	IRIS	04/16/08
2-Butanone	chronic	5.00E+00	mg/m^3	developmental toxicity	300	IRIS	04/16/08
Acetone	--	--	--	--	--	--	--
Benzene	chronic	3.00E-02	mg/m^3	blood system	300	IRIS	04/16/08
Carbon disulfide	chronic	7.00E-01	mg/m^3	central nervous system	30	IRIS	04/16/08
Carbon tetrachloride	--	--	--	--	--	--	--
Chlorobenzene	chronic	5.95E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Chloroform	chronic	4.90E-02	mg/m^3	--	--	R9-PRGa	10/01/04
cis-1,2-Dichloroethene	--	--	--	--	--	--	--
Cyclohexane	chronic	6.00E+00	mg/m^3	developmental toxicity	300	IRIS	04/16/08
Methyl cyclohexane	chronic	3.00E+00	mg/m^3	kidney	100	HEAST	07/01/97
Methylene chloride	chronic	3.00E+00	mg/m^3	liver	100	HEAST	07/01/97
Tetrachloroethene (former)	chronic	3.85E-01	mg/m^3	--	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	chronic	3.50E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Toluene	chronic	5.00E+00	mg/m^3	kidney	10	IRIS	04/16/08
Trichloroethene (former)	--	--	--	--	--	--	--
Trichloroethene (current)	chronic	3.50E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Vinyl chloride	chronic	1.00E-01	mg/m^3	liver	30	IRIS	04/16/08
Xylenes (total)	chronic	1.00E-01	mg/m^3	body weight	300	IRIS	04/16/08
SVOCs							
2-Chlorophenol	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--
Acetophenone	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--
Benzaldehyde	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--
Naphthalene	chronic	3.00E-03	mg/m^3	body weight	3000	IRIS	04/16/08
Nitrobenzene	chronic	2.00E-03	mg/m^3	liver	10000	HEAST	07/01/97
Phenanthrene	--	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--	--

TABLE A.5.2

NON-CANCER TOXICITY DATA -- INHALATION ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Value Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfC:RfD: Target Organ*	*Dates (1) (MM/DD/YY)*
Metals							
Aluminum	chronic	5.00E-03	mg/m^3	--	--	R9-PRGa	10/01/04
Arsenic	--	--	--	--	--	--	--
Cobalt	chronic	2.00E-05	mg/m^3	--	--	R9-PRGa	10/01/04
Copper	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--
Manganese	chronic	5.00E-05	mg/m^3	central nervous system	1000	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/m^3	autoimmune system	30	IRIS	04/16/08
PCBs							
Aroclor-1260	--	--	--	--	--	--	--

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.

TABLE A.5.3

NON-CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern	*Surrogate Compound (1)*	*Oral and Dermal RfD*	*Units*	*Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of Primary Target Organ*	*Date (2) (MM/DD/YY)*
Semivolatile Organic Compounds									
Phenanthrene	Naphthalene	2.00E-02	mg/kg-day	3.00E-03	mg/m^3	body weight	3000	IRIS	04/16/08

Notes:
-- = Not Available
(1) No toxicity data available for this analyte, therefore, a surrogate with toxicity data was determined.
(2) IRIS, Integrated Risk Information System Database, April 16, 2008.

TABLE A.6.1

CANCER TOXICITY DATA - ORAL/DERMAL ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal Cancer Slope Factor (2)*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (3) (MM/DD/YY)*
VOCs							
1,1-Dichloroethene	--	--	--	--	C	--	--
1,2,4-Trichlorobenzene	--	--	--	--	D	--	--
1,2-Dichlorobenzene	--	--	--	--	D	--	--
1,3-Dichlorobenzene	--	--	--	--	D	--	--
1,4-Dichlorobenzene	2.40E-02	100%	2.40E-02	$(mg/kg\text{-}day)^{-1}$	C	HEAST	07/01/97
2-Butanone	--	--	--	--	D	--	--
Acetone	--	--	--	--	D	--	--
Benzene	5.50E-02	100%	5.50E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/08
Carbon disulfide	--	--	--	--	--	--	--
Carbon tetrachloride	1.30E-01	100%	1.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Chlorobenzene	--	--	--	--	D	--	--
Chloroform	--	--	--	--	B2	--	--
cis-1,2-Dichloroethene	--	--	--	--	D	--	--
Cyclohexane	--	--	--	--	--	--	--
Methyl cyclohexane	--	--	--	--	--	--	--
Methylene chloride	7.50E-03	100%	7.50E-03	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Tetrachloroethene (former)	5.20E-02	100%	5.20E-02	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	5.40E-01	100%	5.40E-01	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGa	10/01/04
Toluene	--	--	--	--	D	--	--
Trichloroethene (former)	1.10E-02	100%	1.10E-02	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGb	10/01/99
Trichloroethene (current)	4.00E-01	100%	4.00E-01	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGa	10/01/04
Vinyl chloride	7.50E-01	100%	7.50E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/08
Xylenes (total)	--	--	--	--	D	--	--
SVOCs							
2-Chlorophenol	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	D	--	--
Acetophenone	--	--	--	--	D	--	--
Anthracene	--	--	--	--	D	--	--
Benzaldehyde	--	--	--	--	--	--	--
Benzo(a)pyrene (adolescent)	2.19E+01	100%	2.19E+01	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Benzo(a)pyrene (adult)	7.30E+00	100%	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Benzo(b)fluoranthene (adolescent)	2.19E+00	100%	2.19E+00	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Benzo(b)fluoranthene (adult)	7.30E-01	100%	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	R9-PRGa	10/01/04
Bis(2-ethylhexyl)phthalate	1.40E-02	100%	1.40E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Chrysene (adolescent)	2.19E-02	100%	2.19E-02	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Chrysene (adult)	7.30E-03	100%	7.30E-03	$(mg/kg\text{-}day)^{-1}$	B2	R9-PRGa	10/01/04
Fluoranthene	--	--	--	--	D	--	--

TABLE A.6.1

CANCER TOXICITY DATA - ORAL/DERMAL ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal Cancer Slope Factor (2)*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (3) (MM/DD/YY)*
SVOCs (cont.'d)							
Hexachlorobenzene	1.60E+00	100%	1.60E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Hexachloroethane	1.40E-02	100%	1.40E-02	$(mg/kg\text{-}day)^{-1}$	C	IRIS	04/16/08
Naphthalene	--	--	--	--	C	--	--
Nitrobenzene	--	--	--	--	D	--	--
Phenanthrene	--	--	--	--	D	--	--
Pyrene	--	--	--	--	D	--	--
Metals							
Aluminum	--	--	--	--	--	--	--
Arsenic	1.50E+00	100%	1.50E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/08
Cobalt	--	--	--	--	--	--	--
Copper	--	--	--	--	D	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	B2	--	--
Manganese	--	--	--	--	D	--	--
Mercury	--	--	--	--	D	--	--
PCBs							
Aroclor-1260	2.00E+00	100%	2.00E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08

Notes:

-- = Not Available

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal CSF = Oral CSF / (ABS_{GI}/100), consistent with Equation 4.2 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.
USEPA, Guidelines for Carcinogenic Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, March 2005. For adolescents, default age-dependent adjustment factor of 3 is applied for carcinogens that act via a mutagenic mode of action.

EPA Weight of Evidence Classification :

A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE A.6.2

CANCER TOXICITY DATA -- INHALATION ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Unit Risk*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (1) (MM/DD/YY)*
VOCs					
1,1-Dichloroethene	--	--	C	--	--
1,2,4-Trichlorobenzene	--	--	D	--	--
1,2-Dichlorobenzene	--	--	D	--	--
1,3-Dichlorobenzene	--	--	D	--	--
1,4-Dichlorobenzene	6.00E-03	$(mg/m^3)^{-1}$	C	R9-PRGa	10/01/04
2-Butanone	--	--	D	--	--
Acetone	--	--	D	--	--
Benzene	7.70E-03	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Carbon disulfide	--	--	--	--	--
Carbon tetrachloride	1.50E-02	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Chlorobenzene	--	--	D	--	--
Chloroform	2.30E-02	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
cis-1,2-Dichloroethene	--	--	D	--	--
Cyclohexane	--	--	--	--	--
Methyl cyclohexane	--	--	--	--	--
Methylene chloride	4.70E-04	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Tetrachloroethene (former)	5.70E-04	$(mg/m^3)^{-1}$	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	6.00E-03	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Toluene	--	--	D	--	--
Trichloroethene (former)	1.70E-03	$(mg/m^3)^{-1}$	--	R9-PRGb	10/01/99
Trichloroethene (current)	1.10E-01	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Vinyl chloride	4.40E-03	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Xylenes (total)	--	--	D	--	--
SVOCs					
2-Chlorophenol	--	--	--	--	--
2-Methylnaphthalene	--	--	D	--	--
Acetophenone	--	--	D	--	--
Anthracene	--	--	D	--	--
Benzaldehyde	--	--	--	--	--
Benzo(a)pyrene	--	--	B2	--	--
Benzo(b)fluoranthene	--	--	B2	--	--
Bis(2-ethylhexyl)phthalate	--	--	B2	--	--
Chrysene	--	--	B2	--	--
Fluoranthene	--	--	D	--	--

TABLE A.6.2

CANCER TOXICITY DATA -- INHALATION ROUTE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Unit Risk*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (1) (MM/DD/YY)*
SVOCs (cont.'d)					
Hexachlorobenzene	4.60E-01	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Hexachloroethane	4.00E-03	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Naphthalene	--	--	C	--	--
Nitrobenzene	--	--	D	--	--
Phenanthrene	--	--	D	--	--
Pyrene	--	--	D	--	--
Metals					
Aluminum	--	--	--	--	--
Arsenic	4.30E+00	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Cobalt	2.80E+00	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Copper	--	--	D	--	--
Iron	--	--	--	--	--
Lead	--	--	B2	--	--
Manganese	--	--	D	--	--
Mercury	--	--	D	--	--
PCBs					
Aroclor-1260	5.70E-01	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April 16, 2008.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE A.6.3

CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern	*Surrogate Compound (1)*	*Oral and Dermal CSF*	*Units*	*Inhalation URF*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date MM/DD/YY*
Semivolatile Organic Compounds								
Phenanthrene	Naphthalene	--	--	--	--	D	--	--

Notes:
-- = Not Available
(1) No toxicity data available for this analyte, therefore, a surrogate with toxicity data was determined.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE A.7.1

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	*CSF oral 1/(mg/kg-d)*	*CSF dermal 1/(mg/kg-d)*	*URF inhalation 1/(mg/m³)*	*RfD oral (mg/kg-d)*	*RfD dermal (mg/kg-d)*	*RfC inhalation (mg/m³)*	*Relative Absorption Factor - Oral carc. (%/100)*	*Relative Absorption Factor - Dermal carc. (%/100)*	*VF (m³/kg)*	*Trespasser TR Adolescent (µg/g)*	*Trespasser THQ Adolescent (µg/g)*	*Site-Specific Soil Standard SSS$_{ss}$ (1) (µg/g)*	*Maximum Soil Concentration (µg/g) (2)*
VOCs													
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	7.65E+02	NV	3.59E+05	3.59E+05	2.7E-02
SVOCs													
Benzo(a)pyrene	2.19E+01	2.19E+01	--	--	--	--	1.00E+00	1.30E-01	NA	7.14E-01	NV	7.14E-01	**1.0E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	5.53E+06	5.53E+06	2.0E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	2.11E+01	1.36E+03	2.11E+01	**1.1E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	1.03E+05	9.98E+04	9.98E+04	1.8E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	2.27E+05	2.27E+05	6.3E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	3.98E+06	3.98E+06	1.3E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.1E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	2.74E+04	2.74E+04	4.2E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	3.71E+04	NV	5.76E+02	5.76E+02	**9.1E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	7.44E+00	NV	7.44E+00	4.4E+00

Notes:

-- = Not Available
NA = Not Applicable
Maximum detected concentration exceeds the SSS
NV = No Value
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table A.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1.

Trespasser Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS$_{ss}$	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table A.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table A.5.1
Unit Risk Factor (1/(mg/m³))	URF	chemical-specific	Refer to Table A.6.2
Reference Concentration (mg/m³)	RfC	chemical-specific	Refer to Table A.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table A.4.1
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table A.4.1
Surface Area Exposed (cm²/day)	SA	3,688	Refer to Table A.4.1
Adherence Factor (mg/cm²)	AF	0.4	Refer to Table A.4.1
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table A.4.1
Fraction of Time Exposed (unitless)	FT	4/24	Refer to Table A.4.1
Exposure Frequency (days/year)	EF	28	Refer to Table A.4.1
Exposure Duration (years)	ED	10	Refer to Table A.4.1
Body Weight (kg)	BW	50	Refer to Table A.4.1
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table A.4.1
Averaging Time - carc. (days)	ATc	25,550	Refer to Table A.4.1
Averaging Time - noncarc. (days)	ATnc	3,650	Refer to Table A.4.1
Particulate Emission Factor (m³/kg)	PEF	5.25E+08	Refer to Table A.4.5
Volatilization Factor (m³/kg)	VF	chemical-specific	Refer to Table A.4.7

Exposure Equations

TABLE A.7.2

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - INDUSTRIAL WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	*CSF oral 1/(mg/kg-d)*	*CSF dermal 1/(mg/kg-d)*	*URF inhalation 1/(mg/m³)*	*RfD oral (mg/kg-d)*	*RfD dermal (mg/kg-d)*	*RfC inhalation (mg/m³)*	*Relative Absorption Factor - Oral carc. (%/100)*	*Relative Absorption Factor - Dermal carc. (%/100)*	*VF (m³/kg)*	*Industrial Worker TR Adult (µg/g)*	*Industrial Worker THQ Adult (µg/g)*	*Site-Specific Soil Standard SSS ss (1) (µg/g)*	*Maximum Soil Concentration (µg/g) (2)*
VOCs													
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	1.21E+03	NV	3.18E+04	3.18E+04	2.70E-02
SVOCs													
Benzo(a)pyrene	2.19E+01	2.19E+01	--	--	--	--	1.00E+00	1.30E-01	NA	7.03E-02	NV	7.03E-02	**1.00E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	8.85E+05	8.85E+05	2.01E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	1.59E+00	2.56E+02	1.59E+00	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	2.30E+03	1.35E+04	2.30E+03	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	3.83E+04	3.83E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	6.71E+05	6.71E+05	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	7.23E+03	7.23E+03	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	5.86E+04	NV	6.08E+01	6.08E+01	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	7.44E-01	NV	7.44E-01	4.40E+00

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table A.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1.

Industrial Worker Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS_{ss}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table A.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table A.5.1
Unit Risk Factor (1/(mg/m³))	URF	chemical-specific	Refer to Table A.6.2
Reference Concentration (mg/m³)	RfC	chemical-specific	Refer to Table A.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table A.4.2
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table A.4.2
Surface Area Exposed (cm²/day)	SA	3,300	Refer to Table A.4.2
Adherence Factor (mg/cm²)	AF	0.2	Refer to Table A.4.2
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table A.4.2
Fraction of Time Exposed (unitless)	FT	8/24	Refer to Table A.4.2
Exposure Frequency (days/year)	EF	250	Refer to Table A.4.2
Exposure Duration (years)	ED	25	Refer to Table A.4.2
Body Weight (kg)	BW	70	Refer to Table A.4.2
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table A.4.2
Averaging Time - carc. (days)	ATc	25,550	Refer to Table A.4.2
Averaging Time - noncarc. (days)	ATnc	9,125	Refer to Table A.4.2
Particulate Emission Factor (m³/kg)	PEF	5.25E+08	Refer to Table A.4.5
Volatilization Factor (m³/kg)	VF	chemical-specific	Refer to Table A.4.7

Exposure Equations

Carcinogenic Endpoints:

$$SSS_{ss} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times FT \times (1/VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$SSS_{ss} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times FT \times (1/VF \text{ or } PEF))]}$$

TABLE A.7.3

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE AND SUBSURFACE SOIL - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Construction/Utility Worker TR Adult (µg/g)	Construction/Utility Worker THQ Adult (µg/g)	Site-Specific Soil Standard SSS_{soil} (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
1,2,4-Trichlorobenzene	--	--	--	1.00E-02	1.00E-02	3.50E-03	1.00E+00	3.00E-02	1.02E+04	NV	1.48E+02	1.48E+02	**1.10E+03**
1,4-Dichlorobenzene	2.40E-02	2.40E-02	6.00E-03	3.00E-02	3.00E-02	8.00E-01	1.00E+00	3.00E-02	3.08E+03	1.32E+02	4.76E+03	1.32E+02	**2.00E+03**
Benzene	5.50E-02	5.50E-02	7.70E-03	4.00E-03	4.00E-03	3.00E-02	1.00E+00	5.00E-04	6.33E+02	2.37E+01	7.80E+01	2.37E+01	**4.50E+02**
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	2.05E+02	NV	5.38E+03	5.38E+03	3.40E-02
Methyl cyclohexane	--	--	--	--	--	3.00E+00	1.00E+00	3.00E-02	4.45E+02	NV	5.84E+03	5.84E+03	5.40E-02
Vinyl Chloride	7.50E-01	7.50E-01	4.40E-03	3.00E-03	3.00E-03	1.00E-01	1.00E+00	5.00E-04	2.04E+02	9.52E+00	8.15E+01	9.52E+00	**2.90E+03**
SVOCs													
Benzo(a)pyrene	7.30E+00	7.30E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.14E+00	NV	2.14E+00	1.00E+00
bis(2-Ethylhexyl)phthalate	1.40E-02	1.40E-02	--	2.00E-02	2.00E-02	--	1.00E+00	1.00E-01	NA	1.19E+03	4.76E+03	1.19E+03	**1.30E+03**
Hexachlorobenzene	1.60E+00	1.60E+00	4.60E-01	8.00E-04	8.00E-04	--	1.00E+00	1.00E-01	4.38E+04	7.68E+00	1.91E+02	7.68E+00	**8.20E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.02E+05	1.02E+05	2.27E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	1.29E+01	8.52E+01	1.29E+01	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	7.77E+02	5.64E+02	5.64E+02	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	1.20E+04	1.20E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	2.10E+05	2.10E+05	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	1.08E+03	1.08E+03	**4.20E+03**
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	9.92E+03	NV	1.14E+01	1.14E+01	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	7.62E+00	NV	7.62E+00	4.40E+00

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table A.2.2.
(3) Arithmetic mean lead concentration in Site surface and subsurface soil, as indicated in Table A.3.1.

Construction/Utility Worker Exposure Assumptions

Site-Specific Standard in Soil (mg/kg)	SSS_{soil}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table A.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table A.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table A.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table A.5.2
Ingestion Rate (mg/day)	IR	330	Refer to Table A.4.3
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table A.4.3
Surface Area Exposed (cm^2/day)	SA	3,300	Refer to Table A.4.3
Adherence Factor (mg/cm^2)	AF	0.3	Refer to Table A.4.3
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table A.4.3
Fraction of Time Exposed (unitless)	FT	8/24	Refer to Table A.4.3
Exposure Frequency (days/year)	EF	250	Refer to Table A.4.3
Exposure Duration (years)	ED	1	Refer to Table A.4.3
Body Weight (kg)	BW	70	Refer to Table A.4.3
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table A.4.3
Averaging Time - carc. (days)	ATc	25,550	Refer to Table A.4.3
Averaging Time - noncarc. (days)	ATnc	365	Refer to Table A.4.3
Particulate Emission Factor (m^3/kg)	PEF	7.10E+06	Refer to TableA.4.6
Volatilization Factor (m^3/kg)	VF	chemical-specific	Refer to Table A.4.8

Exposure Equations

Carcinogenic Endpoints:

$$SSS_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times FT \times (1/VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$SSS_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times FT \times (1/VF \text{ or } PEF))]}$$

TABLE A.7.4

DERIVATION OF RISK-BASED TARGET INDOOR AIR CONCENTRATIONS FOR VOLATILE COPCs FROM SOIL AND GROUNDWATER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

			Industrial Worker		*Risk-Based Target*	
	URF	*RfC*	*TR*	*THQ*	*Indoor Air Concentration (1)*	
	inhalation	*inhalation*	*Adult*	*Adult*	C_{TIA} *(1)*	
Chemical of Potential Concern (COPC)	*1/(mg/m³)*	*(mg/m³)*	*(mg/m³)*	*(mg/m³)*	*(mg/m³)*	*(µg/m³)*
VOCs						
1,1-Dichloroethene	--	2.00E-01	NV	8.76E-01	8.76E-01	8.76E+02
1,2,4-Trichlorobenzene	--	3.50E-03	NV	1.53E-02	1.53E-02	1.53E+01
1,2-Dichlorobenzene	--	2.00E-01	NV	8.76E-01	8.76E-01	8.76E+02
1,3-Dichlorobenzene (2)	--	1.05E-01	NV	4.60E-01	4.60E-01	4.60E+02
1,4-Dichlorobenzene	6.00E-03	8.00E-01	2.04E-03	3.50E+00	2.04E-03	2.04E+00
2-Butanone (Methyl Ethyl Ketone)	--	5.00E+00	NV	2.19E+01	2.19E+01	2.19E+04
Acetone (2)	--	3.15E+00	NV	1.38E+01	1.38E+01	1.38E+04
Benzene	7.70E-03	3.00E-02	1.59E-03	1.31E-01	1.59E-03	1.59E+00
Carbon Disulfide	--	7.00E-01	NV	3.07E+00	3.07E+00	3.07E+03
Carbon Tetrachloride	1.50E-02	--	8.18E-04	NV	8.18E-04	8.18E-01
Chlorobenzene	--	5.95E-02	NV	2.61E-01	2.61E-01	2.61E+02
Chloroform	2.30E-02	4.90E-02	5.33E-04	2.15E-01	5.33E-04	5.33E-01
cis-1,2-Dichloroethene (2)	--	3.50E-02	NV	1.53E-01	1.53E-01	1.53E+02
Cyclohexane	--	6.00E+00	NV	2.63E+01	2.63E+01	2.63E+04
Methyl cyclohexane	--	3.00E+00	NV	1.31E+01	1.31E+01	1.31E+04
Methylene chloride	4.70E-04	3.00E+00	2.61E-02	1.31E+01	2.61E-02	2.61E+01
Tetrachloroethene (former)	5.70E-04	3.85E-01	2.15E-02	1.69E+00	2.15E-02	2.15E+01
Tetrachloroethene (current)	6.00E-03	3.50E-02	2.04E-03	1.53E-01	2.04E-03	2.04E+00
Toluene	--	5.00E+00	NV	2.19E+01	2.19E+01	2.19E+04
Trichloroethene (former)	1.70E-03	--	7.21E-03	NV	7.21E-03	7.21E+00
Trichloroethene (current)	1.10E-01	3.50E-02	1.11E-04	1.53E-01	1.11E-04	1.11E-01
Vinyl Chloride	4.40E-03	1.00E-01	2.79E-03	4.38E-01	2.79E-03	2.79E+00
Xylenes (total)	--	1.00E-01	NV	4.38E-01	4.38E-01	4.38E+02
SVOCs						
2-Chlorophenol (2)	--	1.75E-02	NV	7.67E-02	7.67E-02	7.67E+01
2-Methylnaphthalene (2)	--	1.40E-02	NV	6.13E-02	6.13E-02	6.13E+01
Acetophenone (2)	--	3.50E-01	NV	1.53E+00	1.53E+00	1.53E+03
Anthracene (2)	--	1.05E+00	NV	4.60E+00	4.60E+00	4.60E+03
Benzaldehyde (2)	--	3.50E-01	NV	1.53E+00	1.53E+00	1.53E+03
Benzo(b)fluoranthene (2)	2.09E-01	--	5.88E-05	NV	5.88E-05	5.88E-02
Chrysene (2)	2.09E-03	--	5.88E-03	NV	5.88E-03	5.88E+00
Fluoranthene (2)	--	1.40E-01	NV	6.13E-01	6.13E-01	6.13E+02
Hexachlorobenzene	4.60E-01	--	2.67E-05	NV	2.67E-05	2.67E-02
Hexachloroethane	4.00E-03	--	3.07E-03	NV	3.07E-03	3.07E+00
Naphthalene	--	3.00E-03	NV	1.31E-02	1.31E-02	1.31E+01
Nitrobenzene	--	2.00E-03	NV	8.76E-03	8.76E-03	8.76E+00
Phenanthrene	--	3.00E-03	NV	1.31E-02	1.31E-02	1.31E+01
Pyrene (2)	--	1.05E-01	NV	4.60E-01	4.60E-01	4.60E+02
Metals						
Mercury	--	3.00E-04	NV	1.31E-03	1.31E-03	1.31E+00

Notes :

-- = Not Available
N/A = Not Applicable
NV = No Value
(1) The selected Risk-Based Target Indoor Air Concentration is the lower of the carcinogenic-based concentration and the non-carcinogenic based concentration.
(2) Toxicity data based on route to route extrapolation; see oral toxicity data in Tables A.5.1 and A.6.1, with an applied body weight of 70 kg and inhalation rate of 20 m^3/day.

Industrial Worker Exposure Assumptions

Risk-based Target Indoor Air Concentration (mg/m^3)	C_{TIA}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	Refer to Table A.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table A.5.2
Exposure Frequency (days/year)	EF	250	Refer to Table A.4.4
Exposure Duration (years)	ED	25	Refer to Table A.4.4
Fraction of Time Exposed (unitless) - inhalation	FT	8/24	Refer to Table A.4.4
Averaging Time - carc. (days)	ATc	25,550	Refer to Table A.4.4
Averaging Time - noncarc. (days)	ATnc	9,125	Refer to Table A.4.4

Exposure Equations

Carcinogenic Endpoints:

$$C_{TIA} = \frac{TR \times ATc}{EF \times FT \times ED \times URF}$$

Non-Carcinogenic Endpoints:

$$C_{TIA} = \frac{THQ \times ATnc}{FT \times EF \times ED \times (1/RfC)}$$

TABLE A.7.5

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL BASED ON PROTECTION OF INDOOR AIR QUALITY
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

	Chemical Properties (1)					Site-Specific Standards for Soil, SSS_{soil}				
Chemical of Concern (COC)	*Henry's Law Constant, H_L (atm m³/mol)*	*Water Diffusion Coefficient, D^{H2O} (cm²/s)*	*Air Diffusion Coefficient, D^{air} (cm²/s)*	*Organic Carbon Partitioning Coefficient, K_{oc} (mL/g)*	*Johnson & Ettinger Attenuation Factor, α (2)*	*Target Indoor Air Criteria C_{tia} (µg/m³) (3)*	*Soil Gas Criteria C_{sg} (µg/m³) (4)*	*Concentration Sorbed to Soil Particles, C_{sp} (µg/g) (5)*	*Bulk Soil Concentration/ Site-Specific Soil Criteria SSS_{soil} (µg/g) (6)*	*Maximum Soil Concentration (µg/g) (7)*
VOCs										
1,2,4-Trichlorobenzene	6.55E-04 (15° C)	8.23E-06 (25° C)	2.85E-02 (15° C)	1.78E+03	2.24E-05	1.53E+01	6.84E+05	2.64E+02	2.66E+02	**1.10E+03**
1,2-Dichlorobenzene	9.59E-04 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	6.17E+02	4.61E-05	8.76E+02	1.90E+07	1.73E+03	1.78E+03	1.10E+03
1,3-Dichlorobenzene	1.61E-03 (15° C)	7.86E-06 (25° C)	6.57E-02 (15° C)	1.98E+03	4.61E-05	4.60E+02	9.99E+06	1.74E+03	1.75E+03	7.70E+01
1,4-Dichlorobenzene	1.24E-03 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	6.17E+02	4.60E-05	2.04E+00	4.44E+04	3.13E+00	3.22E+00	**2.00E+03**
2-Butanone	3.42E-05 (15° C)	9.80E-06 (25° C)	7.68E-02 (15° C)	2.30E+00	6.72E-05	2.19E+04	3.26E+08	3.11E+03	2.57E+04	3.10E-02
Acetone	2.49E-05 (15° C)	1.14E-05 (25° C)	1.18E-01 (15° C)	5.75E-01	9.35E-05	1.38E+04	1.48E+08	4.82E+02	1.45E+04	1.70E-01
Benzene	3.45E-03 (15° C)	9.80E-06 (25° C)	8.36E-02 (15° C)	5.89E+01	5.62E-05	1.59E+00	2.83E+04	6.86E-02	8.99E-02	**4.50E+02**
Carbon Disulfide	2.05E-02 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	4.57E+01	6.43E-05	8.18E-01	1.27E+04	4.03E-03	6.33E-03	5.00E-03
Chlorobenzene	2.08E-03 (15° C)	8.70E-06 (25° C)	6.94E-02 (15° C)	2.19E+02	4.82E-05	2.61E+02	5.41E+06	8.07E+01	8.72E+01	**5.60E+02**
Chloroform (Trichloromethane)	2.36E-03 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	3.98E+01	6.45E-05	5.33E-01	8.27E+03	1.98E-02	2.86E-02	**8.90E-01**
Cyclohexane	1.22E-01 (15° C)	9.00E-06 (25° C)	7.60E-02 (15° C)	1.60E+02	5.18E-05	2.63E+04	5.08E+08	9.45E+01	1.38E+02	3.40E-02
Methyl cyclohexane	6.24E-02 (15° C)	8.52E-06 (25° C)	6.98E-02 (15° C)	7.85E+01	4.82E-05	1.31E+04	2.73E+08	4.87E+01	7.69E+01	5.40E-02
Methylene chloride	1.45E-03 (15° C)	1.17E-05 (25° C)	9.60E-02 (15° C)	1.17E+01	6.32E-05	2.61E+01	4.13E+05	4.72E-01	1.17E+00	9.50E-02
Tetrachloroethene (former)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.55E+02	4.74E-05	2.15E+01	4.54E+05	9.49E-01	1.08E+00	**1.90E+00**
Tetrachloroethene (current)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.55E+02	5.57E-05	2.04E+00	3.67E+04	7.67E-02	8.74E-02	**1.90E+00**
Vinyl Chloride	2.02E-02 (15° C)	1.23E-05 (25° C)	1.01E-01 (15° C)	1.86E+01	6.53E-05	2.79E+00	4.27E+04	5.59E-03	1.34E-02	**2.90E+03**
Xylenes (total)	2.88E-03 (15° C)	9.34E-06 (25° C)	6.78E-02 (15° C)	3.72E+02	4.72E-05	4.38E+02	9.28E+06	1.70E+02	1.78E+02	8.00E-03
SVOCs										
2-Methylnaphthalene	2.00E-04 (15° C)	7.75E-06 (25° C)	4.96E-02 (15° C)	2.81E+03	3.81E-05	6.13E+01	1.61E+06	3.20E+03	3.22E+03	2.30E+00
Acetophenone	4.52E-06 (15° C)	8.73E-06 (25° C)	5.70E-02 (15° C)	5.77E+01	1.23E-04	1.53E+03	1.25E+07	2.25E+04	2.91E+04	1.20E+00
Anthracene	2.23E-05 (15° C)	7.74E-06 (25° C)	3.08E-02 (15° C)	2.97E+04	4.50E-05	4.60E+03	1.02E+08	1.93E+07	1.93E+07	2.10E-01
Benzaldehyde	1.04E-05 (15° C)	9.07E-06 (25° C)	6.85E-02 (15° C)	4.59E+01	8.97E-05	1.53E+03	1.71E+07	1.07E+04	1.46E+04	6.90E-01
Benzo(b)fluoranthene	2.49E-05 (15° C)	5.56E-06 (25° C)	2.15E-02 (15° C)	1.23E+06	3.15E-05	5.88E-02	1.87E+03	1.31E+04	1.31E+04	2.00E+00
Chrysene	2.26E-05 (15° C)	6.21E-06 (25° C)	2.36E-02 (15° C)	3.98E+05	3.61E-05	5.88E+00	1.63E+05	4.06E+05	4.06E+05	9.30E-01
Fluoranthene	4.99E-06 (15° C)	6.35E-06 (25° C)	2.87E-02 (15° C)	1.07E+05	2.62E-05	6.13E+02	2.34E+07	7.12E+07	7.12E+07	1.50E+00
Hexachlorobenzene	4.09E-04 (15° C)	5.91E-06 (25° C)	5.15E-02 (15° C)	5.50E+04	8.93E-05	2.67E-02	2.98E+02	5.69E+00	5.69E+00	**8.20E+00**
Naphthalene	2.27E-04 (15° C)	7.50E-06 (25° C)	5.61E-02 (15° C)	2.00E+03	3.79E-05	1.31E+01	3.47E+05	4.34E+02	4.38E+02	5.70E-01
Nitrobenzene	1.10E-05 (15° C)	8.60E-06 (25° C)	7.22E-02 (15° C)	6.46E+01	4.18E-05	8.76E+00	2.09E+05	1.75E+02	2.20E+02	9.60E+00
Phenanthrene	4.24E-06 (15° C)	7.47E-06 (25° C)	3.16E-02 (15° C)	2.95E+04	8.76E-05	1.31E+01	1.50E+05	1.48E+05	1.48E+05	1.10E+00
Pyrene	3.28E-06 (15° C)	7.24E-06 (25° C)	2.58E-02 (15° C)	1.05E+05	1.22E-04	4.60E+02	3.78E+06	1.72E+07	1.72E+07	1.60E+00
Metals										
Mercury (8)	4.38E-03 (15° C)	6.30E-06 (25° C)	2.92E-02 (15° C)	8.20E+01	2.21E-05	1.31E+00	5.94E+04	2.63E+01	2.63E+01	**9.13E+03**

TABLE A.7.5

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL BASED ON PROTECTION OF INDOOR AIR QUALITY
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Notes:

NV = No Value due to lack of toxicity data

Maximum detected concentration exceeds the SSS

(1) The applied chemical properties are obtained from the chemical properties database implemented in USEPA (2004). The Henry's Law constant and air diffusion coefficient were corrected for an average vadose zone temperature of 15 °C. The reference temperature for the water diffusion coefficient is 25 °C and, considering its low value, a correction to 15°C was considered negligible.

(2) The soil gas attenuation factor α is based on the solution for soil gas migration to building indoor air presented in Johnson and Ettinger [1991; Equation (21)], the vadose zone and building properties listed below, and the default pressure difference of 4 Pa between the vadose zone and the building (ΔP) as applied by USEPA (2002). The calculation of the soil gas attenuation factor was conducted using the Excel spreadsheet "SL-ADV-Feb04.xls" developed by USEPA (2004) and the following Site-specific vadose zone and building properties.

Vadose Zone Soil Properties:		
Moisture Content, θ_m (%)	10	Conservatively assumed moisture content value for a low lying sand soil.
Total Porosity, ε_T (%)	27.5	Average porosity value for sand soil type after Fetter (2001; Table 3.4).
Moisture-Filled Porosity, ε_m	0.166	Moisture-filled porosity, $\varepsilon_m = \theta_m / 100*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at 15°C.
Vapor-Filled Porosity, ε_v	0.109	Vapor-filled porosity, $\varepsilon_v = \varepsilon_T / 100 - \varepsilon_m$
Dry Bulk Soil Density, ρ_{db} (g/cm³)	1.66	Default dry bulk density for sand soils, as presented in USEPA (2004).
Hydraulic Conductivity, K (cm/s)	1.00E-02	The average hydraulic conductivity of a sand soil as indicated in Fetter (2001).
Intrinsic Permeability, k_i (cm²)	1.16E-07	Intrinsic permeability, k_i=K μ_w / ρ_w g, where water density, ρ_w=999.099 kg/m^3 at 15°C, gravitational acceleration g=9.81 m/s^2, and the dynamic viscosity of water, μ_w=1.14e-3 kg/ms at 15°C (Fetter, 2001).
Relative Vapor Permeability, k_r (cm²)	0.369	Estimated after Parker et al. (1987) for a sand soil type as implemented in USEPA (2004) to account for the reduction in permeability due to the degree of vadose zone water saturation.
Effective Vapor Permeability, k_v (cm²)	4.29E-08	Determined from k_v=k_r*k_i.
Vadose Zone Temperature (°C)	15	Average measured groundwater temperature across the Site.
Fraction of Organic Carbon Content, f_{oc}	6.00E-03	Default fraction of organic carbon content, as presented in USEPA (2002c).
Distance from Source to Building, L_T (m)	0.83	Determined from average depth to volatile impacts in soil measured across the Site of 3.2 ft (0.98 m), less a 0.5 ft (0.15 m) floor slab thickness.
Vapor Viscosity of Air, μ_a at 15°C (g/cm s)	1.77E-04	Vadose zone temperature corrected vapor viscosity as implemented in USEPA (2004).
Building Properties:		
Below-Grade Area of Building Surfaces, A_B (m²)	83	Based on the approximate dimensions of the water treatment facility to be constructed at the Site, 30 ft (9.1m) by 30 ft (9.1 m), with slab-on-grade construction.
Building Volume, V_B (m^3)	505	Based on the approximate dimensions of the water treatment facility to be constructed at the Site, 30 ft (9.1m) by 30 ft (9.1 m), with a 20 ft (6.1 m) high ceiling.
Building Air Exchange Rate, T_{air} (1/hr)	0.83	Industrial indoor air exchange rate after Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, ASTM Designation: E1739-95 (ASTM, 1995).
Ratio of Crack Area to Below-Grade Area, η (%)	0.038	Default crack ratio value for slab-on-grade structures presented in USEPA (2002b; Appendix G).
Foundation Thickness, L_{crack} (cm)	15	Assumed based on a 15 cm (6 inch) floor slab thickness.

(3) Target indoor air criteria obtained from Table A.7.4.

(4) The Site-specific soil gas criteria beneath a Site building is calculated from C_{sg}=C_{tia} / α.

(5) Concentration sorbed to soil particles determined from the corresponding soil gas concentration assuming equilibrium conditions between the gas, aqueous, and sorbed phases using C_{sp}=C_{sg}*K_d/H where the Henry's Law Constant H=H_L/(T*R), T is the vadose temperature in degrees Kelvin, the universal gas constant R is 8.21E-05 atm m^3/mol K, and K_d=K_{oc}*f_{oc}.

(6) Bulk soil concentration comprised of the gas, aqueous, and sorbed phases determined from corresponding C_{sp} using phase relationships as follows: SSS_{soil}=C_{sp}/ρ_{db}*(ε_m/K_d+Hε_v/K_d+ρ_{db}) where ε_m and ε_v are the moisture and vapor filled porosities, respectively, and K_d=K_{oc}*f_{oc}.

(7) Soil concentration is the maximum detected concentration obtained from Table A.2.3.

(8) The reported K_{oc} value for mercury is in fact a K_d value obtained from USEPA (2002c), based on a pH of 7. All calculations account for this K_d value.

TABLE A.7.6

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER BASED ON PROTECTION OF INDOOR AIR QUALITY
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

	Chemical Properties (1)				Site-Specific Standards for Groundwater, SSS_{gw}			
Chemical of Potential Concern (COPC)	*Henry's Law Constant, H_L (atm m³/mol)*	*Water Diffusion Coefficient, D^{H2O} (cm²/s)*	*Air Diffusion Coefficient, D^{air} (cm²/s)*	*Johnson & Ettinger Attenuation Factor, α (2)*	*Target Indoor Air Criteria C_{tia} (µg/m³) (3)*	*Soil Gas Criteria C_{sg} (µg/m³) (4)*	*Site-Specific Groundwater Standard SSS_{gw} (µg/L) (5)*	*Maximum Groundwater Concentration (µg/L) (6)*
VOCs								
1,1-Dichloroethene	1.79E-02 (15° C)	1.04E-05 (25° C)	8.55E-02 (15° C)	1.81E-06	8.76E+02	4.85E+08	6.38E+05	4.10E+01
1,2,4-Trichlorobenzene	6.55E-04 (15° C)	8.23E-06 (25° C)	2.85E-02 (15° C)	3.27E-06	1.53E+01	4.69E+06	1.69E+05	4.20E+03
1,2-Dichlorobenzene	9.59E-04 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	5.12E-06	8.76E+02	1.71E+08	4.22E+06	2.50E+04
1,3-Dichlorobenzene	1.61E-03 (15° C)	7.86E-06 (25° C)	6.57E-02 (15° C)	4.09E-06	4.60E+02	1.12E+08	1.65E+06	2.50E+03
1,4-Dichlorobenzene	1.24E-03 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	4.60E-06	2.04E+00	4.44E+05	8.44E+03	**4.50E+04**
Benzene	3.45E-03 (15° C)	9.80E-06 (25° C)	8.36E-02 (15° C)	3.53E-06	1.59E+00	4.52E+05	3.09E+03	**9.80E+04**
Carbon tetrachloride	1.92E-02 (15° C)	8.80E-06 (25° C)	7.41E-02 (15° C)	1.53E-06	8.18E-01	5.36E+05	6.60E+02	6.00E+02
Chlorobenzene	2.08E-03 (15° C)	8.70E-06 (25° C)	6.94E-02 (15° C)	3.91E-06	2.61E+02	6.67E+07	7.57E+05	2.30E+05
Chloroform	2.36E-03 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	4.68E-06	5.33E-01	1.14E+05	1.14E+03	1.50E+02
cis-1,2-Dichloroethene	2.59E-03 (15° C)	1.13E-05 (25° C)	6.99E-02 (15° C)	4.00E-06	1.53E+02	3.83E+07	3.49E+05	2.40E+01
Cyclohexane	1.22E-01 (15° C)	9.00E-06 (25° C)	7.60E-02 (15° C)	1.17E-06	2.63E+04	2.25E+10	4.37E+06	1.70E+02
Methylene chloride	1.45E-03 (15° C)	1.17E-05 (25° C)	9.60E-02 (15° C)	6.29E-06	2.61E+01	4.15E+06	6.76E+04	7.90E+03
Tetrachloroethene (former)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.74E-06	2.15E+01	1.24E+07	2.78E+04	3.70E+02
Tetrachloroethene (current)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.74E-06	2.04E+00	1.18E+06	2.64E+03	3.70E+02
Toluene	3.89E-03 (15° C)	8.60E-06 (25° C)	8.27E-02 (15° C)	3.09E-06	2.19E+04	7.08E+09	4.31E+07	2.00E+02
Trichloroethene (former)	6.25E-03 (15° C)	9.10E-06 (25° C)	7.51E-02 (15° C)	2.40E-06	7.21E+00	3.00E+06	1.14E+04	1.60E+01
Trichloroethene (current)	6.25E-03 (15° C)	9.10E-06 (25° C)	7.51E-02 (15° C)	2.40E-06	1.11E-01	4.64E+04	1.75E+02	1.60E+01
Vinyl chloride	2.02E-02 (15° C)	1.23E-05 (25° C)	1.01E-01 (15° C)	2.06E-06	2.79E+00	1.35E+06	1.59E+03	**4.00E+03**
SVOCs								
2-Chlorophenol	1.97E-04 (15° C)	9.46E-06 (25° C)	4.76E-02 (15° C)	6.34E-06	7.67E+01	1.21E+07	1.45E+06	3.40E+02
Hexachloroethane	1.96E-03 (15° C)	6.80E-06 (25° C)	2.38E-03 (15° C)	3.44E-07	3.07E+00	8.90E+06	1.07E+05	2.80E+01
Naphthalene	2.27E-04 (15° C)	7.50E-06 (25° C)	5.61E-02 (15° C)	6.75E-06	1.31E+01	1.95E+06	2.03E+05	4.10E+01
Metals								
Mercury	4.38E-03 (15° C)	6.30E-06 (25° C)	2.92E-02 (15° C)	1.50E-06	1.31E+00	8.77E+05	4.73E+03	3.09E+02

TABLE A.7.6

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER BASED ON PROTECTION OF INDOOR AIR QUALITY

INDUSTRIAL LAND USE SCENARIO

OXYCHEM

DELAWARE CITY, DELAWARE

Notes:

NV = No Value due to lack of toxicity data

Maximum detected concentration exceeds the SSS

(1) The applied chemical properties are obtained from the chemical properties database implemented in USEPA (2004). The Henry's Law constant and air diffusion coefficient were corrected for an average vadose zone temperature of 15°C. The reference temperature for the water diffusion coefficient is 25°C and, considering its low value, a correction to 15°C was considered negligible.

(2) The soil gas attenuation factor α is based on the solution for soil gas migration to building indoor air presented in Johnson and Ettinger [1991; Equation (21)], the vadose zone and building properties listed below, and the default pressure difference of 4 Pa between the vadose zone and the building (ΔP) as applied by USEPA (2002). The calculation of the soil gas attenuation factor was conducted using the Excel spreadsheet "GW-ADV-Feb04.xls" developed by USEPA (2004) and the following Site-specific vadose zone and building properties.

Vadose Zone Soil Properties:		
Moisture Content, θ_m (%)	10	Conservatively assumed moisture content value for a low lying sand soil.
Total Porosity, ε_T (%)	27.5	Average porosity value for sand soil type after Fetter (2001; Table 3.4).
Moisture-Filled Porosity, ε_m	0.166	Moisture-filled porosity, $\varepsilon_m = \theta_m / 100 * (\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at 15°C.
Vapour-Filled Porosity, ε_v	0.109	Vapor-filled porosity, $\varepsilon_v = \varepsilon_T / 100 - \varepsilon_m$
Dry Bulk Soil Density, ρ_{db} (g/cm³)	1.66	Default dry bulk density for sand soils, as presented in USEPA (2004).
Hydraulic Conductivity, K (cm/s)	1.00E-02	The average hydraulic conductivity of a sand soil as indicated in Fetter (2001).
Intrinsic Permeability, k_i (cm²)	1.16E-07	Intrinsic permeability, $k_i = K \mu_w / \rho_w g$, where water density, ρ_w=999.099 kg/m^3 at 15°C, gravitational acceleration g=9.81 m/s^2, and the dynamic viscosity of water, μ_w=1.14e-3 kg/ms at 15°C (Fetter, 2001).
Relative Vapor Permeability, k_r (cm²)	0.369	Estimated after Parker et al. (1987) for a sand soil type as implemented in USEPA (2004) to account for the reduction in permeability due to the degree of vadose zone water saturation.
Effective Vapor Permeability, k_v (cm²)	4.29E-08	Determined from $k_v = k_r * k_i$.
Vadose Zone Temperature (°C)	15	Average measured groundwater temperature across the Site.
Distance from Source to Building, L_T (m)	4.42	Determined from the approximate depth to groundwater measured across the Site in 2006 of 15 ft (4.57 m) less a 0.5 ft (0.15 m) floor slab thickness.
Vapor Viscosity of Air, μ_a at 15°C (g/cm s)	1.77E-04	Vadose zone temperature corrected vapor viscosity as implemented in USEPA (2004).
Building Properties:		
Below-Grade Area of Building Surfaces, A_B (m²)	83	Based on the approximate dimensions of the water treatment facility to be constructed at the Site, 30 ft (9.1m) by 30 ft (9.1 m), with slab-on-grade construction.
Building Volume, V_B (m^3)	505	Based on the approximate dimensions of the water treatment facility to be constructed at the Site, 30 ft (9.1m) by 30 ft (9.1 m), with a 20 ft (6.1 m) high ceiling.
Building Air Exchange Rate, T_{air} (1/hr)	0.83	Industrial indoor air exchange rate after Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, ASTM Designation: E1739-95 (ASTM, 1995).
Ratio of Crack Area to Below-Grade Area, η (%)	0.038	Default crack ratio value for slab-on-grade structures presented in USEPA (2002b; Appendix G).
Foundation Thickness, L_{crack} (cm)	15	Assumed based on a 15 cm (6 inch) floor slab thickness.

(3) Target indoor air criteria obtained from Table A.7.4.

(4) The Site-specific soil gas criteria beneath a Site building is calculated from $C_{sg} = C_{tia} / \alpha$.

(5) The Site-specific standard for groundwater was determined from the soil gas criteria assuming equilibrium conditions and Henry's Law; $SSS_{gw} = C_{sg} * (T*R)/H_L$ where T is the vadose temperature in degrees Kelvin and the universal gas constant R is 8.206E-05 atm m^3/mol K.

(6) Groundwater concentration is the maximum detected concentration obtained from Table A.2.4.

TABLE A.7.7

DERIVATION OF SITE SPECIFIC STANDARD (SSS) FOR LEAD IN SOILS FOR THE CURRENT/FUTURE INDUSTRIAL WORKER AND FUTURE CONSTRUCTION/UTILITY WORKER INDUSTRIAL LAND USE SCENARIO OXYCHEM DELAWARE CITY, DELAWARE

Model Parameters	*Symbol*	*Units*	*Current/Future Industrial Worker*	*Future Construction/Utility Worker*	*Reference*
95th Percentile PbB in fetus	$PbB_{fetal,0.95}$	µg/dL	10	10	(1)
R (Mean ratio of fetal to maternal PbB)	$R_{fetal/maternal}$	unitless	0.9	0.9	(1)
Individual geometric standard deviation	GSD_i	unitless	2.11	2.11	(2)
Baseline blood lead value	$PbB_{adult,0}$	µg/dL	1.53	1.53	(2)
Biokinetic slope factor	BKSF	µg/dL per µg/day	0.4	0.4	(1)
Soil ingestion rate	IR_S	g/day	0.1	0.33	(3)
Soil Exposure Frequency	EF_S	days/yr	250	250	Scenario Specific
Absolute absorption fraction of lead in soil	AF_S	unitless	0.12	0.12	(1)
Averaging time	AT	days/yr	365	365	(1)

	Formula			Units
$PbB_{adult, central goal}$	$PbB_{adult, central goal} = PbB_{fetal,0.95} / (R_{fetal/maternal} \times GSD_i^{1.645})$	**3.25**	**3.25**	(µg/dL)
Risk-Based Site-Specific Standard (SSS)	$SSS = \frac{(PbB_{adult, central goal} - PbB_{adult, 0}) \times AT}{(BKSF \times IR_S \times AF_S \times EF_S)}$	524	159	(µg/g)

Notes:

(1) USEPA, 2003:Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January 2003.

(2) USEPA, 2002. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phase 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). Office of Solid Waste and Emergency Response. OSWER #9285.7-52, March 2002.

(3) USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

TABLE A.8.1

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway (1) (Table Reference) Human Health Based SSSs (mg/kg)* 1 (see Table A.7.1)	2 (see Table A.7.2)	*Proposed SSSs* *Minimum Calculated SSS Value (2) (mg/kg)*	*Basis*	*Maximum Detected Concentration (3) (mg/kg)*
Volatile Organic Compounds (VOCs)					
Cyclohexane	3.59E+05	3.18E+04	3.18E+04	Industrial Worker	2.70E-02
Semi-Volatile Organic Compounds (SVOCs)					
Benzo(a)pyrene	7.14E-01	7.03E-02	7.03E-02	Industrial Worker	1.00E+00
Metals					
Aluminum	5.53E+06	8.85E+05	8.85E+05	Industrial Worker	2.01E+04
Arsenic	2.11E+01	1.59E+00	1.59E+00	Industrial Worker	1.10E+02
Cobalt	9.98E+04	2.30E+03	2.30E+03	Industrial Worker	1.82E+02
Copper	2.27E+05	3.83E+04	3.83E+04	Industrial Worker	6.30E+03
Iron	3.98E+06	6.71E+05	6.71E+05	Industrial Worker	1.26E+05
Lead	NV	5.24E+02	5.24E+02	Industrial Worker (4)	1.06E+02 (5)
Manganese	2.74E+04	7.23E+03	7.23E+03	Industrial Worker	4.20E+03
Mercury	5.76E+02	6.08E+01	6.08E+01	Industrial Worker	9.13E+03
PCBs					
Aroclor-1260	7.44E+00	7.44E-01	7.44E-01	Industrial Worker	4.40E+00

Notes:

NV No value.

Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

	Receptor	***Medium***	
1	Trespasser	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
2	Industrial Worker	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)

(2) Minimum calculated SSS value is the lowest of the calculated human health based SSSs.

(3) See Table A.2.1 for surface soil maximum detected concentrations.

(4) See Table A.7.7 for derivation of lead SSS.

TABLE A.8.2

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE AND SUBSURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway [1] (Table Reference) Human Health Based SSSs (mg/kg)*		*Proposed SSSs*		
	1 (see Table A.7.3)	*2 (see Table A.7.5)*	*Minimum Calculated SSS Value [2] (mg/kg)*	*Basis*	*Maximum Detected Concentration [3] (mg/kg)*
Volatile Organic Compounds (VOCs)					
1,2,4-Trichlorobenzene	1.48E+02	2.66E+02	1.48E+02	Construction/ Utility Worker	1.10E+03
1,2-Dichlorobenzene	NA	1.78E+03	1.78E+03	Indoor Air	1.10E+03
1,3-Dichlorobenzene	NA	1.75E+03	1.75E+03	Indoor Air	7.70E+01
1,4-Dichlorobenzene	1.32E+02	3.22E+00	3.22E+00	Indoor Air	2.00E+03
2-Butanone	NA	2.57E+04	2.57E+04	Indoor Air	3.10E-02
Acetone	NA	1.45E+04	1.45E+04	Indoor Air	1.70E-01
Benzene	2.37E+01	8.99E-02	8.99E-02	Indoor Air	4.50E+02
Carbon Disulfide	NA	6.33E-03	6.33E-03	Indoor Air	5.00E-03
Chlorobenzene	NA	8.72E+01	8.72E+01	Indoor Air	5.60E+02
Chloroform (Trichloromethane)	NA	2.86E-02	2.86E-02	Indoor Air	8.90E-01
Cyclohexane	5.38E+03	1.38E+02	1.38E+02	Indoor Air	3.40E-02
Methyl cyclohexane	5.84E+03	7.69E+01	7.69E+01	Indoor Air	5.40E-02
Methylene chloride	NA	1.17E+00	1.17E+00	Indoor Air	9.50E-02
Tetrachloroethene (former)	NA	1.08E+00	1.08E+00	Indoor Air	1.90E+00
Tetrachloroethene (current)	NA	8.74E-02	8.74E-02	Indoor Air	1.90E+00
Vinyl Chloride	9.52E+00	1.34E-02	1.34E-02	Indoor Air	2.90E+03
Xylenes (total)	NA	1.78E+02	1.78E+02	Indoor Air	8.00E-03
Semi-Volatile Organic Compounds (SVOCs)					
2-Methylnaphthalene	NA	3.22E+03	3.22E+03	Indoor Air	2.30E+00
Acetophenone	NA	2.91E+04	2.91E+04	Indoor Air	1.20E+00
Anthracene	NA	1.93E+07	1.93E+07	Indoor Air	2.10E-01
Benzaldehyde	NA	1.46E+04	1.46E+04	Indoor Air	6.90E-01
Benzo(a)pyrene	2.14E+00	NA	2.14E+00	Construction/ Utility Worker	1.00E+00
Benzo(b)fluoranthene	NA	1.31E+04	1.31E+04	Indoor Air	2.00E+00
Bis(2-ethylhexyl)phthalate	1.19E+03	NA	1.19E+03	Construction/ Utility Worker	1.30E+03
Chrysene	NA	4.06E+05	4.06E+05	Indoor Air	9.30E-01
Fluoranthene	NA	7.12E+07	7.12E+07	Indoor Air	1.50E+00
Hexachlorobenzene	7.68E+00	5.69E+00	5.69E+00	Indoor Air	8.20E+00
Naphthalene	NA	4.38E+02	4.38E+02	Indoor Air	5.70E-01
Nitrobenzene	NA	2.20E+02	2.20E+02	Indoor Air	9.60E+00
Phenanthrene	NA	1.48E+05	1.48E+05	Indoor Air	1.10E+00
Pyrene	NA	1.72E+07	1.72E+07	Indoor Air	1.60E+00

TABLE A.8.2

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE AND SUBSURFACE SOIL
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway* [1] *(Table Reference) Human Health Based SSSs (mg/kg)* 1 *(see Table A.7.3)*	2 *(see Table A.7.5)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(mg/kg)*	*Basis*	*Maximum Detected Concentration* [3] *(mg/kg)*
Metals					
Aluminum	1.02E+05	NA	1.02E+05	Construction/ Utility Worker	2.27E+04
Arsenic	1.29E+01	NA	1.29E+01	Construction/ Utility Worker	1.10E+02
Cobalt	5.64E+02	NA	5.64E+02	Construction/ Utility Worker	1.82E+02
Copper	1.20E+04	NA	1.20E+04	Construction/ Utility Worker	6.30E+03
Iron	2.10E+05	NA	2.10E+05	Construction/ Utility Worker	1.26E+05
Lead	1.59E+02	NA	1.59E+02	Construction/ Utility Worker [4]	7.39E+01 [5]
Manganese	1.08E+03	NA	1.08E+03	Construction/ Utility Worker	4.20E+03
Mercury	1.14E+01	2.63E+01	1.14E+01	Construction/ Utility Worker	9.13E+03
PCBs					
Aroclor-1260	7.62E+00	NA	7.62E+00	Construction/ Utility Worker	4.40E+00

Notes:

NA Not applicable.

Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

	Receptor	***Medium***	***Pathway***
1	Construction/Utility Worker	Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
2	Industrial Worker	Soil (indoor air)	Direct Contact (inhalation of vapors)

(2) Minimum calculated SSS value is the lowest of the calculated human health based SSSs.

(3) See Table A.2.2 and/or Table A.2.3 for soil maximum detected concentrations.

(4) See Table A.7.7 for derivation of lead SSS.

TABLE A.8.3

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) GROUNDWATER (µg/L)	*Calculated PSSs Per Exposure Pathway* [1] *(Table Reference) Human Health Based SSSs (µg/L) 1 (see Table A.7.6)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(µg/L)*	*Basis*	*Maximum Detected Concentration* [3] *(µg/L)*
Volatile Organic Compounds (VOCs)				
1,1-Dichloroethene	6.38E+05	6.38E+05	Indoor Air	4.10E+01
1,2,4-Trichlorobenzene	1.69E+05	1.69E+05	Indoor Air	4.20E+03
1,2-Dichlorobenzene	4.22E+06	4.22E+06	Indoor Air	2.50E+04
1,3-Dichlorobenzene	1.65E+06	1.65E+06	Indoor Air	2.50E+03
1,4-Dichlorobenzene	8.44E+03	8.44E+03	Indoor Air	4.50E+04
Benzene	3.09E+03	3.09E+03	Indoor Air	9.80E+04
Carbon tetrachloride	6.60E+02	6.60E+02	Indoor Air	6.00E+02
Chlorobenzene	7.57E+05	7.57E+05	Indoor Air	2.30E+05
Chloroform	1.14E+03	1.14E+03	Indoor Air	1.50E+02
cis-1,2-Dichloroethene	3.49E+05	3.49E+05	Indoor Air	2.40E+01
Cyclohexane	4.37E+06	4.37E+06	Indoor Air	1.70E+02
Methylene chloride	6.76E+04	6.76E+04	Indoor Air	7.90E+03
Tetrachloroethene (former)	2.78E+04	2.78E+04	Indoor Air	3.70E+02
Tetrachloroethene (current)	2.64E+03	2.64E+03	Indoor Air	3.70E+02
Toluene	4.31E+07	4.31E+07	Indoor Air	2.00E+02
Trichloroethene (former)	1.14E+04	1.14E+04	Indoor Air	1.60E+01
Trichloroethene (current)	1.75E+02	1.75E+02	Indoor Air	1.60E+01
Vinyl chloride	1.59E+03	1.59E+03	Indoor Air	4.00E+03
Semi-Volatile Organic Compounds (SVOCs)				
2-Chlorophenol	1.45E+06	1.45E+06	Indoor Air	3.40E+02
Hexachloroethane	1.07E+05	1.07E+05	Indoor Air	2.80E+01
Naphthalene	2.03E+05	2.03E+05	Indoor Air	4.10E+01

TABLE A.8.3

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER
INDUSTRIAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) GROUNDWATER (µg/L)	*Calculated PSSs Per Exposure Pathway* [1] *(Table Reference)* *Human Health Based SSSs (µg/L)* *1* *(see Table A.7.6)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(µg/L)*	*Basis*	*Maximum Detected Concentration* [3] *(µg/L)*
Metals				
Mercury	4.73E+03	4.73E+03	Indoor Air	3.09E+02

Notes:

[ ] Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

Receptor	***Pathway***
1 Industrial Worker	Indoor Air (inhalation of vapors)

(2) Minimum calculated SSS value is the lowest calculated human health based SSS.

(3) See Table A.2.4 for groundwater maximum detected concentrations.

APPENDIX B

EXPOSURE ASSUMPTIONS FOR THE DEVELOPMENT OF SITE-SPECIFIC STANDARDS – RECREATIONAL LAND USE

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TABLE B.1.1

SELECTION OF EXPOSURE PATHWAY SCENARIOS
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe	*Medium*	*Exposure Medium*	*Exposure Point*	*Receptor Population*	*Receptor Age*	*Exposure Route*	*Type of Analysis*	*Rationale for Selection or Exclusion of Exposure Pathway*
Future:	Surface Soil (0 to 2 ft bgs)	Surface Soil	Direct Contact	Soccer Player	Child	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while playing soccer.
		Ambient Air	Direct Contact	Soccer Player	Child	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while playing while playing soccer.
		Surface Soil	Direct Contact	Golfer	Child & Adult	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while playing golf at the course.
		Ambient Air	Direct Contact	Golfer	Child & Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while playing golf at the course.
		Surface Soil	Direct Contact	Golf Course Employee	Adult	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while working outside.
		Ambient Air	Direct Contact	Golf Course Employee	Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while working outside.
	Soil (0 to 15 ft bgs)	Soil	Direct Contact	Construction/Utility Worker	Adult	Ingestion Dermal	Quant	Potential exposure to contaminated soil during ground intrusive activities.
		Ambient Air	Direct Contact	Construction/Utility Worker	Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air during ground intrusive activities.
		Indoor Air	Direct Contact	Golfer	Child & Adult	Inhalation of Vapors	Qual	Potential exposure to indoor air.
			Direct Contact	Golf Course Employee	Adult	Inhalation of Vapors	Quant	Potential exposure to indoor air while working indoors.
	Groundwater	Indoor Air	Direct Contact	Golfer	Child & Adult	Inhalation of Vapors	Qual	Potential exposure to indoor air.
			Direct Contact	Golf Course Employee	Adult	Inhalation of Vapors	Quant	Potential exposure to indoor air while working indoors.
		Ambient Air	Direct Contact	Soccer Player	Child	Inhalation of Vapors	Qual	Potential exposure to ambient air while playing soccer.
			Direct Contact	Golfer	Child & Adult	Inhalation of Vapors	Qual	Potential exposure to ambient air while playing golf at the course.
			Direct Contact	Golf Course Employee	Adult	Inhalation of Vapors	Qual	Potential exposure to ambient air while working outside.

TABLE B.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - SOCCER PLAYER/GOLFER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.003	K	130		mg/kg	SB-13; SC Pipeline Area; 0-2 ftbgs (08/18/98)	26/65	0.0008 - 2.7	130	78	N	N/A	N/A	X	ASC
95-50-1	1,2-Dichlorobenzene	0.0066		79		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	25/65	0.0009 - 2.7	79	700	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.11	J	0.11	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.11	7	C	N/A	N/A		BSC
541-73-1	1,3-Dichlorobenzene	0.0062		5.2		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	13/65	0.0008 - 2.7	5.2	23	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	100		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	26/65	0.0009 - 2.7	100	27	C	N/A	N/A	X	ASC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.022	J	mg/kg	SCPX-01-10; SC Pipeline Area; 1 ftbgs (05/18/04)	15/45	0.0009 - 2.7	0.022	4700	N	N/A	N/A		BSC
67-64-1	Acetone	0.007	B	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	30/45	0.006 - 2.7	0.17	7000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		1.3	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	9/51	0.0008 - 2.7	1.3	12	C	N/A	N/A		BSC
75-25-2	Bromoform	0.001		0.001		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.001	81	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/41	0.0008 - 2.7	0.27	11	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.0026	J	mg/kg	SCPX-04-10; SC Pipeline Area; 1 ftbgs (05/18/04)	2/35	0.0008 - 2.7	0.0026	780	N	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	38		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	18/51	0.0009 - 2.7	38	160	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.017	K	0.017	K	mg/kg	SCPX-04-14; SC Pipline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.017	78	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.027	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	2/34	0.0008 - 2.7	0.027	--	N	N/A	N/A	X	AD
108-87-2	Methyl cyclohexane	0.016	K	0.016	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/34	0.0008 - 2.7	0.016	--	N	N/A	N/A		LDF
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	33/51	0.001 - .7	0.095	85	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.004	J	0.012	J	mg/kg	WB-18; Waste Lake 2; 0-2 ftbgs (08/18/98)	12/51	0.0008 - 2.7	0.012	1.2	C	N/A	N/A		BSC
108-88-3	Toluene	0.007	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.007	630	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	0.0045	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.0045	0.09	C	N/A	N/A		BSC
	Semi-volatile Organic Compounds															
120-83-2	2,4-Dichlorophenol	0.45		0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	1/51	0.35 - 0.47	0.45	23	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.072	J	0.15	J	mg/kg	FLD-32; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	2/97	0.33 - 2.4	0.15	31	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.44		0.44		mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.35 - 0.47	0.44	31	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/87	0.33 - 2.4	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/34	0.36 - 0.47	1.2	780	N	N/A	N/A		BSC
120-12-7	Anthracene	0.086	J	0.17	J	mg/kg	FLD-06; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	4/97	0.33 - 2.4	0.17	2300	N	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/34	0.35 - 0.42	0.69	780	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	0.83	0.22	C	N/A	N/A	X	ASC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	22/97	0.33 - 2.4	1	0.022	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.065	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	2	0.22	C	N/A	N/A	X	ASC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	9/97	0.33 - 2.4	0.3	31 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	19/97	0.33 - 2.4	1.7	2.2	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1.3		mg/kg	OBSL-CAP-10;Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	27/51	0.35 - 0.42	1.3	46	C	N/A	N/A		BSC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	5/51	0.35 - 0.47	0.92	1600	N	N/A	N/A		BSC
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	27/97	0.33 - 2.2	0.93	22	C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.085	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	3/97	0.33 - 2.4	0.15	0.022	C	N/A	N/A		LDF
84-66-2	Diethyl phthalate	0.34	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	6/41	0.37 - 0.47	0.53	6300	N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12	J	0.32	J	mg/kg	OBSL-CAP-10; Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	2/51	0.35 - 0.47	0.32	780 (7)	N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.04	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	32/97	0.33 - 2.2	1.5	310	N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.051	J	0.62		mg/kg	WB-32; Waste Lake 2; 0-2 ftbgs (08/17/98)	6/65	0.35 - 0.47	0.62	0.4	C	N/A	N/A	X	ASC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	11/97	0.33 - 2.4	0.45	0.22	C	N/A	N/A	X	ASC
78-59-1	Isophorone	0.072	J	0.072	J	mg/kg	WB-19; Waste Lake 2; 0-2 ftbgs (08/20/98)	1/50	0.35 - 0.47	0.072	670	C	N/A	N/A		BSC
91-20-3	Naphthalene	0.1	J	0.22	J	mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	2/97	0.33 - 2.4	0.22	160	N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.1	J	3.1	K	mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	4/41	0.35 - 0.47	3.1	3.9	N	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	24/97	0.33 - 2.4	1.1	31 (6)	N	N/A	N/A		BSC
129-00-0	Pyrene	0.071	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/97	0.34 - 2.2	1.6	230	N	N/A	N/A		BSC

TABLE B.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - SOCCER PLAYER/GOLFER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Metals															
7429-90-5	Aluminum	5120		20100	J	mg/kg	SC-4; SC Pipeline Area; 0-4 ftbgs (04/05/04)	54/54	--	20100	--	N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	10.4	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	41/59	0.18 - 5	10.4	3.1	N	N/A	N/A	X	ASC
7440-38-2	Arsenic	0.44		110		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	110	0.43	C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	14.9		520		mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	60/60	--	520	1600	N	N/A	N/A		BSC
7440-41-7	Beryllium	0.37		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	59/60	0.62	69.3	16	N	N/A	N/A	X	ASC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	39/60	0.013 - 0.62	6.4	7.8	N	N/A	N/A		BSC
7440-70-2	Calcium	146	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	30400	--	N	N/A	N/A		NUT
7440-47-3	Chromium Total	6.5		99		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	99	12000	N	N/A	N/A		BSC
7440-48-4	Cobalt	2.2	B	182		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	182	--	N	N/A	N/A	X	AD
7440-50-8	Copper	2.7		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	55/60	11 - 12	6300	310	N	N/A	N/A	X	ASC
7439-89-6	Iron	6900		126000		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	126000	5500	N	N/A	N/A	X	ASC
7439-92-1	Lead	2.6		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	3410	400 (9)	N	N/A	N/A	X	ASC
7439-95-4	Magnesium	500		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	12100	--	N	N/A	N/A		NUT
7439-96-5	Manganese	40.6		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	106/106	--	4200	160	N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	156/158	0.21 - 48	9131	3.31 (10)	N	N/A	N/A	X	ASC
7440-02-0	Nickel	4.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	674	160	N	N/A	N/A	X	ASC
7440-09-7	Potassium	373	J	5590	J	mg/kg	PE-SBG-GRID 12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	5590	--	N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.2	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	38/106	0.18 - 0.62	3.2	39	N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	0.68	B	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	8/60	0.048 - 60	0.68	39	N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		8650		mg/kg	PE-SBG-GRID-12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	8650	--	N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		0.72	B	mg/kg	OBSL-CAP-5; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	12/60	0.19 - 180	0.72	0.55	N	N/A	N/A	X	ASC
7440-62-2	Vanadium	10.3	J	45		mg/kg	SCPX-02-17; Chlorine Pipeline Area; 1- ftbgs (05/19/04)	54/54	--	45	7.8	N	N/A	N/A	X	ASC
7440-66-6	Zinc	17.4		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	28800	2300	N	N/A	N/A	X	ASC

TABLE B.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - SOCCER PLAYER/GOLFER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	0.32 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-03R, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, PE-RTR-DIRT-FROM-BRINE-RR, PE-GTB-BUILDING 1, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SC-6, WL2-F1, WL2-F2, WL2-F3, WL2-F4, WL2-F5, WL2-F6, WL2-F7, WL2-F8, WL2-F9, WL2-F10, WL2-F11, WL2-F12, WL2-F13, WL2-F14, SS-07, SS-08, SS-09, SS-10, WB-04, WB-17, WB-28, WB-29, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, PE-WWTP, A, A/B, B, C, D.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Residential Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.

TABLE B.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - GOLF COURSE EMPLOYEE EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.003	K	130		mg/kg	SB-13; SC Pipeline Area; 0-2 ftbgs (08/18/98)	26/65	0.0008 - 2.7	130	1000	N	N/A	N/A		BSC
95-50-1	1,2-Dichlorobenzene	0.0066		79		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	25/65	0.0009 - 2.7	79	9200	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.11	J	0.11	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.11	31	C	N/A	N/A		BSC
541-73-1	1,3-Dichlorobenzene	0.0062		5.2		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	13/65	0.0008 - 2.7	5.2	310	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	100		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	26/65	0.0009 - 2.7	100	120	C	N/A	N/A		BSC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.022	J	mg/kg	SCPX-01-10; SC Pipeline Area; 1 ftbgs (05/18/04)	15/45	0.0009 - 2.7	0.022	61000	N	N/A	N/A		BSC
67-64-1	Acetone	0.007	B	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	30/45	0.006 - 2.7	0.17	92000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		1.3	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	9/51	0.0008 - 2.7	1.3	52	C	N/A	N/A		BSC
75-25-2	Bromoform	0.001		0.001		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.001	360	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/41	0.0008 - 2.7	0.27	140	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.0026	J	mg/kg	SCPX-04-10; SC Pipeline Area; 1 ftbgs (05/18/04)	2/35	0.0008 - 2.7	0.0026	10000	N	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	38		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	18/51	0.0009 - 2.7	38	2000	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.017	K	0.017	K	mg/kg	SCPX-04-14; SC Pipline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.017	1000	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.027	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	2/34	0.0008 - 2.7	0.027	--	N	N/A	N/A	X	AD
108-87-2	Methyl cyclohexane	0.016	K	0.016	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/34	0.0008 - 2.7	0.016	--	N	N/A	N/A		LDF
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	33/51	0.001 - .7	0.095	380	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.004	J	0.012	J	mg/kg	WB-18; Waste Lake 2; 0-2 ftbgs (08/18/98)	12/51	0.0008 - 2.7	0.012	5.3	C	N/A	N/A		BSC
108-88-3	Toluene	0.007	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.007	8200	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	0.0045	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.0045	4	C	N/A	N/A		LDF
	Semi-volatile Organic Compounds															
120-83-2	2,4-Dichlorophenol	0.45		0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	1/51	0.35 - 0.47	0.45	310	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.072	J	0.15	J	mg/kg	FLD-32; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	2/97	0.33 - 2.4	0.15	410	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.44		0.44		mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.35 - 0.47	0.44	410	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/87	0.33 - 2.4	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/34	0.36 - 0.47	1.2	10000	N	N/A	N/A		BSC
120-12-7	Anthracene	0.086	J	0.17	J	mg/kg	FLD-06; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	4/97	0.33 - 2.4	0.17	31000	N	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/34	0.35 - 0.42	0.69	10000	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	0.83	3.9	C	N/A	N/A		BSC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	22/97	0.33 - 2.4	1	0.39	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.065	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	2	3.9	C	N/A	N/A		BSC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	9/97	0.33 - 2.4	0.3	410 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	19/97	0.33 - 2.4	1.7	39	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1.3		mg/kg	OBSL-CAP-10;Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	27/51	0.35 - 0.42	1.3	200	C	N/A	N/A		BSC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	5/51	0.35 - 0.47	0.92	20000	N	N/A	N/A		BSC
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	27/97	0.33 - 2.2	0.93	390	C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.085	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	3/97	0.33 - 2.4	0.15	0.39	C	N/A	N/A		BSC
84-66-2	Diethyl phthalate	0.34	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	6/41	0.37 - 0.47	0.53	82000	N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12	J	0.32	J	mg/kg	OBSL-CAP-10; Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	2/51	0.35 - 0.47	0.32	10000 (7)	N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.04	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	32/97	0.33 - 2.2	1.5	4100	N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.051	J	0.62		mg/kg	WB-32; Waste Lake 2; 0-2 ftbgs (08/17/98)	6/65	0.35 - 0.47	0.62	1.8	C	N/A	N/A		BSC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	11/97	0.33 - 2.4	0.45	3.9	C	N/A	N/A		BSC
78-59-1	Isophorone	0.072	J	0.072	J	mg/kg	WB-19; Waste Lake 2; 0-2 ftbgs (08/20/98)	1/50	0.35 - 0.47	0.072	3000	C	N/A	N/A		BSC
91-20-3	Naphthalene	0.1	J	0.22	J	mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	2/97	0.33 - 2.4	0.22	2000	N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.1	J	3.1	K	mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	4/41	0.35 - 0.47	3.1	51	N	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	24/97	0.33 - 2.4	1.1	410 (6)	N	N/A	N/A		BSC
129-00-0	Pyrene	0.071	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/97	0.34 - 2.2	1.6	3100	N	N/A	N/A		BSC

TABLE B.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - GOLF COURSE EMPLOYEE EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Metals															
7429-90-5	Aluminum	5120		20100	J	mg/kg	SC-4; SC Pipeline Area; 0-4 ftbgs (04/05/04)	54/54	--	20100	--	N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	10.4	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	41/59	0.18 - 5	10.4	41	N	N/A	N/A		BSC
7440-38-2	Arsenic	0.44		110		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	110	1.9	C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	14.9		520		mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	60/60	--	520	20000	N	N/A	N/A		BSC
7440-41-7	Beryllium	0.37		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	59/60	0.62	69.3	200	N	N/A	N/A		BSC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	39/60	0.013 - 0.62	6.4	100	N	N/A	N/A		BSC
7440-70-2	Calcium	146	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	30400	--	N	N/A	N/A		NUT
7440-47-3	Chromium Total	6.5		99		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	99	150000	N	N/A	N/A		BSC
7440-48-4	Cobalt	2.2	B	182		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	182	--	N	N/A	N/A	X	AD
7440-50-8	Copper	2.7		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	55/60	11 - 12	6300	4100	N	N/A	N/A	X	ASC
7439-89-6	Iron	6900		126000		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	126000	72000	N	N/A	N/A	X	ASC
7439-92-1	Lead	2.6		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	3410	800 (9)	N	N/A	N/A	X	ASC
7439-95-4	Magnesium	500		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	12100	--	N	N/A	N/A		NUT
7439-96-5	Manganese	40.6		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	106/106	--	4200	2000	N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	156/158	0.21 - 48	9131	3.31 (10)	N	N/A	N/A	X	ASC
7440-02-0	Nickel	4.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	674	2000	N	N/A	N/A		BSC
7440-09-7	Potassium	373	J	5590	J	mg/kg	PE-SBG-GRID 12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	5590	--	N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.2	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	38/106	0.18 - 0.62	3.2	510	N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	0.68	B	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	8/60	0.048 - 60	0.68	510	N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		8650		mg/kg	PE-SBG-GRID-12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	8650	--	N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		0.72	B	mg/kg	OBSL-CAP-5; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	12/60	0.19 - 180	0.72	7.2	N	N/A	N/A		BSC
7440-62-2	Vanadium	10.3	J	45		mg/kg	SCPX-02-17; Chlorine Pipeline Area; 1- ftbgs (05/19/04)	54/54	--	45	100	N	N/A	N/A		BSC
7440-66-6	Zinc	17.4		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	28800	31000	N	N/A	N/A		BSC

TABLE B.2.2

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS) - GOLF COURSE EMPLOYEE EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	1.4 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-03R, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, PE-RTR-DIRT-FROM-BRINE-RR, PE-GTB-BUILDING 1, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SC-6, WL2-F1, WL2-F2, WL2-F3, WL2-F4, WL2-F5, WL2-F6, WL2-F7, WL2-F8, WL2-F9, WL2-F10, WL2-F11, WL2-F12, WL2-F13, WL2-F14, SS-07, SS-08, SS-09, SS-10, WB-04, WB-17, WB-28, WB-29, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, PE-WWTP, A, A/B, B, C, D.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Industrial Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.

TABLE B.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.002		1100	L	mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	51/142	0.0008 - 2.8	1100	1000	N	N/A	N/A	X	ASC
95-50-1	1,2-Dichlorobenzene	0.0025		1100		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	56/142	0.0009 - 2.8	1100	9200	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.0098	J	0.47		mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	4/117	0.0008 - 31	0.47	31	C	N/A	N/A		BSC
540-59-0	1,2-Dichloroethene (total)	0.013	J	0.013	J	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/63	0.005 - 31	0.013	--	N	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	0.0036		77		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	32/141	0.0008 - 2.8	77	310	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	2000		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	62/142	0.009 - 2.8	2000	120	C	N/A	N/A	X	ASC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.031	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	19/87	0.0008 - 2.7	0.031	61000	N	N/A	N/A		BSC
67-64-1	Acetone	0.002	JB	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	65/87	0.006 - 2.7	0.17	92000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		450		mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	34/146	0.0008 - 31	450	52	C	N/A	N/A	X	ASC
75-25-2	Bromoform	0.001		0.0034		mg/kg	SC-1; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/117	0.0008 - 31	0.0034	360	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/114	0.0008 - 62	0.27	140	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.005	J	mg/kg	WL1-5; Vicinity of Waste Lake 1; 15 ftbgs (02/18/02)	3/58	0.0008 - 4.1	0.005	10000	N	N/A	N/A		BSC
56-23-5	Carbon tetrachloride	0.011		0.041		mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	3/117	0.0008 - 31	0.041	22	C	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	560		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	69/146	0.0008 - 31	560	2000	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.004	J	0.89	J	mg/kg	WB-12; Old Brine Sludge LF; 8-10 ftbgs (09/23/93)	9/117	0.0008 - 31	0.89	1000	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.034	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	5/54	0.0008 - 10	0.034	--	N	N/A	N/A	X	AD
100-41-4	Ethylbenzene	0.03		0.03		mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.03	10000	N	N/A	N/A		BSC
108-87-2	Methyl cyclohexane	0.016	K	0.054	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	4/54	0.0008 - 12	0.054	--	N	N/A	N/A	X	AD
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-1; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	73/146	0.001 - 62	0.095	380	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.002	B	1.9		mg/kg	WB-12; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	41/146	0.0008 - 31	1.9	5.3	C	N/A	N/A		BSC
108-88-3	Toluene	0.002	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	4/117	0.0008 - 31	0.007	8200	N	N/A	N/A		BSC
156-60-5	trans-1,2-Dichloroethene	0.013	JP	0.013	JP	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/102	0.0008 - 31	0.013	2000	N	N/A	N/A		BSC
79-01-6	Trichloroethene	0.012	J	0.012	J	mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.012	7.2	C	N/A	N/A		BSC
75-69-4	Trichlorofluoromethane (CFC-11)	0.0111		0.0111		mg/kg	WB-04; Waste Lake 2; 10-12 ftbgs (10/18/93)	1/113	0.0008 - 31	0.0111	31000	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	2900		mg/kg	WB-11; Waste Lake 3; 12-14 ftbgs (09/22/93)	12/115	0.0008 - 28	2900	4	C	N/A	N/A	X	ASC
1330-20-7	Xylene (total)	0.002	J	0.008	J	mg/kg	WB-19; Waste Lake 2; 8-10 ftbgs (08/20/98)	5/87	0.0008 - 21	0.008	20000	N	N/A	N/A		BSC
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	0.06	J	0.07	J	mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	2/93	0.36 - 370	0.07	10000	N	N/A	N/A		BSC
120-83-2	2,4-Dichlorophenol	0.05	J	0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	6/141	0.35 - 370	0.45	310	N	N/A	N/A		BSC
95-57-8	2-Chlorophenol	0.36	J	1.1		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/138	0.35 - 370	1.1	510	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.062	J	2.3	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	16/213	0.33 - 370	2.3	410	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.2	J	2	J	mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/102	0.35 - 370	2	410	N	N/A	N/A		BSC
106-44-5	4-Methylphenol	0.074	J	0.25	J	mg/kg	WB-20; Waste Lake 2; 8-10 ftbgs (08/24/98)	13/121	0.35 - 370	0.25	510	N	N/A	N/A		BSC
83-32-9	Acenaphthene	0.059	J	0.22	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	6/221	0.33 - 370	0.22	6100	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/192	0.33 - 370	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/51	0.35 - 3.6	1.2	10000	N	N/A	N/A		BSC
120-12-7	Anthracene	0.054	J	0.21	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	12/223	0.33 - 370	0.21	31000	N	N/A	N/A		BSC
1912-24-9	Atrazine	0.17	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/04/05)	1/51	0.35 - 3.6	0.17	13	C	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/51	0.35 - 3.6	0.69	10000	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	35/223	0.33 - 370	0.83	3.9	C	N/A	N/A		BSC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/223	0.33 - 370	1	0.39	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.056	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	33/223	0.33 - 370	2	3.9	C	N/A	N/A		BSC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	20/223	0.33 - 370	0.3	410 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	33/223	0.33 - 370	1.7	39	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1300	J	mg/kg	WB-32; Waste Lake 2; 8-10 ftbgs (09/23/93)	61/139	0.35 - 120	1300	200	C	N/A	N/A	X	ASC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	7/142	0.35 - 370	0.92	20000	N	N/A	N/A		BSC

TABLE B.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Semi-volatile Organic Compounds (cont.'d)														
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	47/223	0.33 - 370	0.93	390 C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.056	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	6/223	0.33 - 370	0.15	0.39 C	N/A	N/A		BSC
84-66-2	Diethyl phthalate	0.08	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	11/113	0.35 - 370	0.53	82000 N	N/A	N/A		BSC
84-74-2	Di-n-butylphthalate	0.04	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/05/05)	10/113	0.35 - 370	0.17	10000 N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12		3.8		mg/kg	WB-22; Waste Lake 2; 2-4 ftbgs (08/19/98)	6/135	0.35 - 120	3.8	10000 (7) N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.038	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	56/223	0.33 - 370	1.5	4100 N	N/A	N/A		BSC
86-73-7	Fluorene	0.053	J	0.33	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	8/223	0.33 - 370	0.33	4100 N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.04	J	8.2	D	mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	11/154	0.35 - 370	8.2	1.8 C	N/A	N/A	X	ASC
87-68-3	Hexachlorobutadiene	0.1	J	0.41		mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	2/86	0.35 - 11	0.41	37 C	N/A	N/A		BSC
67-72-1	Hexachloroethane	0.2	J	0.63		mg/kg	PE-SCL-Sewer Compression Line; Process Line; 4 ftbgs (01/20/04)	2/94	0.35 - 11	0.63	200 C	N/A	N/A		BSC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/218	0.33 - 370	0.45	3.9 C	N/A	N/A		BSC
78-59-1	Isophorone	0.072	J	0.1	J	mg/kg	WB-23; Waste Lake 2; 4-6 ftbgs (08/20/98)	2/115	0.35 - 11	0.1	3000 C	N/A	N/A		BSC
91-20-3	Naphthalene	0.063	J	0.57		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	22/214	0.33 - 11	0.57	2000 N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.04	J	9.6		mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	11/95	0.35 - 11	9.6	51 N	N/A	N/A		BSC
86-30-6	N-Nitrosodiphenylamine	0.06	J	0.06	J	mg/kg	WB-24; Waste Lake 2; 4-6 ftbgs (08/24/98)	1/140	0.35 - 370	0.06	580 C	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	45/223	0.33 - 370	1.1	410 (6) N	N/A	N/A		BSC
108-95-2	Phenol	0.62	J	0.71		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/140	0.35 - 370	0.71	31000 N	N/A	N/A		BSC
129-00-0	Pyrene	0.045	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	59/223	0.34 - 370	1.6	3100 N	N/A	N/A		BSC
	Metals														
7429-90-5	Aluminum	1080		22700		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	22700	-- N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	23		mg/kg	WB-13; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	67/136	0.18 - 310	23	41 N	N/A	N/A		BSC
7440-38-2	Arsenic	0.34		110		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	1.2 - 1.8	110	1.9 C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	7.1		7500	J	mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	137/143	20 - 42	7500	20000 N	N/A	N/A		BSC
7440-41-7	Beryllium	0.15		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	108/143	0.5 - 1	69.3	200 N	N/A	N/A		BSC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	92/143	0.013 - 1	6.4	100 N	N/A	N/A		BSC
7440-70-2	Calcium	112	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	30400	-- N	N/A	N/A		NUT
7440-47-3	Chromium Total	2.5		121		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	224/224	--	121	150000 N	N/A	N/A		BSC
7440-48-4	Cobalt	1.6		182		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	182	-- N	N/A	N/A	X	AD
7440-50-8	Copper	1.8		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	118/143	11 - 21	6300	4100 N	N/A	N/A	X	ASC
7439-89-6	Iron	730		126000		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	126000	72000 N	N/A	N/A	X	ASC
7439-92-1	Lead	1.5		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	224/224	--	3410	800 (9) N	N/A	N/A	X	ASC
7439-95-4	Magnesium	136		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	12100	-- N	N/A	N/A		NUT
7439-96-5	Manganese	21.3		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	224/224	--	4200	2000 N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	307/322	0.018 - 48	9131	3.31 (10) N	N/A	N/A	X	ASC
7440-02-0	Nickel	3.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	3.5 - 4	674	2000 N	N/A	N/A		BSC
7440-09-7	Potassium	108		5600		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	5600	-- N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.3	L	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	78/224	0.18 - 4.8	3.3	510 N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	1.7		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	23/143	0.043 - 60	1.7	510 N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		18000		mg/kg	WB-03; Waste Lake 2; 6-8 ftbgs (10/18/93)	136/143	110 - 500	18000	-- N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		1		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98) WB-26; Waste Lake 2; 6-8 ftbgs (08/20/98)	24/143	0.19 - 180	1	7.2 N	N/A	N/A		BSC
7440-62-2	Vanadium	5.5		79.6	J	mg/kg	WB-15; Waste Lake 2; 8-105 ftbgs (08/25/98)	84/84	--	79.6	100 N	N/A	N/A		BSC
7440-66-6	Zinc	6.3		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	28800	31000 N	N/A	N/A		BSC

TABLE B.2.3

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - CONSTRUCTION/UTILITY WORKER EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	1.4 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: KOH-DILUTION, LOADING-SCALE, SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, SCPX-04-14, SCPX-04-18, SB-03, WB-14A, A-67D, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, A-69, A-70, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, SB-02, WB-12, WB-13, WB-13T, PE-RTR-DIRT-FROM-BRINE-44, PE-GTB-GTW-EXCAVATION, PE-SCL-Sewer Compression Line, PE-BWC-1+00, PE-BWC-2+00, PE-BWC-3+00, PE-BWC-4+00, PE-BWC-5+00, PE-BWC-6+00, PE-BWC-7+00, PE-BWC-8+00, PE-BWC-9+50, PE-BWC-10+00, PE-BWC-11+45, PE-BWC-12+00, PE-BWC-13+00, PE-BWC-13+85, PE-BWC-14+60, PE-BWC-15+70, PE-BWC-18+00, PE-BWC-18+50, PE-BWC-19+00, PE-BWC-20+00, PE-BWC-21+00, PE-BWC-22+00, PE-BWC-23+00, PE-BWC-24+00, PE-BWC-25+00, PE-BWC-26+00, PE-BWC-27+40, PE-BWC-28+00, PE-BWC-29+00, PE-BWC-30+00, PE-BWC-31+00, PE-BWC-32+00, PE-GTB-BUILDING 1, Pipe Support Foundation, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, A-62S, SB-10, SB-11, SB-12, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SB-6, SB-8, SS-06, SB-01, SB-07, WL1-5, WL2-F1, WL2-F2, WL2-F3, WL2-F4, SS-07, SS-08, SS-09, SS-10, SB-04, SB-04A, SB-04B, SB-05, WB-03, WB-04, WB-05, WB-06, WB-07, WB-08, WB-09, WB-14-1998, WB-15, WB-16, WB-17, WB-18, WB-19, WB-20, WB-21, WB-22, WB-23, WB-24, WB-25, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, SB-08, SB-09, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, WB-11, PE-WWTP, A, A/B, B, C, D, E.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Industrial Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.
P = Greater than 25% difference between two GC columns.

TABLE B.2.4

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.002		1100	L	mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	51/142	0.0008 - 2.8	1100	--	N	N/A	N/A	X	VOC
95-50-1	1,2-Dichlorobenzene	0.0025		1100		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	56/142	0.0009 - 2.8	1100	--	N	N/A	N/A	X	VOC
107-06-2	1,2-Dichloroethane	0.0098	J	0.47		mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	4/117	0.0008 - 31	0.47	--	C	N/A	N/A		LDF
540-59-0	1,2-Dichloroethene (total)	0.013	J	0.013	J	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/63	0.005 - 31	0.013	--	N	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	0.0036		77		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	32/141	0.0008 - 2.8	77	--	N	N/A	N/A	X	VOC
106-46-7	1,4-Dichlorobenzene	0.0011	B	2000		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	62/142	0.009 - 2.8	2000	--	C	N/A	N/A	X	VOC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.031	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	19/87	0.0008 - 2.7	0.031	--	N	N/A	N/A	X	VOC
67-64-1	Acetone	0.002	JB	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	65/87	0.006 - 2.7	0.17	--	N	N/A	N/A	X	VOC
71-43-2	Benzene	0.0011		450		mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	34/146	0.0008 - 31	450	--	C	N/A	N/A	X	VOC
75-25-2	Bromoform	0.001		0.0034		mg/kg	SC-1; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/117	0.0008 - 31	0.0034	--	C	N/A	N/A		LDF
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/114	0.0008 - 62	0.27	--	N	N/A	N/A		LDF
75-15-0	Carbon disulfide	0.002	J	0.005	J	mg/kg	WL1-5; Vicinity of Waste Lake 1; 15 ftbgs (02/18/02)	3/58	0.0008 - 4.1	0.005	--	N	N/A	N/A	X	VOC
56-23-5	Carbon tetrachloride	0.011		0.041		mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	3/117	0.0008 - 31	0.041	--	C	N/A	N/A		LDF
108-90-7	Chlorobenzene	0.001	J	560		mg/kg	SC-6; SC Pipeline Area; 12-16 ftbgs (02/19/02)	69/146	0.0008 - 31	560	--	N	N/A	N/A	X	VOC
67-66-3	Chloroform (Trichloromethane)	0.004	J	0.89	J	mg/kg	WB-12; Old Brine Sludge LF; 8-10 ftbgs (09/23/93)	9/117	0.0008 - 31	0.89	--	N	N/A	N/A	X	VOC
110-82-7	Cyclohexane	0.0052		0.034	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	5/54	0.0008 - 10	0.034	--	N	N/A	N/A	X	VOC
100-41-4	Ethylbenzene	0.03		0.03		mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.03	--	N	N/A	N/A		LDF
108-87-2	Methyl cyclohexane	0.016	K	0.054	K	mg/kg	SC-4; SC Pipeline Area; 11-12 ftbgs (02/19/02)	4/54	0.0008 - 12	0.054	--	N	N/A	N/A	X	VOC
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-1; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	73/146	0.001 - 62	0.095	--	C	N/A	N/A	X	VOC
127-18-4	Tetrachloroethene	0.002	B	1.9		mg/kg	WB-12; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	41/146	0.0008 - 31	1.9	--	C	N/A	N/A	X	VOC
108-88-3	Toluene	0.002	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	4/117	0.0008 - 31	0.007	--	N	N/A	N/A		LDF
156-60-5	trans-1,2-Dichloroethene	0.013	JP	0.013	JP	mg/kg	SB-03; Chemfix Test Unit Area; 8-10 ftbgs (10/21/93)	1/102	0.0008 - 31	0.013	--	N	N/A	N/A		LDF
79-01-6	Trichloroethene	0.012	J	0.012	J	mg/kg	WB-14A; Chemfix Test Unit Area; 2-4 ftbgs (09/22/93)	1/117	0.0008 - 31	0.012	--	C	N/A	N/A		LDF
75-69-4	Trichlorofluoromethane (CFC-11)	0.0111		0.0111		mg/kg	WB-04; Waste Lake 2; 10-12 ftbgs (10/18/93)	1/113	0.0008 - 31	0.0111	--	N	N/A	N/A		LDF
75-01-4	Vinyl chloride	0.0045	J	2900		mg/kg	WB-11; Waste Lake 3; 12-14 ftbgs (09/22/93)	12/115	0.0008 - 28	2900	--	C	N/A	N/A	X	VOC
1330-20-7	Xylene (total)	0.002	J	0.008	J	mg/kg	WB-19; Waste Lake 2; 8-10 ftbgs (08/20/98)	5/87	0.0008 - 21	0.008	--	N	N/A	N/A	X	VOC
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	0.06	J	0.07	J	mg/kg	SC-5; SC Pipeline Area; 4-8 ftbgs (02/19/02)	2/93	0.36 - 370	0.07	--	N	N/A	N/A		NVOC
120-83-2	2,4-Dichlorophenol	0.05	J	0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	6/141	0.35 - 370	0.45	--	N	N/A	N/A		NVOC
95-57-8	2-Chlorophenol	0.36	J	1.1		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/138	0.35 - 370	1.1	--	N	N/A	N/A		LDF
91-57-6	2-Methylnaphthalene	0.062	J	2.3	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	16/213	0.33 - 370	2.3	--	N	N/A	N/A	X	VOC
106-47-8	4-Chloroaniline	0.2	J	2	J	mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	4/102	0.35 - 370	2	--	N	N/A	N/A		NVOC
106-44-5	4-Methylphenol	0.074	J	0.25	J	mg/kg	WB-20; Waste Lake 2; 8-10 ftbgs (08/24/98)	13/121	0.35 - 370	0.25	--	N	N/A	N/A		NVOC
83-32-9	Acenaphthene	0.059	J	0.22	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	6/221	0.33 - 370	0.22	--	N	N/A	N/A		LDF
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/192	0.33 - 370	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/51	0.35 - 3.6	1.2	--	N	N/A	N/A	X	VOC
120-12-7	Anthracene	0.054	J	0.21	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	12/223	0.33 - 370	0.21	--	N	N/A	N/A	X	VOC
1912-24-9	Atrazine	0.17	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/04/05)	1/51	0.35 - 3.6	0.17	--	C	N/A	N/A		NVOC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/51	0.35 - 3.6	0.69	--	N	N/A	N/A	X	VOC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	35/223	0.33 - 370	0.83	--	C	N/A	N/A		NVOC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/223	0.33 - 370	1	--	C	N/A	N/A		NVOC
205-99-2	Benzo(b)fluoranthene	0.056	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	33/223	0.33 - 370	2	--	C	N/A	N/A	X	VOC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	20/223	0.33 - 370	0.3	--	N	N/A	N/A		NVOC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	33/223	0.33 - 370	1.7	--	C	N/A	N/A		NVOC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1300	J	mg/kg	WB-32; Waste Lake 2; 8-10 ftbgs (09/23/93)	61/139	0.35 - 120	1300	--	C	N/A	N/A		NVOC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	7/142	0.35 - 370	0.92	--	N	N/A	N/A		NVOC

TABLE B.2.4

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Semi-volatile Organic Compounds (cont.'d)															
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	47/223	0.33 - 370	0.93	--	C	N/A	N/A	X	VOC
53-70-3	Dibenz(a,h)anthracene	0.056	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	6/223	0.33 - 370	0.15	--	C	N/A	N/A		NVOC
84-66-2	Diethyl phthalate	0.08	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	11/113	0.35 - 370	0.53	--	N	N/A	N/A		NVOC
84-74-2	Di-n-butylphthalate	0.04	J	0.17	J	mg/kg	KOH-DILUTION; Process Area; 3 ftbgs (01/05/05)	10/113	0.35 - 370	0.17	--	N	N/A	N/A		NVOC
117-84-0	Di-n-octyl phthalate	0.12		3.8		mg/kg	WB-22; Waste Lake 2; 2-4 ftbgs (08/19/98)	6/135	0.35 - 120	3.8	--	N	N/A	N/A		LDF
206-44-0	Fluoranthene	0.038	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	56/223	0.33 - 370	1.5	--	N	N/A	N/A	X	VOC
86-73-7	Fluorene	0.053	J	0.33	J	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	8/223	0.33 - 370	0.33	--	N	N/A	N/A		LDF
118-74-1	Hexachlorobenzene	0.04	J	8.2	D	mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	11/154	0.35 - 370	8.2	--	C	N/A	N/A	X	VOC
87-68-3	Hexachlorobutadiene	0.1	J	0.41		mg/kg	PE-SCL-Sewer Compression Line; Process Area; 4 ftbgs (01/20/04)	2/86	0.35 - 11	0.41	--	C	N/A	N/A		LDF
67-72-1	Hexachloroethane	0.2	J	0.63		mg/kg	PE-SCL-Sewer Compression Line; Process Line; 4 ftbgs (01/20/04)	2/94	0.35 - 11	0.63	--	C	N/A	N/A		LDF
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/218	0.33 - 370	0.45	--	C	N/A	N/A		NVOC
78-59-1	Isophorone	0.072	J	0.1	J	mg/kg	WB-23; Waste Lake 2; 4-6 ftbgs (08/20/98)	2/115	0.35 - 11	0.1	--	C	N/A	N/A		NVOC
91-20-3	Naphthalene	0.063	J	0.57		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	22/214	0.33 - 11	0.57	--	N	N/A	N/A	X	VOC
98-95-3	Nitrobenzene	0.04	J	9.6		mg/kg	SC-8; SC Pipeline Area; 4-8 ftbgs (02/19/02)	11/95	0.35 - 11	9.6	--	N	N/A	N/A	X	VOC
86-30-6	N-Nitrosodiphenylamine	0.06	J	0.06	J	mg/kg	WB-24; Waste Lake 2; 4-6 ftbgs (08/24/98)	1/140	0.35 - 370	0.06	--	C	N/A	N/A		NVOC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	45/223	0.33 - 370	1.1	--	N	N/A	N/A	X	VOC
108-95-2	Phenol	0.62	J	0.71		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	2/140	0.35 - 370	0.71	--	N	N/A	N/A		NVOC
129-00-0	Pyrene	0.045	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	59/223	0.34 - 370	1.6	--	N	N/A	N/A	X	VOC
	Metals															
7429-90-5	Aluminum	1080		22700		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	22700	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	0.19	L	23		mg/kg	WB-13; Old Brine Sludge LF; 4-6 ftbgs (09/23/93)	67/136	0.18 - 310	23	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	0.34		110		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	1.2 - 1.8	110	--	C	N/A	N/A		NVOC
7440-39-3	Barium	7.1		7500	J	mg/kg	WB-30; Waste Lake 2; 6-8 ftbgs (09/23/93)	137/143	20 - 42	7500	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.15		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	108/143	0.5 - 1	69.3	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	92/143	0.013 - 1	6.4	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	112	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	30400	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	2.5		121		mg/kg	WB-16; Waste Lake 2; 6-8 ftbgs (08/19/98)	224/224	--	121	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.6		182		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	182	--	N	N/A	N/A		NVOC
7440-50-8	Copper	1.8		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	118/143	11 - 21	6300	--	N	N/A	N/A		NVOC
7439-89-6	Iron	730		126000		mg/kg	PE-SBG-GRID-3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	126000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.5		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	224/224	--	3410	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	136		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	84/84	--	12100	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	21.3		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	224/224	--	4200	--	N	N/A	N/A		NVOC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	307/322	0.018 - 48	9131	--	N	N/A	N/A	X	VOC
7440-02-0	Nickel	3.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	220/224	3.5 - 4	674	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	108		5600		mg/kg	WB-28; Waste Lake 2; 4-6 ftbgs (08/17/98)	84/84	--	5600	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	0.23	BN	3.3	L	mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	78/224	0.18 - 4.8	3.3	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.066	L	1.7		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98)	23/143	0.043 - 60	1.7	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	17.4		18000		mg/kg	WB-03; Waste Lake 2; 6-8 ftbgs (10/18/93)	136/143	110 - 500	18000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	0.2		1		mg/kg	WB-15; Waste Lake 2; 8-10 ftbgs (08/25/98) WB-26; Waste Lake 2; 6-8 ftbgs (08/20/98)	24/143	0.19 - 180	1	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	5.5		79.6	J	mg/kg	WB-15; Waste Lake 2; 8-105 ftbgs (08/25/98)	84/84	--	79.6	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	6.3		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	143/143	--	28800	--	N	N/A	N/A		NVOC

TABLE B.2.4

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE AND SUBSURFACE SOIL (0-15 FT BGS) - MIGRATION TO INDOOR AIR
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil (0-15 ft bgs)
Exposure Medium: Indoor Air

CAS Number	*Chemical*	*Minimum Concentration (1,2)*	*Minimum Qualifier*	*Maximum Concentration (1,2)*	*Maximum Qualifier*	*Units*	*Location of Maximum Concentration*	*Detection Frequency (2)*	*Range of Detection Limits (2)*	*Maximum Concentration Used for Screening (3)*	*Screening Toxicity Value*	*Potential ARAR/TBC Value*	*Potential ARAR/TBC Source*	*COPC Flag*	*Rationale for Contaminant Deletion or Selection (4)*
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	-- C	N/A	N/A		NVOC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: KOH-DILUTION, LOADING-SCALE, SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, SCPX-04-14, SCPX-04-18, SB-03, WB-14A, A-67D, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, A-69, A-70, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, SB-02, WB-12, WB-13, WB-13T, PE-RTR-DIRT-FROM-BRINE-44, PE-GTB-GTW-EXCAVATION, PE-SCL-Sewer Compression Line, PE-BWC-1+00, PE-BWC-2+00, PE-BWC-3+00, PE-BWC-4+00, PE-BWC-5+00, PE-BWC-6+00, PE-BWC-7+00, PE-BWC-8+00, PE-BWC-9+50, PE-BWC-10+00, PE-BWC-11+45, PE-BWC-12+00, PE-BWC-13+00, PE-BWC-13+85, PE-BWC-14+60, PE-BWC-15+70, PE-BWC-18+00, PE-BWC-18+50, PE-BWC-19+00, PE-BWC-20+00, PE-BWC-21+00, PE-BWC-22+00, PE-BWC-23+00, PE-BWC-24+00, PE-BWC-25+00, PE-BWC-26+00, PE-BWC-27+40, PE-BWC-28+00, PE-BWC-29+00, PE-BWC-30+00, PE-BWC-31+00, PE-BWC-32+00, PE-GTB-BUILDING 1, Pipe Support Foundation, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, A-62S, SB-10, SB-11, SB-12, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SB-6, SB-8, SS-06, SB-01, SB-07, WL1-5, WL2-F1, WL2-F2, WL2-F3, WL2-F4, SS-07, SS-08, SS-09, SS-10, SB-04, SB-04A, SB-04B, SB-05, WB-03, WB-04, WB-05, WB-06, WB-07, WB-08, WB-09, WB-14-1998, WB-15, WB-16, WB-17, WB-18, WB-19, WB-20, WB-21, WB-22, WB-23, WB-24, WB-25, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, SB-08, SB-09, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, WB-11, PE-WWTP, A, A/B, B, C, D, E.

(3) Screening concentration is the maximum detected concentration.

(4) Rationale Codes
Selection Reason : Analyte considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway complete (VOC).
Deletion Reason : Not considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway incomplete (NVOC).
Low Detection Frequency, less than 5% (LDF)

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.
P = Greater than 25% difference between two GC columns.

TABLE B.2.5

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN OVERBURDEN/ WATER TABLE WELL GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
71-55-6	1,1,1-Trichloroethane	1		4.9	K	µg/L	A-46; Vicinity of Process Area (03/16/05)	29/230	1 - 1200	4.9	310	N	N/A	N/A		BSC
79-34-5	1,1,2,2-Tetrachloroethane	2		2		µg/L	A-48; Process Area (06/24/05)	1/230	1 - 1200	2	3	C	N/A	N/A		BSC
75-34-3	1,1-Dichloroethane	1	K	2	K	µg/L	A-59S; Vicinity of Waste Lake 1 (10/13/05)	7/230	1 - 1200	2	220	N	N/A	N/A		BSC
							A-59S; Vicinity of Waste Lake 1 (12/08/05)									
							A-59S; Vicinity of Waste Lake 1 (02/24/06)									
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
75-35-4	1,1-Dichloroethene	1		41		µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	42/230	1 - 1200	41	19	N	N/A	N/A	X	ASC
120-82-1	1,2,4-Trichlorobenzene	1		4200		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	64/230	1 - 1200	4200	340	N	N/A	N/A	X	ASC
95-50-1	1,2-Dichlorobenzene	1		25000		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	109/230	1	25000	260	N	N/A	N/A	X	ASC
107-06-2	1,2-Dichloroethane	5.2		14		µg/L	A-39S; Vicinity of Waste Lake 1 (10/12/05)	2/230	1 - 1200	14	5 *	C	N/A	N/A		LDF
541-73-1	1,3-Dichlorobenzene	1		2500		µg/L	A-61S; Vicinity of Waste Lake 1 (12/08/05)	89/230	1 - 2000	2500	83	N	N/A	N/A	X	ASC
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
106-46-7	1,4-Dichlorobenzene	1	B	45000		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	119/230	1	45000	820	C	N/A	N/A	X	ASC
							A-61S; Vicinity of Waste Lake 1 (02/24/06)									
78-93-3	2-Butanone (Methyl Ethyl Ketone)	2	K	25		µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	4/230	5 - 6200	25	44000	N	N/A	N/A		BSC
591-78-6	2-Hexanone	1	J	1	J	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/230	5 - 6200	1	--	N	N/A	N/A		LDF
108-10-1	4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	7	J	7	J	µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	1/230	5 - 6200	7	1400	N	N/A	N/A		BSC
67-64-1	Acetone	3	J	1100	J	µg/L	A-69; Vicinity of Waste Lake 1 (10/14/05)	62/230	5 - 6200	1100	22000	N	N/A	N/A		BSC
							A-75; Vicinity of Waste Lake 1 (10/14/05)									
71-43-2	Benzene	1		98000		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	94/230	0.7	98000	5 *	C	N/A	N/A	X	ASC
75-27-4	Bromodichloromethane	3.1		3.1		µg/L	A-49; Vicinity of Process Area (05/19/06)	1/230	1 - 1200	3.1	2.1	C	N/A	N/A		LDF
75-15-0	Carbon disulfide	1	K	15		µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	10/230	1 - 1200	15	56	N	N/A	N/A		BSC
56-23-5	Carbon tetrachloride	1		600		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	54/230	1 - 1200	600	5 *	C	N/A	N/A	X	ASC
108-90-7	Chlorobenzene	1		230000		µg/L	A-37S; Vicinity of Waste Lake 1 (10/13/05)	119/230	1	230000	39	N	N/A	N/A	X	ASC
75-00-3	Chloroethane	1		19	K	µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	4/230	1 - 1200	19	2800	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	1		150	J	µg/L	A-27S; Vicinity of Process Area (05/24/06)	97/230	1 - 1200	150	80 *	C	N/A	N/A	X	ASC
74-87-3	Chloromethane (Methyl Chloride)	3	J	6	J	µg/L	A-37S; Vicinity of Waste Lake 1 (02/23/06)	1/230	1 - 1200	6	6.7	C	N/A	N/A		BSC
156-59-2	cis-1,2-Dichloroethene	1	J	24		µg/L	A-48; Process Area (06/24/05)	37/230	1 - 1200	24	21	N	N/A	N/A	X	ASC
110-82-7	Cyclohexane	1		170			A-37S; Vicinity of Waste Lake 1 (12/08/05)	25/230	1 - 1200	170	--	N	N/A	N/A	X	AD
100-41-4	Ethylbenzene	1		4.8		µg/L	A-50; Vicinity of Process Area (03/16/05)	7/230	1 - 1200	4.8	700 *	N	N/A	N/A		LDF
108-87-2	Methylcyclohexane	2	K	39	K		A-61S; Vicinity of Waste Lake 1 (02/24/06)	18/230	1 - 1200	39	71	N	N/A	N/A		BSC
1634-04-4	Methyl Tert Butyl Ether	1		10		µg/L	A-67S; Vicinity of Process Area/ Vicinity of Chlorine Pipeline (10/12/05)	21/230	1 - 1200	10	12000	C	N/A	N/A		BSC
75-09-2	Methylene chloride	1		7900		µg/L	A-37S; Vicinity of Waste Lake 1 (08/31/06)	22/230	1 - 1200	7900	58	C	N/A	N/A	X	ASC
127-18-4	Tetrachloroethene	1		370		µg/L	A-48; Process Area (06/24/05)	128/230	1 - 2000	370	5 *	C	N/A	N/A	X	ASC
108-88-3	Toluene	1	K	200		µg/L	R-110; Vicinity of Waste Lake 1 (12/08/05)	47/230	1 - 1200	200	150	N	N/A	N/A	X	ASC
156-60-5	trans-1,2-Dichloroethene	1	J	9		µg/L	A-37S; Vicinity of Waste Lake 1 (12/08/05)	8/230	1 - 1200	9	18	N	N/A	N/A		BSC
79-01-6	Trichloroethene	1	B	16		µg/L	A-37S; Vicinity of Waste Lake 1 (12/08/05)	69/230	1 - 1200	16	5 *	C	N/A	N/A	X	ASC
75-01-4	Vinyl chloride	1		4000		µg/L	A-37S; Vicinity of Waste Lake 1 (03/17/05)	64/230	1 - 2000	4000	2 *	C	N/A	N/A	X	ASC
1330-20-7	Xylene (total)	2	K	19		µg/L	A-50; Vicinity of Process Area (03/16/05)	12/230	1 - 1200	19	2200 (6)	N	N/A	N/A		BSC

TABLE B.2.5

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN OVERBURDEN/WATER TABLE WELL GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Semi-volatile Organic Compounds															
95-95-4	2,4,5-Trichlorophenol	1	J	2	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	2/75	25 - 250	2	--	N	N/A	N/A		NVOC
88-06-2	2,4,6-Trichlorophenol	1	J	2	K	µg/L	A-37S; Vicinity of Waste Lake 1 (10/13/05)	2/75	10 - 100	2	--	C	N/A	N/A		NVOC
120-83-2	2,4-Dichlorophenol	1	J	39	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	14/75	10 - 100	39	--	N	N/A	N/A		NVOC
95-57-8	2-Chlorophenol	4	J	340	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	13/75	10 - 100	340	110	N	N/A	N/A	X	ASC
91-57-6	2-Methylnaphthalene	2	J	2	J	µg/L	A-27D; Vicinity of Process Area (10/12/05)	1/76	10 - 100	2	330	N	N/A	N/A		BSC
95-48-7	2-Methylphenol	63		95		µg/L	A-75; Vicinity of Waste Lake 1 (08/30/06)	2/75	10 - 100	95	--	N	N/A	N/A		NVOC
106-44-5	4-Methylphenol	5	J	130	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	4/75	10 - 100	130	--	N	N/A	N/A		NVOC
98-86-2	Acetophenone	10		52		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	4/76	10 - 100	52	80000	N	N/A	N/A		BSC
1912-24-9	Atrazine	1	L	5	J	µg/L	A-23; Old/ New Brine Sludge LF (08/24/06)	8/76	10 - 100	5	--	C	N/A	N/A		NTX
100-52-7	Benzaldehyde	2	K	2	K	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/76	10 - 100	2	36000	N	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	1	J	3	J	µg/L	A-27S; Vicinity of Process Area (10/12/05)	13/76	10 - 100	3	--	C	N/A	N/A		NVOC
105-60-2	Caprolactam	1	J	1	J	µg/L	A-76; Waste Lake 1/ Vicinity of Waste Lake 1 (10/12/05) R-110; Vicinity of Waste Lake 1 (10/13/05)	2/76	10 - 100	1	--	N	N/A	N/A		LDF
84-66-2	Diethyl phthalate	8	J	34	J	µg/L	A-62S; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/13/05)	3/76	10 - 100	34	--	N	N/A	N/A		NVOC
84-74-2	Di-n-butylphthalate	1	B	3	J	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	12/76	10 - 100	3	--	N	N/A	N/A		NVOC
87-68-3	Hexachlorobutadiene	1	J	4	J	µg/L	A-44; Vicinity of Process Area (08/28/06)	2/76	10 - 100	4	0.33	C	N/A	N/A		LDF
67-72-1	Hexachloroethane	2	J	28		µg/L	A-27D; Vicinity of Process Area (08/28/06)	5/76	10 - 100	28	3.8	C	N/A	N/A	X	ASC
78-59-1	Isophorone	1	J	1	J	µg/L	A-62D; Waste Lake 3/ Vicinity of Chlorine Pipeline (10/11/05)	1/76	10 - 100	1	--	C	N/A	N/A		NVOC
91-20-3	Naphthalene	1	J	41		µg/L	A-75; Vicinity of Waste Lake 1 (08/30/06)	16/76	10 - 100	41	15	N	N/A	N/A	X	ASC
98-95-3	Nitrobenzene	2	J	2	J	µg/L	A-69; Vicinity of Waste Lake 1 (08/31/06)	1/76	10 - 100	2	200	N	N/A	N/A		BSC
108-95-2	Phenol	4	J	620	K	µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	13/75	10 - 100	620	--	N	N/A	N/A		NVOC
	Metals															
7429-90-5	Aluminum	9.5	B	11500		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	133/139	9.9 - 12.4	11500	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	2.3		8	J	µg/L	A-7A; New Brine Sludge LF (08/24/06)	14/139	2.1 - 5.8	8	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	1.8	B	1560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	59/139	1.7 - 5.6	1560	--	C	N/A	N/A		NVOC
7440-39-3	Barium	4.4		1400		µg/L	A-32OB; Waste Lake 2 (06/23/05)	138/139	6.4	1400	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.1		2	B	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	47/139	0.1 - 17.1	2	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.16	B	11.8		µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	76/139	0.12 - 0.65	11.8	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	606	B	461000		µg/L	A-35D; Process Area (06/24/05)	161/161	--	461000	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	0.55	J	183		µg/L	A-27D; Vicinity of Process Area (08/28/06)	93/139	0.34 - 2.4	183	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.2	J	361		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	87/139	1.1 - 3	361	--	N	N/A	N/A		NVOC
7440-50-8	Copper	1		22.6		µg/L	R-110; Vicinity of Waste Lake 1 (02/23/06)	84/139	0.96 - 1.6	22.6	--	N	N/A	N/A		NVOC
7439-89-6	Iron	11.1		293000		µg/L	A-55; Waste Lake 1 (06/24/05)	127/139	4.3 - 17.8	293000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.4		32.5		µg/L	A-55; Waste Lake 1 (06/24/05)	31/139	1.1 - 15.2	32.5	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	12.1	B	259000		µg/L	A-32OB; Waste Lake 2 (06/23/05)	139/139	--	259000	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	2.9	J	57100		µg/L	A-29S; Waste Lake 2 (06/23/05) A-59S; Vicinity of Waste Lake 1 (06/17/05)	171/171	--	57100	--	N	N/A	N/A		NVOC
7439-97-6	Mercury	0.1		309	K	µg/L	A-34S; Process Area (06/24/05)	143/211	0.1	309	0.068	N	N/A	N/A	X	ASC
7440-02-0	Nickel	1.4	J	66.6		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	94/139	1 - 6.6	66.6	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	1370	B	2430000		µg/L	A-40D; Process Area (06/24/05)	173/173	--	2430000	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	2		17.4		µg/L	A-57; Waste Lake 1 (06/24/05)	53/139	1.7 - 5.4	17.4	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.47	J	8.8	J	µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	30/139	0.38 - 3.6	8.8	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	11100		9150000		µg/L	A-47; Vicinity of Waste Lake 1 (02/23/06)	172/172	--	9150000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	1.8		14.2		µg/L	A-75; Vicinity of Waste Lake 1 (11/16/06)	32/139	1.7 - 5	14.2	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	1.8		4560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	43/139	1.3 - 5.4	4560	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	3.2	B	1060		µg/L	A-76; Waste Lake 1/ Vicinity of Waste Lake 1 (09/06/06)	138/139	2.1	1060	--	N	N/A	N/A		NVOC

TABLE B.2.5

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN OVERBURDEN/WATER TABLE WELL GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Overburden/ Water Table Well Groundwater
Exposure Medium: Indoor Air

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Dissolved Metals															
7429-90-5	Aluminum	8	B	8540		µg/L	A-47; Vicinity of Waste Lake 1 (03/17/05)	104/161	6.5 - 12.4	8540	--	N	N/A	N/A		NVOC
7440-36-0	Antimony	2.2		8.9		µg/L	A-29S; Waste Lake 2 (06/23/05)	10/161	2.1 - 5.8	8.9	--	N	N/A	N/A		NVOC
7440-38-2	Arsenic	1.7		1560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	86/161	1.7 - 5.6	1560	--	C	N/A	N/A		NVOC
7440-39-3	Barium	3.8	B	1210		µg/L	A-32OB; Waste Lake 2 (06/23/05)	160/161	6.4	1210	--	N	N/A	N/A		NVOC
7440-41-7	Beryllium	0.1		1.8	B	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	49/161	0.1 - 17.1	1.8	--	N	N/A	N/A		NVOC
7440-43-9	Cadmium	0.13	B	182	J	µg/L	A-33D; Waste Lake 3/ Vicinity of Chlorine Pipeline (08/25/06)	68/161	0.12 - 0.65	182	--	N	N/A	N/A		NVOC
7440-70-2	Calcium	650	B	290000		µg/L	A-35D; Process Area (06/24/05)	161/161	--	290000	--	N	N/A	N/A		NVOC
7440-47-3	Chromium Total	0.39	B	186		µg/L	A-27D; Vicinity of Process Area (08/28/06)	93/161	0.34 - 2.4	186	--	N	N/A	N/A		NVOC
7440-48-4	Cobalt	1.3	J	366		µg/L	A-39D; Vicinity of Waste Lake 1 (03/16/05)	89/161	1.2 - 3	366	--	N	N/A	N/A		NVOC
7440-50-8	Copper	0.97	B	39	J	µg/L	A-68S; Vicinity of Process Area/ Vicinity of Chlorine Pipeline (08/29/06)	91/161	0.9 - 1.6	39	--	N	N/A	N/A		NVOC
7439-89-6	Iron	4.2	B	262000		µg/L	A-75; Vicinity of Waste Lake 1 (10/14/05)	142/161	6.3 - 17.8	262000	--	N	N/A	N/A		NVOC
7439-92-1	Lead	1.2	J	21.3		µg/L	A-29S; Waste Lake 2 (06/23/05)	25/162	1.1 - 15.2	21.3	--	N	N/A	N/A		NVOC
7439-95-4	Magnesium	11.4	B	237000		µg/L	A-32OB; Waste Lake 2 (06/23/05)	161/161	--	237000	--	N	N/A	N/A		NVOC
7439-96-5	Manganese	0.93	J	59500		µg/L	A-29S; Waste Lake 2 (06/23/05)	184/185	1.2	59500	--	N	N/A	N/A		NVOC
7487-94-7	Mercury	0.1		272		µg/L	A-34S; Process Area (06/24/05)	132/225	0.1	272	0.068	N	N/A	N/A	X	ASC
7440-02-0	Nickel	1.4		64.5		µg/L	A-39D; Vicinity of Waste Lake 1 (06/16/05)	113/161	1 - 6.6	64.5	--	N	N/A	N/A		NVOC
7440-09-7	Potassium	1490		2550000		µg/L	A-40D; Process Area (06/24/05)	187/187	--	2550000	--	N	N/A	N/A		NVOC
7782-49-2	Selenium	2.1		22.4		µg/L	A-61S; Vicinity of Waste Lake 1 (03/17/05)	85/161	1.7 - 5.4	22.4	--	N	N/A	N/A		NVOC
7440-22-4	Silver	0.46	J	3.2	J	µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	39/161	0.38 - 3.6	3.2	--	N	N/A	N/A		NVOC
7440-23-5	Sodium	21300		8880000		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	185/185	--	8880000	--	N	N/A	N/A		NVOC
7440-28-0	Thallium	1.8		8.7		µg/L	A-39D; Vicinity of Waste Lake 1 (02/23/06)	40/161	1.7 - 31	8.7	--	N	N/A	N/A		NVOC
7440-62-2	Vanadium	1.3		4560		µg/L	R-110; Vicinity of Waste Lake 1 (08/30/06)	35/161	1 - 5.4	4560	--	N	N/A	N/A		NVOC
7440-66-6	Zinc	1.2		489		µg/L	A-47; Vicinity of Waste Lake 1 (08/30/06)	152/161	2.1	489	--	N	N/A	N/A		NVOC
	Gas															
--	Ethane	0.5	J	15		µg/L	A-62S; Waste Lake 3/ Vicinity of Chlorine Pipeline (02/22/06)	36/156	1	15	--	--	N/A	N/A		NTX
--	Ethene	0.8	J	3400		µg/L	A-37S; Vicinity of Waste Lake 1 (02/23/06)	24/156	1 - 260	3400	--	--	N/A	N/A		NTX
--	Methane	1		100000		µg/L	A-32D; Waste lake 2 (06/23/05)	127/156	1	100000	--	--	N/A	N/A		NTX

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: A-6A, A-7A, A-11A, A-12, A-13, A-14, A-15, A-16, A-23, A-24, A-25D, A-26D, A-26OB, A-26S, A-27D, A-27S, A-29D, A-29OB, A-29S, A-30OB, A-31OB, A-32D, A-32OB, A-32S, A-33D, A-33S, A-34D, A-34S, A-35D, A-35S, A-36D, A-36S, A-37S, A-39D, A-39OB, A-39S, A-40D, A-44, A-45, A-46, A-47, A-48, A-49, A-50, A-51, A-53, A-55, A-57, A-59S, A-60S, A-61S, A-62D, A-62S, A-66D, A-66S, A-67D, A-67S, A-68D, A-68S, A-69, A-70, A-71, A-75, A-76, B-5, R-110, R-112.

(3) Screening concentration is the maximum detected concentration.

(4) Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils, USEPA, Table 2c: Generic Screening Levels and Summary Sheet, Target Groundwater Concentration Corresponding to Target Indoor Air Concentration, November 20, 2002. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1. The parameters marked with an * are based on the Maximum Contaminant Levels (MCLs).

(5) Rationale Codes

Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)

Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Not considered to be a Volatile Organic Compound as defined by USEPA (2002); therefore pathway incomplete (NVOC).
No Toxicity Data (NTX)

(6) The lowest criterion from each isomer (p-xylene) substituted.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.

TABLE B.4.1

EXPOSURE ASSUMPTIONS FOR FUTURE CHILD SOCCER PLAYER EXPOSURE TO SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Soccer Player
Receptor Age: Child

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	200	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	54	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	BW	Body Weight	kg	39	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (4)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,938	USEPA, 1997 (5)
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	54	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	BW	Body Weight	kg	39	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.3	USEPA, 2002 (6)
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (7)
Inhalation	FT	Fraction of Time Exposed	unitless	2/24	Professional Judgement (8)
	EF	Exposure Frequency	days/year	54	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table B.4.7
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table B.4.9

Notes:

(1) Professional Judgement; assumed child soccer player plays twice a week from May to October (27 weeks).
(2) Professional Judgement; child soccer player is a 6 through 16 year old therefore the exposure duration is 11 years.
(3) Body weight is the average of 10-11 yrs old mean body weights, Table 7-3 of Exposure Factor Handbook, Volume 1.
(4) Professional Judgement; assumed 100% absorption for conservatism.
(5) Skin surface area is the average of 10-11 yr old mean total surface areas assuming 25% of total body area is exposed, Tables 6-6 and 6-7 of Exposure Factor Handbook, Volume 1.
(6) Soil to skin adherence factor is for Soccer Player #1 in moist conditions.
(7) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(8) Professional Judgement; assumed soccer players spends 2 hours per day (i.e., 2 out of 24 hours) playing soccer.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 1997: Exposure Factors Handbook. Volume. 1: General Factors. EPA/600/P-95/002Fa. August 1997.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.2

EXPOSURE ASSUMPTIONS FOR FUTURE CHILD GOLFER EXPOSURE TO SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Golfer
Receptor Age: Child

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	200	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	52	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	BW	Body Weight	kg	39	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (4)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	2,938	USEPA, 1997 (5)
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	52	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	BW	Body Weight	kg	39	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (6)
Inhalation	FT	Fraction of Time Exposed	unitless	5/24	Professional Judgement (7)
	EF	Exposure Frequency	days/year	52	Professional Judgement (1)
	ED	Exposure Duration	years	11	Professional Judgement (2)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	4,015	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table B.4.7
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table B.4.9

Notes:

(1) Professional Judgement; assumed child golfer golfs once a week from February to June (21 weeks), twice a week from July to August (9 weeks), and once a week from September to November (13 weeks).
(2) Professional Judgement; child golfer is a 6 through 16 year old therefore the exposure duration is 11 years.
(3) Body weight is the average of 10-11 yrs old mean body weights, Table 7-3 of Exposure Factor Handbook, Volume 1.
(4) Professional Judgement; assumed 100% absorption for conservatism.
(5) Skin surface area is the average of 10-11 yr old mean total surface areas assuming 25% of total body area is exposed, Tables 6-6 and 6-7 of Exposure Factor Handbook, Volume 1.
(6) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(7) Professional Judgement; assumed golfers spends 5 hours per day (i.e., 5 out of 24 hours) golfing.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 1997: Exposure Factors Handbook. Volume. 1: General Factors. EPA/600/P-95/002Fa. August 1997.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.3

EXPOSURE ASSUMPTIONS FOR FUTURE ADULT GOLFER EXPOSURE TO SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Golfer
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	100	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	130	Professional Judgement (1)
	ED	Exposure Duration	years	30	Professional Judgement (2)
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	10,950	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (3)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,300	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	130	Professional Judgement (1)
	ED	Exposure Duration	years	30	Professional Judgement (2)
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	10,950	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2002 (4)
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (5)
Inhalation	FT	Fraction of Time Exposed	unitless	5/24	Professional Judgement (6)
	EF	Exposure Frequency	days/year	130	Professional Judgement (1)
	ED	Exposure Duration	years	30	Professional Judgement (2)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	10,950	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table B.4.7
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table B.4.9

Notes:

(1) Professional Judgement; assumed golfer golfs 3 times per week for 10 months of the year.
(2) Professional Judgement; assumed golfer resides in same area for 30 years, and frequents the same course.
(3) Professional Judgement; assumed 100% absorption for conservatism.
(4) Professional Judgement; conservatively applied adherence factor for an outdoor worker.
(5) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(6) Professional Judgement; assumed golfers spends 5 hours per day (i.e., 5 out of 24 hours) golfing.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.4

EXPOSURE ASSUMPTIONS FOR FUTURE GOLF COURSE EMPLOYEE EXPOSURE TO SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Golf Course Employee
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	100	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	217	Professional Judgement (1)
	ED	Exposure Duration	years	25	USEPA, 2004
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (2)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,300	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	217	Professional Judgement (1)
	ED	Exposure Duration	years	25	USEPA, 2004
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (3)
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgement (4)
	EF	Exposure Frequency	days/year	217	Professional Judgement (1)
	ED	Exposure Duration	years	25	USEPA, 2004
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table B.4.7
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table B.4.9

Notes:
(1) Professional Judgement; assumed golf course employee works 5 days per week for 10 months of the year.
(2) Professional Judgement; assumed 100% absorption for conservatism.
(3) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(4) Professional Judgement; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

References:
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.5

EXPOSURE ASSUMPTIONS FOR FUTURE CONSTRUCTION/UTILITY WORKER EXPOSURE TO SURFACE AND SUBSURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Soil/ Ambient Air
Receptor Population: Construction/Utility Worker
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	330	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (1)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,300	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	BW	Body Weight	kg	70	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.3	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (2)
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgement (3)
	EF	Exposure Frequency	days/year	250	USEPA, 2002
	ED	Exposure Duration	years	1	USEPA, 2002
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	365	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	7.10E+06	Refer to Table B.4.8
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table B.4.10

Notes:
(1) Professional Judgement; assumed 100% absorption for conservatism.
(2) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(3) Professional Judgement; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

References:
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.6

EXPOSURE ASSUMPTIONS FOR FUTURE GOLF COURSE EMPLOYEE EXPOSURE TO INDOOR AIR
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Soil or Groundwater
Exposure Medium: Indoor Air
Receptor Population: Golf Course Employee
Receptor Age: Adult

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Inhalation	FT	Fraction of Time Exposed	unitless	8/24	Professional Judgement (1)
	EF	Exposure Frequency	days/year	217	Professional Judgement (2)
	ED	Exposure Duration	years	25	USEPA, 2004
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	9,125	USEPA, 1989

Notes:

(1) Professional Judgement; assumed 8 hour work day, thus 8 out of 24 hours spent at the Site.

(2) Professional Judgement; assumed golf course employee works 5 days per week for 10 months of the year.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE B.4.7

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

PEF: Soil-to-Air Particulate Emission Factor

$$PEF = Q/C_{wind} \times \frac{3600}{0.036 \times (1 - V) \times \left(U_m / U_t\right)^3 \times F(x)}$$

				Reference	*Units*	*Value*
Where:	PEF	=	soil-to-air particulate emission factor	Equation 4-8, USEPA, 2002	m^3/kg	5.25E+08
	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	V	=	fraction of vegetative cover	USEPA, 2002	unitless	0.5
	U_m	=	mean annual windspeed	USEPA, 2002	m/s	4.69
	U_t	=	equivalent threshold value of windspeed at 7 m	USEPA, 2002	m/s	11.32
	F(x)	=	function dependent on U_m/U_t	USEPA, 2002	unitless	0.194

Q/C_{wind}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{wind} = A \times \exp\frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	"A"	=	constant	USEPA, 2002 (1)	unitless	14.0111
	Area	=	areal extent of the site or contamination	(2)	acres	146
	"B"	=	constant	USEPA, 2002 (1)	unitless	19.6154
	"C"	=	constant	USEPA, 2002 (1)	unitless	225.3397

Note:

(1) Based on Zone 8 - Philadelphia, Pennsylvania.

(2) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

Reference:

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE B.4.8

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SURFACE AND SUBSURFACE SOIL EXPOSURE - FUTURE CONSTRUCTION/UTILITY WORKER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$PEF_{SC} = Q/C_{sr} \times 1/F_D \times [(T \times A_R) / (556 \times ((W/3)^{0.4} \times ((365\ d/y - p) / 365\ d/y) \times VKT)]$$

$$Q/C_{sr} = A \times EXP [(\ln A_s - B)^2 / C]$$

INPUT PARAMETERS	*VALUE*	*REFERENCE*
PEF_{sc}/ subchronic road particulate emission factor (m^3/kg) =	**7.10E+06**	Equation 5-5, USEPA, 2002
Q/C_{sr}/ inverse of ratio of the 1-h geometric mean air concentration =	13.04	Equation 5-6, USEPA, 2002
A/ constant (unitless) =	12.9351	USEPA, 2002
B/ constant (unitless) =	5.7383	USEPA, 2002
C/ constant (unitless) =	71.7711	USEPA, 2002
A_s/ areal extent of site surface soil contamination (acres) =	146	Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs)
F_D/ dispersion correction factor (unitless) =	0.185	USEPA, 2002
T/ total time over which construction occurs (s) =	3.15E+07	USEPA, 2002 (site-specific, within a 1 year construction campaign)
A_R/ surface area of contaminated road segment (m^2) =	4,687	USEPA, 2002 ($A_R = L_R*W_R*0.092903\ m^2/ft^2$)
L_R - length of road segment (ft) =	2522	USEPA, 2002
W_R - width of road segment (ft) =	20	USEPA, 2002
W/ mean vehicle weight (tons) =	8	USEPA, 2002, Assumes 20 two-ton cars and 10 twenty-ton trucks (W = (20*2+10*20)/30)
p/ number of days with at least 0.01 inches of precipitation (days/yr) =	130	USEPA, 2002
VKT/ sum of fleet vehicle kilometres travelled during the exposure duration (km) =	2,768	Assuming that the area is configured as a square with the unpaved construction access road segment dividing the square evenly, the road length would be equal to the square root of 590,841 m^2, also equal to 769m or 0.769km. Assuming that each vehicle travels the length of the road once per day, 5 days per week for a total of 120 days, (30*0.769*120).

Reference:

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE B.4.9

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	*Units*	1,2,4-Trichlorobenzene	1,4-Dichlorobenzene	Cyclohexane	Hexachlorobenzene	Mercury
						Child Soccer Player				
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m³/kg	4.00E+04	1.21E+04	8.03E+02	1.72E+05	3.89E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23	36.23	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	3.47E+08	3.47E+08	3.47E+08	3.47E+08	3.47E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66	1.66	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23	36.23	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111	14.0111	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146	146	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154	19.6154	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397	225.3397	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units					
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109	0.109	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166	0.166	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01	2.75E-01	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66	1.66	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	5.82E-02	9.96E-02	8.20E+00	5.41E-02	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm²/s	3.00E-02	6.90E-02	8.00E-02	5.42E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm²/s	8.23E-06	7.90E-06	9.00E-06	5.91E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units					
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm³/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	1.78E+03	6.17E+02	1.60E+02	5.50E+04	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006	0.006	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.

(2) Based on Zone 8 - Philadelphia, Pennsylvania.

(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$

(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15 °C.

(6) Average porosity of a sand soil applied.

(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.4.9

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
RECREATIONAL LAND USE (SOCCER FIELD/ GOLF COURSE) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	Units	1,2,4-Trichlorobenzene	1,4-Dichlorobenzene	Cyclohexane	Hexachlorobenzene	Mercury
						Child Golfer				
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m³/kg	4.00E+04	1.21E+04	8.03E+02	1.72E+05	3.89E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23	36.23	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	3.47E+08	3.47E+08	3.47E+08	3.47E+08	3.47E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66	1.66	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q / C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	(g/m²-sec)/(kg/m³)	36.23	36.23	36.23	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111	14.0111	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146	146	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154	19.6154	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397	225.3397	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units					
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm²/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109	0.109	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166	0.166	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01	2.75E-01	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm³	1.66	1.66	1.66	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	5.82E-02	9.96E-02	8.20E+00	5.41E-02	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm²/s	3.00E-02	6.90E-02	8.00E-02	5.42E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm²/s	8.23E-06	7.90E-06	9.00E-06	5.91E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units					
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm³/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm³/g	1.78E+03	6.17E+02	1.60E+02	5.50E+04	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006	0.006	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.

(2) Based on Zone 8 - Philadelphia, Pennsylvania.

(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$

(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15 °C.

(6) Average porosity of a sand soil applied.

(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.4.9

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
RECREATIONAL LAND USE (SOCCER FIELD/ GOLF COURSE) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	Units	Adult Golfer: 1,2,4-Trichlorobenzene	1,4-Dichlorobenzene	Cyclohexane	Hexachlorobenzene	Mercury
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	6.61E+04	1.99E+04	1.33E+03	2.84E+05	6.42E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23	36.23	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	9.46E+08	9.46E+08	9.46E+08	9.46E+08	9.46E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66	1.66	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23	36.23	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111	14.0111	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146	146	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154	19.6154	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397	225.3397	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units					
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	8.10E-07	8.89E-06	2.01E-03	4.39E-08	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109	0.109	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166	0.166	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01	2.75E-01	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66	1.66	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	5.82E-02	9.96E-02	8.20E+00	5.41E-02	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm^2/s	3.00E-02	6.90E-02	8.00E-02	5.42E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm^2/s	8.23E-06	7.90E-06	9.00E-06	5.91E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units					
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm^3/g	1.07E+01	3.70E+00	9.60E-01	3.30E+02	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.78E+03	6.17E+02	1.60E+02	5.50E+04	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006	0.006	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.

(2) Based on Zone 8 - Philadelphia, Pennsylvania.

(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$

(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15 °C.

(6) Average porosity of a sand soil applied.

(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.4.9

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
RECREATIONAL LAND USE (SOCCER FIELD/ GOLF COURSE) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	*Units*	*Golf Course Employee* Cyclohexane	Mercury
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	1.21E+03	5.86E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	7.88E+08	7.88E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units		
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	8.20E+00	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm^2/s	8.00E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm^2/s	9.00E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	9.60E-01	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units		
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm^3/g	9.60E-01	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.60E+02	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.

(2) Based on Zone 8 - Philadelphia, Pennsylvania.

(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$

(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15 °C.

(6) Average porosity of a sand soil applied.

(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.4.10

DERIVATION OF VOLATILIZATION FACTOR FOR SOIL - CONSTRUCTION/UTILITY WORKER INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$VF = (Q/C_{sa}) \times 1/F_D \times ((3.14 \times D_A \times T)^{1/2}) \times 10^{-4} / (2 \times \rho_b \times D_A)$$

$$D_A = ((\Theta_a^{10/3} \times D_i \times H + \Theta_w^{10/3} \times D_w) / n^2)/(\rho_b \times K_d + \Theta_w + \Theta_a \times H)$$

$$Q/C_{sa} = A \times EXP [(\ln A_c - B)^2 / C]$$

INPUT PARAMETERS	*REFERENCE*	*Chemical of Concern*			
		1,2,4-Trichlorobenzene	1,4-Dichlorobenzene	Benzene	Cyclohexane
VF/ volatilization factor (m^3/kg) =	Equation 5-14, USEPA, 2002	**1.02E+04**	**3.08E+03**	**6.33E+02**	**2.05E+02**
D_A/ apparent diffusivity (cm^2/s) =	Equation 5-14, USEPA, 2002	8.10E-07	8.89E-06	2.11E-04	2.01E-03
Q/C_{sa}/ inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3) =	Equation 5-15, USEPA, 2002	5.67	5.67	5.67	5.67
A/ constant (unitless) =	USEPA, 2002	2.4538	2.4538	2.4538	2.4538
B/ constant (unitless) =	USEPA, 2002	17.566	17.566	17.566	17.566
C/ constant (unitless) =	USEPA, 2002	189.0426	189.0426	189.0426	189.0426
A_s/ areal extent of site surface soil contamination (acres) =	(1)	146	146	146	146
F_D/ dispersion correction factor (unitless) =	USEPA, 2002	0.185	0.185	0.185	0.185
Θ_a/ air-filled soil porosity (L_{air}/L_{soil}) =	(2)	0.109	0.109	0.109	0.109
Di/ diffusivity in air (cm^2/s) =	USEPA, 2002; USEPA, 2004b	3.00E-02	6.90E-02	8.80E-02	8.00E-02
H/ dimensionless Henry's law constant =	USEPA, 2002; USEPA, 2004b	5.82E-02	9.96E-02	2.28E-01	8.20E+00
Θ_w/ water-filled soil porosity (L_{water}/L_{soil}) =	(3)	0.166	0.166	0.166	0.166
D_w/ diffusivity in water (cm^2/s) =	USEPA, 2002; USEPA, 2004b	8.23E-06	7.90E-06	9.80E-06	9.00E-06
n/ total soil porosity (L_{pore}/L_{soil}) =	Fetter, 2001: Table 3.4 (4)	0.275	0.275	0.275	0.275
ρ_b/ dry soil bulk density (g/cm^3) =	USEPA, 2004a (5)	1.66	1.66	1.66	1.66
Kd/ soil-water partition coefficient (cm^3/g) =	USEPA, 2002 (Kd = Koc x foc) (6)	1.07E+01	3.70E+00	3.53E-01	9.60E-01
Koc/ soil organic carbon-water partition coefficient (cm^3/g) =	USEPA, 2002; USEPA, 2004b	1.78E+03	6.17E+02	5.89E+01	1.60E+02
foc/ organic carbon content of soil (g/g) =	USEPA, 2002	0.006	0.006	0.006	0.006
T/ exposure interval (s) =	USEPA, 2002	31536000	31536000	31536000	31536000
Conversion Factor/ 10^{-4} (m^2/cm^2) =	USEPA, 2002	1.00E-04	1.00E-04	1.00E-04	1.00E-04

Notes:

(1) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(2) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(3) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$,
where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(4) Average porosity of a sand soil applied.
(5) Default dry bulk density for sand soils applied.
(6) Value for mercury is based on pH 7.

References:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.4.9

DERIVATION OF VOLATILIZATION FACTOR FOR SOIL - CONSTRUCTION/UTILITY WORKER INHALATION EXPOSURE
RECREATIONAL LAND USE (GOLF COURSE) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

$$VF = (Q/C_{sa}) \times 1/F_D \times ((3.14 \times D_A \times T)^{1/2}) \times 10^{-4} / (2 \times \rho_b \times D_A)$$

$$D_a = ((\Theta_a^{10/3} \times D_i \times H + \Theta_w^{10/3} \times D_w) / n^2)/(\rho_b \times K_d + \Theta_w + \Theta_a \times H)$$

$$Q/C_{sa} = A \times EXP [(\ln A_c - B)^2 / C]$$

INPUT PARAMETERS	*REFERENCE*	Methyl cyclohexane	Vinyl chloride	Hexachlorobenzene	Mercury
VF/ volatilization factor (m^3/kg) =	Equation 5-14, USEPA, 2002	**4.45E+02**	**2.04E+02**	**4.38E+04**	**9.92E+03**
D_A/ apparent diffusivity (cm^2/s) =	Equation 5-14, USEPA, 2002	4.27E-04	2.03E-03	4.39E-08	8.58E-07
Q/C_{sa}/ inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3) =	Equation 5-15, USEPA, 2002	5.67	5.67	5.67	5.67
A/ constant (unitless) =	USEPA, 2002	2.4538	2.4538	2.4538	2.4538
B/ constant (unitless) =	USEPA, 2002	17.566	17.566	17.566	17.566
C/ constant (unitless) =	USEPA, 2002	189.0426	189.0426	189.0426	189.0426
A_s/ areal extent of site surface soil contamination (acres) =	(1)	146	146	146	146
F_D/ dispersion correction factor (unitless) =	USEPA, 2002	0.185	0.185	0.185	0.185
Θ_a/ air-filled soil porosity (L_{air}/L_{soil}) =	(2)	0.109	0.109	0.109	0.109
Di/ diffusivity in air (cm^2/s) =	USEPA, 2002; USEPA, 2004b	7.00E-02	1.06E-01	5.42E-02	3.07E-02
H/ dimensionless Henry's law constant =	USEPA, 2002; USEPA, 2004b	1.80E+01	1.11E+00	5.41E-02	4.67E-01
Θ_w/ water-filled soil porosity (L_{water}/L_{soil}) =	(3)	0.166	0.166	0.166	0.166
D_w/ diffusivity in water (cm^2/s) =	USEPA, 2002; USEPA, 2004b	9.00E-06	1.23E-05	5.91E-06	6.30E-06
n/ total soil porosity (L_{pore}/L_{soil}) =	Fetter, 2001: Table 3.4 (4)	0.275	0.275	0.275	0.275
ρ_b/ dry soil bulk density (g/cm^3) =	USEPA, 2004a (5)	1.66	1.66	1.66	1.66
Kd/ soil-water partition coefficient (cm^3/g) =	USEPA, 2002 (Kd = Koc x foc) (6)	1.32E+01	1.12E-01	3.30E+02	8.20E+01
Koc/ soil organic carbon-water partition coefficient (cm^3/g) =	USEPA, 2002; USEPA, 2004b	2.20E+03	1.86E+01	5.50E+04	--
foc/ organic carbon content of soil (g/g) =	USEPA, 2002	0.006	0.006	0.006	0.006
T/ exposure interval (s) =	USEPA, 2002	31536000	31536000	31536000	31536000
Conversion Factor/ 10^{-4} (m^2/cm^2) =	USEPA, 2002	1.00E-04	1.00E-04	1.00E-04	1.00E-04

Notes:

(1) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

(2) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$

(3) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.

(4) Average porosity of a sand soil applied.

(5) Default dry bulk density for sand soils applied.

(6) Value for mercury is based on pH 7.

References:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE B.5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal RfD (2)*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (3) (MM/DD/YY)*
VOCs										
1,1-Dichloroethene	chronic	5.00E-02	mg/kg-d	100%	5.00E-02	mg/kg-d	liver	100	IRIS	04/16/08
1,2,4-Trichlorobenzene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	adrenal weights	1000	IRIS	04/16/08
1,2-Dichlorobenzene	chronic	9.00E-02	mg/kg-d	100%	9.00E-02	mg/kg-d	no effects	1000	IRIS	04/16/08
1,3-Dichlorobenzene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
1,4-Dichlorobenzene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
2-Butanone	chronic	6.00E-01	mg/kg-d	100%	6.00E-01	mg/kg-d	developmental toxicity	1000	IRIS	04/16/08
Acetone	chronic	9.00E-01	mg/kg-d	100%	9.00E-01	mg/kg-d	liver	1000	IRIS	04/16/08
Benzene	chronic	4.00E-03	mg/kg-d	100%	4.00E-03	mg/kg-d	blood system	300	IRIS	04/16/08
Carbon disulfide	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	developmental toxicity	100	IRIS	04/16/08
Carbon tetrachloride	chronic	7.00E-04	mg/kg-d	100%	7.00E-04	mg/kg-d	liver	1000	IRIS	04/16/08
Chlorobenzene	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Chloroform	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
cis-1,2-Dichloroethene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	blood system	3000	HEAST	07/01/97
Cyclohexane	chronic	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	chronic	--	--	--	--	--	--	--	--	--
Methylene chloride	chronic	6.00E-02	mg/kg-d	100%	6.00E-02	mg/kg-d	liver	100	IRIS	04/16/08
Tetrachloroethene	chronic	1.00E-02	mg/kg-d	100%	1.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Toluene	chronic	8.00E-02	mg/kg-d	100%	8.00E-02	mg/kg-d	kidney	3000	IRIS	04/16/08
Trichloroethene (former)	chronic	6.00E-03	mg/kg-d	100%	6.00E-03	mg/kg-d	--	--	R9-PRGb	10/01/99
Trichloroethene (current)	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	--	--	R9-PRGa	10/01/04
Vinyl chloride	chronic	3.00E-03	mg/kg-d	100%	3.00E-03	mg/kg-d	liver	30	IRIS	04/16/08
Xylenes (total)	chronic	2.00E-01	mg/kg-d	100%	2.00E-01	mg/kg-d	body weight	1000	IRIS	04/16/08
SVOCs										
2-Chlorophenol	chronic	5.00E-03	mg/kg-d	100%	5.00E-03	mg/kg-d	reproductive effects	1000	IRIS	04/16/08
2-Methylnaphthalene	chronic	4.00E-03	mg/kg-d	100%	4.00E-03	mg/kg-d	respiratory system	3000	IRIS	04/16/08
Acetophenone	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	general toxicity	3000	IRIS	04/16/08
Anthracene	chronic	3.00E-01	mg/kg-d	100%	3.00E-01	mg/kg-d	no effects	3000	IRIS	04/16/08
Benzaldehyde	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	kidney	1000	IRIS	04/16/08
Benzo(a)anthracene	chronic	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	chronic	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	chronic	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	liver	1000	IRIS	04/16/08
Chrysene	chronic	--	--	--	--	--	--	--	--	--
Fluoranthene	chronic	4.00E-02	mg/kg-d	100%	4.00E-02	mg/kg-d	liver	3000	IRIS	04/16/08
Hexachlorobenzene	chronic	8.00E-04	mg/kg-d	100%	8.00E-04	mg/kg-d	liver	100	IRIS	04/16/08
Hexachloroethane	chronic	1.00E-03	mg/kg-d	100%	1.00E-03	mg/kg-d	kidney	1000	IRIS	04/16/08
Indeno(1,2,3-cd)pyrene	chronic	--	--	--	--	--	--	--	--	--
Naphthalene	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	body weight	3000	IRIS	04/16/08
Nitrobenzene	chronic	5.00E-04	mg/kg-d	100%	5.00E-04	mg/kg-d	liver	10000	IRIS	04/16/08
Phenanthrene	chronic	--	--	--	--	--	--	--	--	--
Pyrene	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	kidney	3000	IRIS	04/16/08

TABLE B.5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal RfD (2)*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (3) (MM/DD/YY)*
Metals										
Aluminum	chronic	1.00E+00	mg/kg-d	100%	1.00E+00	mg/kg-d	--	--	R9-PRGa	10/01/04
Antimony	chronic	4.00E-04	mg/kg-d	15%	6.00E-05	mg/kg-d	blood system	1000	IRIS	04/16/08
Arsenic	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	skin discoloration	3	IRIS	04/16/08
Beryllium	chronic	2.00E-03	mg/kg-d	0.7%	1.40E-05	mg/kg-d	chronic beryllium disease	300	IRIS	04/16/08
Cobalt	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
Copper	chronic	4.00E-02	mg/kg-d	100%	4.00E-02	mg/kg-d	--	--	R9-PRGa	10/01/04
Iron	chronic	7.00E-01	mg/kg-d	100%	7.00E-01	mg/kg-d	--	--	R3-RBC	10/16/07
Lead	chronic	--	--	--	--	--	--	--	--	--
Manganese	chronic	2.00E-02	mg/kg-d	4%	8.00E-04	mg/kg-d	central nervous system	6	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	autoimmune system	1000	IRIS	04/16/08
Nickel	chronic	2.00E-02	mg/kg-d	4%	8.00E-04	mg/kg-d	body weight	300	IRIS	04/16/08
Thallium	chronic	7.00E-05	mg/kg-d	100%	7.00E-05	mg/kg-d	--	--	R9-PRGa	10/01/04
Vanadium	chronic	1.00E-03	mg/kg-d	2.6%	2.60E-05	mg/kg-d	--	--	R9-PRG	10/01/04
Zinc	chronic	3.00E-01	mg/kg-d	100%	3.00E-01	mg/kg-d	blood system	3	IRIS	04/16/08
PCBs										
Aroclor-1260	chronic	--	--	--	--	--	--	--	--	--

Notes:

-- = Not Available

N/A = Not Applicable

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended by USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal RfD = Oral RfD x (ABS_{GI}/100), consistent with Equation 4.3 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.
Region III Risk-Based Concentrations (R3-RBC) Table, October 16, 2007. USEPA peer-reviewed value.

TABLE B.5.2

NON-CANCER TOXICITY DATA -- INHALATION ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Value Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfC:RfD: Target Organ*	*Dates (1) (MM/DD/YY)*
VOCs							
1,1-Dichloroethene	chronic	2.00E-01	mg/m^3	liver	30	IRIS	04/16/08
1,2,4-Trichlorobenzene	chronic	3.50E-03	mg/m^3	--	--	R9-PRGa	10/01/04
1,2-Dichlorobenzene	chronic	2.00E-01	mg/m^3	body weight	1000	HEAST	07/01/97
1,3-Dichlorobenzene	--	--	--	--	--	--	--
1,4-Dichlorobenzene	chronic	8.00E-01	mg/m^3	liver	100	IRIS	04/16/08
2-Butanone	chronic	5.00E+00	mg/m^3	developmental toxicity	300	IRIS	04/16/08
Acetone	--	--	--	--	--	--	--
Benzene	chronic	3.00E-02	mg/m^3	blood system	300	IRIS	04/16/08
Carbon disulfide	chronic	7.00E-01	mg/m^3	central nervous system	30	IRIS	04/16/08
Carbon tetrachloride	--	--	--	--	--	--	--
Chlorobenzene	chronic	5.95E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Chloroform	chronic	4.90E-02	mg/m^3	--	--	R9-PRGa	10/01/04
cis-1,2-Dichloroethene	--	--	--	--	--	--	--
Cyclohexane	chronic	6.00E+00	mg/m^3	developmental toxicity	300	IRIS	04/16/08
Methyl cyclohexane	chronic	3.00E+00	mg/m^3	kidney	100	HEAST	07/01/97
Methylene chloride	chronic	3.00E+00	mg/m^3	liver	100	HEAST	07/01/97
Tetrachloroethene (former)	chronic	3.85E-01	mg/m^3	--	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	chronic	3.50E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Toluene	chronic	5.00E+00	mg/m^3	kidney	10	IRIS	04/16/08
Trichloroethene (former)	--	--	--	--	--	--	--
Trichloroethene (current)	chronic	3.50E-02	mg/m^3	--	--	R9-PRGa	10/01/04
Vinyl chloride	chronic	1.00E-01	mg/m^3	liver	30	IRIS	04/16/08
Xylenes (total)	chronic	1.00E-01	mg/m^3	body weight	300	IRIS	04/16/08
SVOCs							
2-Chlorophenol	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--
Acetophenone	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	--
Benzaldehyde	--	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--

TABLE B.5.2

NON-CANCER TOXICITY DATA -- INHALATION ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Value Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfC:RfD: Target Organ*	*Dates (1) (MM/DD/YY)*
SVOCs (cont.'d)							
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--
Naphthalene	chronic	3.00E-03	mg/m^3	body weight	3000	IRIS	04/16/08
Nitrobenzene	chronic	2.00E-03	mg/m^3	liver	10000	HEAST	07/01/97
Phenanthrene	--	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--	--
Metals							
Aluminum	chronic	5.00E-03	mg/m^3	--	--	R9-PRGa	10/01/04
Antimony	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--
Beryllium	chronic	2.00E-05	mg/m^3	chronic beryllium disease	10	IRIS	04/16/08
Cobalt	chronic	2.00E-05	mg/m^3	--	--	R9-PRGa	10/01/04
Copper	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--
Manganese	chronic	5.00E-05	mg/m^3	central nervous system	1000	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/m^3	autoimmune system	30	IRIS	04/16/08
Nickel	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--
PCBs							
Aroclor-1260	--	--	--	--	--	--	--

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April, 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.

TABLE B.5.3

NON-CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern	*Surrogate Compound (1)*	*Oral and Dermal RfD*	*Units*	*Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of Primary Target Organ*	*Date (2) (MM/DD/YY)*
Semivolatile Organic Compounds									
Phenanthrene	Naphthalene	2.00E-02	mg/kg-day	3.00E-03	mg/m^3	body weight	3000	IRIS	04/16/08

Notes:

-- = Not Available

(1) No toxicity data available for this analyte, therefore, a surrogate with toxicity data was determined.

(2) IRIS, Integrated Risk Information System Database, April 16, 2008.

TABLE B.6.1

CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal Cancer Slope Factor (2)*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (3) (MM/DD/YY)*
VOCs							
1,1-Dichloroethene	--	--	--	--	C	--	--
1,2,4-Trichlorobenzene	--	--	--	--	D	--	--
1,2-Dichlorobenzene	--	--	--	--	D	--	--
1,3-Dichlorobenzene	--	--	--	--	D	--	--
1,4-Dichlorobenzene	2.40E-02	100%	2.40E-02	$(mg/kg\text{-}day)^{-1}$	C	HEAST	07/01/97
2-Butanone	--	--	--	--	D	--	--
Acetone	--	--	--	--	D	--	--
Benzene	5.50E-02	100%	5.50E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/08
Carbon disulfide	--	--	--	--	--	--	--
Carbon tetrachloride	1.30E-01	100%	1.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Chlorobenzene	--	--	--	--	D	--	--
Chloroform	--	--	--	--	B2	--	--
cis-1,2-Dichloroethene	--	--	--	--	D	--	--
Cyclohexane	--	--	--	--	--	--	--
Methyl cyclohexane	--	--	--	--	--	--	--
Methylene chloride	7.50E-03	100%	7.50E-03	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Tetrachloroethene (former)	5.20E-02	100%	5.20E-02	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	5.40E-01	100%	5.40E-01	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGa	10/01/04
Toluene	--	--	--	--	D	--	--
Trichloroethene (former)	1.10E-02	100%	1.10E-02	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGb	10/01/99
Trichloroethene (current)	4.00E-01	100%	4.00E-01	$(mg/kg\text{-}day)^{-1}$	--	R9-PRGa	10/01/04
Vinyl chloride	7.50E-01	100%	7.50E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/16/08
Xylenes (total)	--	--	--	--	D	--	--
SVOCs							
2-Chlorophenol	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	D	--	--
Acetophenone	--	--	--	--	D	--	--
Anthracene	--	--	--	--	D	--	--
Benzaldehyde	--	--	--	--	--	--	--
Benzo(a)anthracene (adolescent)	2.19E+00	100%	2.19E+00	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Benzo(a)anthracene (adult)	7.30E-01	100%	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	R9-PRGa	10/01/04
Benzo(a)pyrene (adolescent)	2.19E+01	100%	2.19E+01	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Benzo(a)pyrene (adult)	7.30E+00	100%	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Benzo(b)fluoranthene (adolescent)	2.19E+00	100%	2.19E+00	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Benzo(b)fluoranthene (adult)	7.30E-01	100%	7.30E-01	$(mg/kg\text{-}day)^{-1}$	B2	R9-PRGa	10/01/04
Bis(2-ethylhexyl)phthalate	1.40E-02	100%	1.40E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	04/16/08
Chrysene (adolescent)	2.19E-02	100%	2.19E-02	$(mg/kg\text{-}day)^{-1}$	B2	USEPA	03/01/05
Chrysene (adult)	7.30E-03	100%	7.30E-03	$(mg/kg\text{-}day)^{-1}$	B2	R9-PRGa	10/01/04
Fluoranthene	--	--	--	--	D	--	--

TABLE B.6.1

CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal Cancer Slope Factor (2)*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (3) (MM/DD/YY)*
SVOCs (cont.'d)							
Hexachlorobenzene	1.60E+00	100%	1.60E+00	(mg/kg-day) $^{-1}$	B2	IRIS	04/16/08
Hexachloroethane	1.40E-02	100%	1.40E-02	(mg/kg-day) $^{-1}$	C	IRIS	04/16/08
Indeno(1,2,3-cd)pyrene (adolescent)	2.19E+00	100%	2.19E+00	(mg/kg-day) $^{-1}$	B2	USEPA	03/01/05
Indeno(1,2,3-cd)pyrene (adult)	7.30E-01	100%	7.30E-01	(mg/kg-day) $^{-1}$	B2	R9-PRGa	10/01/04
Naphthalene	--	--	--	--	C	--	--
Nitrobenzene	--	--	--	--	D	--	--
Phenanthrene	--	--	--	--	D	--	--
Pyrene	--	--	--	--	D	--	--
Metals							
Aluminum	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--
Arsenic	1.50E+00	100%	1.50E+00	(mg/kg-day) $^{-1}$	A	IRIS	04/16/08
Beryllium	--	--	--	--	B1	--	--
Cobalt	--	--	--	--	--	--	--
Copper	--	--	--	--	D	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	B2	--	--
Manganese	--	--	--	--	D	--	--
Mercury	--	--	--	--	D	--	--
Nickel	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--
Zinc	--	--	--	--	D	--	--
PCBs							
Aroclor-1260	2.00E+00	100%	2.00E+00	(mg/kg-day) $^{-1}$	B2	IRIS	04/16/08

Notes:

-- = Not Available

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal CSF = Oral CSF / (ABS_{GI}/100), consistent with Equation 4.2 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
HEAST, Health Effects Assessment Summary Table, July 1, 1997.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999. Provisional values supplied by NCEA.
USEPA, Guidelines for Carcinogenic Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, March 2005. For adolescents, default age-dependent adjustment factor of 3 is applied for carcinogens that act via a mutagenic mode of action.

EPA Weight of Evidence Classification :

A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE B.6.2

CANCER TOXICITY DATA -- INHALATION ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Unit Risk*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (1) (MM/DD/YY)*
VOCs					
1,1-Dichloroethene	--	--	C	--	--
1,2,4-Trichlorobenzene	--	--	D	--	--
1,2-Dichlorobenzene	--	--	D	--	--
1,3-Dichlorobenzene	--	--	D	--	--
1,4-Dichlorobenzene	6.00E-03	$(mg/m^3)^{-1}$	C	R9-PRGa	10/01/04
2-Butanone	--	--	D	--	--
Acetone	--	--	D	--	--
Benzene	7.70E-03	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Carbon disulfide	--	--	--	--	--
Carbon tetrachloride	1.50E-02	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Chlorobenzene	--	--	D	--	--
Chloroform	2.30E-02	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
cis-1,2-Dichloroethene	--	--	D	--	--
Cyclohexane	--	--	--	--	--
Methyl cyclohexane	--	--	--	--	--
Methylene chloride	4.70E-04	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Tetrachloroethene (former)	5.70E-04	$(mg/m^3)^{-1}$	--	R9-PRGb	10/01/99
Tetrachloroethene (current)	6.00E-03	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Toluene	--	--	D	--	--
Trichloroethene (former)	1.70E-03	$(mg/m^3)^{-1}$	--	R9-PRGb	10/01/99
Trichloroethene (current)	1.10E-01	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Vinyl chloride	4.40E-03	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Xylenes (total)	--	--	D	--	--
SVOCs					
2-Chlorophenol	--	--	--	--	--
2-Methylnaphthalene	--	--	D	--	--
Acetophenone	--	--	D	--	--
Anthracene	--	--	D	--	--
Benzaldehyde	--	--	--	--	--
Benzo(a)anthracene	--	--	B2	--	--
Benzo(a)pyrene	--	--	B2	--	--
Benzo(b)fluoranthene	--	--	B2	--	--
Bis(2-ethylhexyl)phthalate	--	--	B2	--	--
Chrysene	--	--	B2	--	--
Fluoranthene	--	--	D	--	--
Hexachlorobenzene	4.60E-01	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08

TABLE B.6.2

CANCER TOXICITY DATA -- INHALATION ROUTE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Unit Risk*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (1) (MM/DD/YY)*
SVOCs (cont.'d)					
Hexachloroethane	4.00E-03	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08
Indeno(1,2,3-cd)pyrene	--	--	B2	--	--
Naphthalene	--	--	C	--	--
Nitrobenzene	--	--	D	--	--
Phenanthrene	--	--	D	--	--
Pyrene	--	--	D	--	--
Metals					
Aluminum	--	--	--	--	--
Antimony	--	--	--	--	--
Arsenic	4.30E+00	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Beryllium	2.40E+00	$(mg/m^3)^{-1}$	B1	IRIS	04/16/08
Cobalt	2.80E+00	$(mg/m^3)^{-1}$	--	R9-PRGa	10/01/04
Copper	--	--	D	--	--
Iron	--	--	--	--	--
Lead	--	--	B2	--	--
Manganese	--	--	D	--	--
Mercury	--	--	D	--	--
Nickel	--	--	--	--	--
Thallium	--	--	--	--	--
Vanadium	--	--	--	--	--
Zinc	--	--	D	--	--
PCBs					
Aroclor-1260	5.70E-01	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April 16, 2008.
R9-PRGa, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004.
Provisional values supplied by NCEA.
R9-PRGb, Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 1999.
Provisional values supplied by NCEA.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE B.6.3

CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern	*Surrogate Compound (1)*	*Oral and Dermal CSF*	*Units*	*Inhalation URF*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date MM/DD/YY*
Semivolatile Organic Compounds								
Phenanthrene	Naphthalene	--	--	--	--	D	--	--

Notes:
-- = Not Available
(1) No toxicity data available for this analyte, therefore, a surrogate with toxicity data was determined.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE B.7.1

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - CHILD SOCCER PLAYER ORAL, DERMAL, AND INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Child Soccer Player TR Child (µg/g)	Child Soccer Player THQ Child (µg/g)	Site-Specific Soil Standard SSS$_{ss}$ (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
1,2,4-Trichlorobenzene	--	--	--	1.00E-02	1.00E-02	3.50E-03	1.00E+00	3.00E-02	4.00E+04	NV	5.73E+03	5.73E+03	1.30E+02
1,4-Dichlorobenzene	2.40E-02	2.40E-02	6.00E-03	3.00E-02	3.00E-02	8.00E-01	1.00E+00	5.00E-04	1.21E+04	2.60E+02	3.73E+04	2.60E+02	1.00E+02
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	8.03E+02	NV	3.91E+05	3.91E+05	2.70E-02
SVOCs													
Benzo(a)anthracene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.42E+00	NV	2.42E+00	8.30E-01
Benzo(a)pyrene	2.19E+01	2.19E+01	--	--	--	--	1.00E+00	1.30E-01	NA	2.42E-01	NV	2.42E-01	**1.00E+00**
Benzo(b)fluoranthene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.42E+00	NV	2.42E+00	2.00E+00
Hexachlorobenzene	1.60E+00	1.60E+00	4.60E-01	8.00E-04	8.00E-04	--	1.00E+00	1.30E-01	1.72E+05	3.25E+00	6.65E+02	3.25E+00	6.20E-01
Indeno(1,2,3-cd)pyrene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.42E+00	NV	2.42E+00	4.50E-01
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.25E+06	1.25E+06	2.01E+04
Antimony	--	--	--	4.00E-04	6.00E-05	--	1.00E+00	3.00E-02	NA	NV	2.78E+02	2.78E+02	1.04E+01
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	4.90E+00	3.47E+02	4.90E+00	**1.10E+02**
Beryllium	--	--	2.40E+00	2.00E-03	1.40E-05	2.00E-05	1.00E+00	1.00E-02	NA	1.13E+05	3.58E+02	3.58E+02	6.93E+01
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	9.68E+04	2.43E+04	2.43E+04	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	5.01E+04	5.01E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	8.77E+05	8.77E+05	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	1.24E+04	1.24E+04	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	3.89E+04	NV	2.69E+02	2.69E+02	**9.13E+03**
Nickel	--	--	--	2.00E-02	8.00E-04	--	1.00E+00	1.00E-02	NA	NV	1.24E+04	1.24E+04	6.74E+02
Thallium	--	--	--	7.00E-05	7.00E-05	--	1.00E+00	1.00E-02	NA	NV	8.77E+01	8.77E+01	7.20E-01
Vanadium	--	--	--	1.00E-03	2.60E-05	--	1.00E+00	1.00E-02	NA	NV	4.85E+02	4.85E+02	4.50E+01
Zinc	--	--	--	3.00E-01	3.00E-01	--	1.00E+00	1.00E-02	NA	NV	3.76E+05	3.76E+05	2.88E+04
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	2.57E+00	NV	2.57E+00	**4.40E+00**

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS

(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table B.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as presented in Table A.3.1 of Appendix A.

Child Golfer Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS$_{ss}$	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table B.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table B.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Ingestion Rate (mg/day)	IR	200	Refer to Table B.4.1
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table B.4.1
Surface Area Exposed (cm^2/day)	SA	2,938	Refer to Table B.4.1
Adherence Factor (mg/cm^2)	AF	0.3	Refer to Table B.4.1
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table B.4.1
Fraction of Time Exposed (unitless)	FT	2/24	Refer to Table B.4.1
Exposure Frequency (days/year)	EF	54	Refer to Table B.4.1
Exposure Duration (years)	ED	11	Refer to Table B.4.1
Body Weight (kg)	BW	39	Refer to Table B.4.1
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table B.4.1
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.1
Averaging Time - noncarc. (days)	ATnc	4,015	Refer to Table B.4.1
Particulate Emission Factor (m^3/kg)	PEF	5.25E+08	Refer to Table B.4.7
Volatilization Factor (m^3/kg)	VF	chemical-specific	Refer to Table B.4.9

Exposure Equations

Carcinogenic Endpoints:

$$SSS_{ss} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times FT \times (1/VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$SSS_{ss} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times FT \times (1/VF \text{ or } PEF))]}$$

TABLE B.7.2

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - CHILD GOLFER ORAL, DERMAL, AND INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Child Golfer TR Child (µg/g)	Child Golfer THQ Child (µg/g)	Site-Specific Soil Standard SSS$_{ss}$ (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
1,2,4-Trichlorobenzene	--	--	--	1.00E-02	1.00E-02	3.50E-03	1.00E+00	3.00E-02	4.00E+04	NV	3.43E+03	3.43E+03	1.30E+02
1,4-Dichlorobenzene	2.40E-02	2.40E-02	6.00E-03	3.00E-02	3.00E-02	8.00E-01	1.00E+00	5.00E-04	1.21E+04	1.96E+02	3.62E+04	1.96E+02	1.00E+02
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	8.03E+02	NV	1.62E+05	1.62E+05	2.70E-02
SVOCs													
Benzo(a)anthracene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.86E+00	NV	2.86E+00	8.30E-01
Benzo(a)pyrene	2.19E+01	2.19E+01	--	--	--	--	1.00E+00	1.30E-01	NA	2.86E-01	NV	2.86E-01	**1.00E+00**
Benzo(b)fluoranthene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.86E+00	NV	2.86E+00	2.00E+00
Hexachlorobenzene	1.60E+00	1.60E+00	4.60E-01	8.00E-04	8.00E-04	--	1.00E+00	1.30E-01	1.72E+05	3.73E+00	7.86E+02	3.73E+00	6.20E-01
Indeno(1,2,3-cd)pyrene	2.19E+00	2.19E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.86E+00	NV	2.86E+00	4.50E-01
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.30E+06	1.30E+06	2.01E+04
Antimony	--	--	--	4.00E-04	6.00E-05	--	1.00E+00	3.00E-02	NA	NV	3.42E+02	3.42E+02	1.04E+01
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	5.29E+00	3.74E+02	5.29E+00	**1.10E+02**
Beryllium	--	--	2.40E+00	2.00E-03	1.40E-05	2.00E-05	1.00E+00	1.00E-02	NA	4.69E+04	5.22E+02	5.22E+02	6.93E+01
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	4.02E+04	2.46E+04	2.46E+04	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	5.28E+04	5.28E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	9.24E+05	9.24E+05	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	1.54E+04	1.54E+04	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	3.89E+04	NV	1.97E+02	1.97E+02	**9.13E+03**
Nickel	--	--	--	2.00E-02	8.00E-04	--	1.00E+00	1.00E-02	NA	NV	1.57E+04	1.57E+04	6.74E+02
Thallium	--	--	--	7.00E-05	7.00E-05	--	1.00E+00	1.00E-02	NA	NV	9.24E+01	9.24E+01	7.20E-01
Vanadium	--	--	--	1.00E-03	2.60E-05	--	1.00E+00	1.00E-02	NA	NV	6.38E+02	6.38E+02	4.50E+01
Zinc	--	--	--	3.00E-01	3.00E-01	--	1.00E+00	1.00E-02	NA	NV	3.96E+05	3.96E+05	2.88E+04
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	3.06E+00	NV	3.06E+00	**4.40E+00**

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS

(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table B.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

Child Golfer Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS$_{ss}$	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table B.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table B.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Ingestion Rate (mg/day)	IR	200	Refer to Table B.4.2
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table B.4.2
Surface Area Exposed (cm^2/day)	SA	2,938	Refer to Table B.4.2
Adherence Factor (mg/cm^2)	AF	0.2	Refer to Table B.4.2
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table B.4.2
Fraction of Time Exposed (unitless)	FT	5/24	Refer to Table B.4.2
Exposure Frequency (days/year)	EF	52	Refer to Table B.4.2
Exposure Duration (years)	ED	11	Refer to Table B.4.2
Body Weight (kg)	BW	39	Refer to Table B.4.2
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table B.4.2
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.2
Averaging Time - noncarc. (days)	ATnc	4,015	Refer to Table B.4.2
Particulate Emission Factor (m^3/kg)	PEF	5.25E+08	Refer to Table B.4.7
Volatilization Factor (m^3/kg)	VF	chemical-specific	Refer to Table B.4.9

Exposure Equations

Carcinogenic Endpoints:

$$SSS_{ss} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times FT \times (1/VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$SSS_{ss} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times FT \times (1/VF \text{ or } PEF))]}$$

TABLE B.7.3

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - ADULT GOLFER ORAL, DERMAL, AND INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Adult Golfer TR Adult (µg/g)	Adult Golfer THQ Adult (µg/g)	Site-Specific Soil Standard SSS_{ss} (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
1,2,4-Trichlorobenzene	--	--	--	1.00E-02	1.00E-02	3.50E-03	1.00E+00	3.00E-02	6.61E+04	NV	2.62E+03	2.62E+03	1.30E+02
1,4-Dichlorobenzene	2.40E-02	2.40E-02	6.00E-03	3.00E-02	3.00E-02	8.00E-01	1.00E+00	5.00E-04	1.99E+04	6.75E+01	4.62E+04	6.75E+01	**1.00E+02**
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	1.33E+03	NV	1.07E+05	1.07E+05	2.70E-02
SVOCs													
Benzo(a)anthracene	7.30E-01	7.30E-01	--	--	--	--	1.00E+00	1.30E-01	NA	3.38E+00	NV	3.38E+00	8.30E-01
Benzo(a)pyrene	7.30E+00	7.30E+00	--	--	--	--	1.00E+00	1.30E-01	NA	3.38E-01	NV	3.38E-01	**1.00E+00**
Benzo(b)fluoranthene	7.30E-01	7.30E-01	--	--	--	--	1.00E+00	1.30E-01	NA	3.38E+00	NV	3.38E+00	2.00E+00
Hexachlorobenzene	1.60E+00	1.60E+00	4.60E-01	8.00E-04	8.00E-04	--	1.00E+00	1.30E-01	2.84E+05	1.43E+00	8.46E+02	1.43E+00	6.20E-01
Indeno(1,2,3-cd)pyrene	7.30E-01	7.30E-01	--	--	--	--	1.00E+00	1.30E-01	NA	3.38E+00	NV	3.38E+00	4.50E-01
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.75E+06	1.75E+06	2.01E+04
Antimony	--	--	--	4.00E-04	6.00E-05	--	1.00E+00	3.00E-02	NA	NV	3.39E+02	3.39E+02	1.04E+01
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	2.55E+00	4.92E+02	2.55E+00	**1.10E+02**
Beryllium	--	--	2.40E+00	2.00E-03	1.40E-05	2.00E-05	1.00E+00	1.00E-02	NA	6.88E+03	3.76E+02	3.76E+02	6.93E+01
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	5.90E+03	2.93E+04	5.90E+03	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	7.37E+04	7.37E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	1.29E+06	1.29E+06	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	1.42E+04	1.42E+04	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	6.42E+04	NV	1.77E+02	1.77E+02	**9.13E+03**
Nickel	--	--	--	2.00E-02	8.00E-04	--	1.00E+00	1.00E-02	NA	NV	1.48E+04	1.48E+04	6.74E+02
Thallium	--	--	--	7.00E-05	7.00E-05	--	1.00E+00	1.00E-02	NA	NV	1.29E+02	1.29E+02	7.20E-01
Vanadium	--	--	--	1.00E-03	2.60E-05	--	1.00E+00	1.00E-02	NA	NV	5.55E+02	5.55E+02	4.50E+01
Zinc	--	--	--	3.00E-01	3.00E-01	--	1.00E+00	1.00E-02	NA	NV	5.53E+05	5.53E+05	2.88E+04
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	1.19E+00	NV	1.19E+00	**4.40E+00**

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table B.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

Adult Golfer Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS_{ss}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table B.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table B.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table B.4.3
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table B.4.3
Surface Area Exposed (cm^2/day)	SA	3,300	Refer to Table B.4.3
Adherence Factor (mg/cm^2)	AF	0.2	Refer to Table B.4.3
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table B.4.3
Fraction of Time Exposed (unitless)	FT	5/24	Refer to Table B.4.3
Exposure Frequency (days/year)	EF	130	Refer to Table B.4.3
Exposure Duration (years)	ED	30	Refer to Table B.4.3
Body Weight (kg)	BW	70	Refer to Table B.4.3
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table B.4.3
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.3

TABLE B.7.4

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - GOLF COURSE EMPLOYEE ORAL, DERMAL, AND INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Golf Course Employee TR Adult (µg/g)	Golf Course Employee THQ Adult (µg/g)	Site-Specific Soil Standard SSS_{ss} (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	1.21E+03	NV	3.66E+04	3.66E+04	2.70E-02
SVOCs													
Benzo(a)pyrene	7.30E+00	7.30E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.43E-01	NV	2.43E-01	**1.00E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.02E+06	1.02E+06	2.01E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	1.83E+00	2.95E+02	1.83E+00	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	2.65E+03	1.56E+04	2.65E+03	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	4.42E+04	4.42E+04	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	7.73E+05	7.73E+05	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	8.33E+03	8.33E+03	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	5.86E+04	NV	7.00E+01	7.00E+01	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	8.57E-01	NV	8.57E-01	**4.40E+00**

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table B.2.2.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

Golf Course Employee Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS_{ss}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table B.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table B.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table B.4.3
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table B.4.3
Surface Area Exposed (cm^2/day)	SA	3,300	Refer to Table B.4.4
Adherence Factor (mg/cm^2)	AF	0.2	Refer to Table B.4.4
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table B.4.4
Fraction of Time Exposed (unitless)	FT	8/24	Refer to Table B.4.4
Exposure Frequency (days/year)	EF	217	Refer to Table B.4.4
Exposure Duration (years)	ED	25	Refer to Table B.4.4
Body Weight (kg)	BW	70	Refer to Table B.4.4
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table B.4.4
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.4
Averaging Time - noncarc. (days)	ATnc	9,125	Refer to Table B.4.4
Particulate Emission Factor (m^3/kg)	PEF	5.25E+08	Refer to Table B.4.7
Volatilization Factor (m^3/kg)	VF	chemical-specific	Refer to Table B.4.9

Exposure Equations

Carcinogenic Endpoints:

$$SSS_{ss} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times RAFo)/BW + (CSF \times SA \times AF \times CF \times RAFd)/BW + (URF \times FT \times (1/VF \text{ or } PEF))]}$$

Non-Carcinogenic Endpoints:

$$SSS_{ss} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times RAFo)/BW + ((1/RfD) \times SA \times AF \times CF \times RAFd)/BW + ((1/RfC) \times FT \times (1/VF \text{ or } PEF))]}$$

TABLE B.7.5

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE AND SUBSURFACE SOIL - CONSTRUCTION/UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	CSF oral 1/(mg/kg-d)	CSF dermal 1/(mg/kg-d)	URF inhalation 1/(mg/m^3)	RfD oral (mg/kg-d)	RfD dermal (mg/kg-d)	RfC inhalation (mg/m^3)	Relative Absorption Factor - Oral carc. (%/100)	Relative Absorption Factor - Dermal carc. (%/100)	VF (m^3/kg)	Construction/Utility Worker TR Adult (µg/g)	Construction/Utility Worker THQ Adult (µg/g)	Site-Specific Soil Standard SSS_{soil} (1) (µg/g)	Maximum Soil Concentration (µg/g) (2)
VOCs													
1,2,4-Trichlorobenzene	--	--	--	1.00E-02	1.00E-02	3.50E-03	1.00E+00	3.00E-02	1.02E+04	NV	1.48E+02	1.48E+02	**1.10E+03**
1,4-Dichlorobenzene	2.40E-02	2.40E-02	6.00E-03	3.00E-02	3.00E-02	8.00E-01	1.00E+00	3.00E-02	3.08E+03	1.32E+02	4.76E+03	1.32E+02	**2.00E+03**
Benzene	5.50E-02	5.50E-02	7.70E-03	4.00E-03	4.00E-03	3.00E-02	1.00E+00	5.00E-04	6.33E+02	2.37E+01	7.80E+01	2.37E+01	**4.50E+02**
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	2.05E+02	NV	5.38E+03	5.38E+03	3.40E-02
Methyl cyclohexane	--	--	--	--	--	3.00E+00	1.00E+00	3.00E-02	4.45E+02	NV	5.84E+03	5.84E+03	5.40E-02
Vinyl Chloride	7.50E-01	7.50E-01	4.40E-03	3.00E-03	3.00E-03	1.00E-01	1.00E+00	5.00E-04	2.04E+02	9.52E+00	8.15E+01	9.52E+00	**2.90E+03**
SVOCs													
Benzo(a)pyrene	7.30E+00	7.30E+00	--	--	--	--	1.00E+00	1.30E-01	NA	2.14E+00	NV	2.14E+00	1.00E+00
bis(2-Ethylhexyl)phthalate	1.40E-02	1.40E-02	--	2.00E-02	2.00E-02	--	1.00E+00	1.00E-01	NA	1.19E+03	4.76E+03	1.19E+03	**1.30E+03**
Hexachlorobenzene	1.60E+00	1.60E+00	4.60E-01	8.00E-04	8.00E-04	--	1.00E+00	1.00E-01	4.38E+04	7.68E+00	1.91E+02	7.68E+00	**8.20E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	1.02E+05	1.02E+05	2.27E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	1.29E+01	8.52E+01	1.29E+01	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	7.77E+02	5.64E+02	5.64E+02	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	1.20E+04	1.20E+04	**6.30E+03**
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	2.10E+05	2.10E+05	**1.26E+05**
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	7.39E+01 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	1.08E+03	1.08E+03	**4.20E+03**
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	9.92E+03	NV	1.14E+01	1.14E+01	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	7.62E+00	NV	7.62E+00	4.40E+00

Notes:
-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table B.2.3.
(3) Arithmetic mean lead concentration in Site surface and subsurface soil, as indicated in Table A.3.1 of Appendix A.

Construction/Utility Worker Exposure Assumptions

Site-Specific Standard in Soil (mg/kg)	SSS_{soil}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table B.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table B.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Ingestion Rate (mg/day)	IR	330	Refer to Table B.4.5
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table B.4.5
Surface Area Exposed (cm^2/day)	SA	3,300	Refer to Table B.4.5
Adherence Factor (mg/cm^2)	AF	0.3	Refer to Table B.4.5
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table B.4.5
Fraction of Time Exposed (unitless)	FT	8/24	Refer to Table B.4.5
Exposure Frequency (days/year)	EF	250	Refer to Table B.4.5
Exposure Duration (years)	ED	1	Refer to Table B.4.5
Body Weight (kg)	BW	70	Refer to Table B.4.5
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table B.4.5
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.5
Averaging Time - noncarc. (days)	ATnc	365	Refer to Table B.4.5
Particulate Emission Factor (m^3/kg)	PEF	7.10E+06	Refer to Table B.4.8

TABLE B.7.6

DERIVATION OF RISK-BASED TARGET INDOOR AIR CONCENTRATIONS FOR VOLATILE COPCs FROM SOIL AND GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*URF inhalation 1/(mg/m³)*	*RfC inhalation (mg/m³)*	*Golf Course Employee* *TR Adult (mg/m³)*	*Golf Course Employee* *THQ Adult (mg/m³)*	*Risk-Based Target Indoor Air Concentration (1)* C_{tia} *(1)* *(mg/m³)*	*Risk-Based Target Indoor Air Concentration (1)* C_{tia} *(1)* *(µg/m³)*
VOCs						
1,1-Dichloroethene	--	2.00E-01	NV	1.01E+00	1.01E+00	1.01E+03
1,2,4-Trichlorobenzene	--	3.50E-03	NV	1.77E-02	1.77E-02	1.77E+01
1,2-Dichlorobenzene	--	2.00E-01	NV	1.01E+00	1.01E+00	1.01E+03
1,3-Dichlorobenzene (2)	--	1.05E-01	NV	5.30E-01	5.30E-01	5.30E+02
1,4-Dichlorobenzene	6.00E-03	8.00E-01	2.35E-03	4.04E+00	2.35E-03	2.35E+00
2-Butanone (Methyl Ethyl Ketone)	--	5.00E+00	NV	2.52E+01	2.52E+01	2.52E+04
Acetone (2)	--	3.15E+00	NV	1.59E+01	1.59E+01	1.59E+04
Benzene	7.70E-03	3.00E-02	1.83E-03	1.51E-01	1.83E-03	1.83E+00
Carbon Disulfide	--	7.00E-01	NV	3.53E+00	3.53E+00	3.53E+03
Carbon Tetrachloride	1.50E-02	--	9.42E-04	NV	9.42E-04	9.42E-01
Chlorobenzene	--	5.95E-02	NV	3.00E-01	3.00E-01	3.00E+02
Chloroform	2.30E-02	4.90E-02	6.14E-04	2.47E-01	6.14E-04	6.14E-01
cis-1,2-Dichloroethene (2)	--	3.50E-02	NV	1.77E-01	1.77E-01	1.77E+02
Cyclohexane	--	6.00E+00	NV	3.03E+01	3.03E+01	3.03E+04
Methyl cyclohexane	--	3.00E+00	NV	1.51E+01	1.51E+01	1.51E+04
Methylene chloride	4.70E-04	3.00E+00	3.01E-02	1.51E+01	3.01E-02	3.01E+01
Tetrachloroethene (former)	5.70E-04	3.85E-01	2.48E-02	1.94E+00	2.48E-02	2.48E+01
Tetrachloroethene (current)	6.00E-03	3.50E-02	2.35E-03	1.77E-01	2.35E-03	2.35E+00
Toluene	--	5.00E+00	NV	2.52E+01	2.52E+01	2.52E+04
Trichloroethene (former)	1.70E-03	--	8.31E-03	NV	8.31E-03	8.31E+00
Trichloroethene (current)	1.10E-01	3.50E-02	1.28E-04	1.77E-01	1.28E-04	1.28E-01
Vinyl Chloride	4.40E-03	1.00E-01	3.21E-03	5.05E-01	3.21E-03	3.21E+00
Xylenes (total)	--	1.00E-01	NV	5.05E-01	5.05E-01	5.05E+02
SVOCs						
2-Chlorophenol (2)	--	1.75E-02	NV	8.83E-02	8.83E-02	8.83E+01
2-Methylnaphthalene (2)	--	1.40E-02	NV	7.06E-02	7.06E-02	7.06E+01
Acetophenone (2)	--	3.50E-01	NV	1.77E+00	1.77E+00	1.77E+03
Anthracene (2)	--	1.05E+00	NV	5.30E+00	5.30E+00	5.30E+03
Benzaldehyde (2)	--	3.50E-01	NV	1.77E+00	1.77E+00	1.77E+03
Benzo(b)fluoranthene (2)	2.09E-01	--	6.77E-05	NV	6.77E-05	6.77E-02
Chrysene (2)	2.09E-03	--	6.77E-03	NV	6.77E-03	6.77E+00
Fluoranthene (2)	--	1.40E-01	NV	7.06E-01	7.06E-01	7.06E+02
Hexachlorobenzene	4.60E-01	--	3.07E-05	NV	3.07E-05	3.07E-02
Hexachloroethane	4.00E-03	--	3.53E-03	NV	3.53E-03	3.53E+00
Naphthalene	--	3.00E-03	NV	1.51E-02	1.51E-02	1.51E+01
Nitrobenzene	--	2.00E-03	NV	1.01E-02	1.01E-02	1.01E+01
Phenanthrene	--	3.00E-03	NV	1.51E-02	1.51E-02	1.51E+01
Pyrene (2)	--	1.05E-01	NV	5.30E-01	5.30E-01	5.30E+02
Metals						
Mercury	--	3.00E-04	NV	1.51E-03	1.51E-03	1.51E+00

Notes:

-- = Not Available
N/A = Not Applicable
NV = No Value
(1) The selected Risk-Based Target Indoor Air Concentration is the lower of the carcinogenic-based concentration and the non-carcinogenic based concentration.
(2) Toxicity data based on route to route extrapolation; see oral toxicity data in Tables A.5.1 and A.6.1, with an applied body weight of 70 kg and inhalation rate of 20 m^3/day.

Golf Course Employee Exposure Assumptions

Risk-based Target Indoor Air Concentration (mg/m^3)	C_{tia}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	Refer to Table B.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table B.5.2
Exposure Frequency (days/year)	EF	217	Refer to Table B.4.6
Exposure Duration (years)	ED	25	Refer to Table B.4.6
Fraction of Time Exposed (unitless) - inhalation	FT	8/24	Refer to Table B.4.6
Averaging Time - carc. (days)	ATc	25,550	Refer to Table B.4.6
Averaging Time - noncarc. (days)	ATnc	9,125	Refer to Table B.4.6

Exposure Equations

Carcinogenic Endpoints:

$$C_{tia} = \frac{TR \times ATc}{EF \times FT \times ED \times URF}$$

Non-Carcinogenic Endpoints:

$$C_{tia} = \frac{THQ \times ATnc}{FT \times EF \times ED \times (1/RfC)}$$

TABLE B.7.7

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL BASED ON PROTECTION OF INDOOR AIR QUALITY
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	Chemical Properties (1): Henry's Law Constant, H_L (atm m³/mol)	Chemical Properties (1): Water Diffusion Coefficient, D^{H2O} (cm²/s)	Chemical Properties (1): Air Diffusion Coefficient, D^{air} (cm²/s)	Chemical Properties (1): Organic Carbon Partitioning Coefficient, K_{oc} (mL/g)	Johnson & Ettinger Attenuation Factor, α (2)	Site-Specific Standards for Soil, SSS_{soil}: Target Indoor Air Criteria C_{tia} (µg/m³) (3)	Site-Specific Standards for Soil, SSS_{soil}: Soil Gas Criteria C_{sg} (µg/m³) (4)	Site-Specific Standards for Soil, SSS_{soil}: Concentration Sorbed to Soil Particles, C_{sp} (µg/g) (5)	Site-Specific Standards for Soil, SSS_{soil}: Bulk Soil Concentration/ Site-Specific Soil Criteria SSS_{soil} (µg/g) (6)	Maximum Soil Concentration (µg/g) (7)
VOCs										
1,2,4-Trichlorobenzene	6.55E-04 (15° C)	8.23E-06 (25° C)	2.85E-02 (15° C)	1.78E+03	4.53E-05	1.77E+01	3.90E+05	1.50E+02	1.52E+02	**1.10E+03**
1,2-Dichlorobenzene	9.59E-04 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	6.17E+02	9.27E-05	1.01E+03	1.09E+07	9.94E+02	1.02E+03	**1.10E+03**
1,3-Dichlorobenzene	1.61E-03 (15° C)	7.86E-06 (25° C)	6.57E-02 (15° C)	1.98E+03	9.26E-05	5.30E+02	5.72E+06	9.96E+02	1.00E+03	7.70E+01
1,4-Dichlorobenzene	1.24E-03 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	6.17E+02	9.25E-05	2.35E+00	2.55E+04	1.79E+00	1.84E+00	**2.00E+03**
2-Butanone	3.42E-05 (15° C)	9.80E-06 (25° C)	7.68E-02 (15° C)	2.30E+00	1.34E-04	2.52E+04	1.88E+08	1.79E+03	1.48E+04	3.10E-02
Acetone	2.49E-05 (15° C)	1.14E-05 (25° C)	1.18E-01 (15° C)	5.75E-01	1.86E-04	1.59E+04	8.55E+07	2.80E+02	8.40E+03	1.70E-01
Benzene	3.45E-03 (15° C)	9.80E-06 (25° C)	8.36E-02 (15° C)	5.89E+01	1.13E-04	1.83E+00	1.63E+04	3.94E-02	5.17E-02	**4.50E+02**
Carbon Disulfide	2.05E-02 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	4.57E+01	1.29E-04	3.53E+03	2.75E+07	8.69E+00	1.37E+01	5.00E-03
Chlorobenzene	2.08E-03 (15° C)	8.70E-06 (25° C)	6.94E-02 (15° C)	2.19E+02	9.67E-05	3.00E+02	3.10E+06	4.63E+01	5.00E+01	**5.60E+02**
Chloroform	2.36E-03 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	3.98E+01	1.29E-04	6.14E-01	4.76E+03	1.14E-02	1.65E-02	**8.90E-01**
Cyclohexane	1.22E-01 (15° C)	9.00E-06 (25° C)	7.60E-02 (15° C)	1.60E+02	1.04E-04	3.03E+04	2.91E+08	5.43E+01	7.90E+01	3.40E-02
Methyl cyclohexane	6.24E-02 (15° C)	8.52E-06 (25° C)	6.98E-02 (15° C)	7.85E+01	9.68E-05	1.51E+04	1.56E+08	2.79E+01	4.41E+01	5.40E-02
Methylene chloride	1.45E-03 (15° C)	1.17E-05 (25° C)	9.60E-02 (15° C)	1.17E+01	1.26E-04	3.01E+01	2.38E+05	2.72E-01	6.75E-01	9.50E-02
Tetrachloroethene (former)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.55E+02	9.52E-05	2.48E+01	2.60E+05	5.44E-01	6.20E-01	**1.90E+00**
Tetrachloroethene (current)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	1.55E+02	1.12E-04	2.35E+00	2.11E+04	4.41E-02	5.02E-02	**1.90E+00**
Vinyl Chloride	2.02E-02 (15° C)	1.23E-05 (25° C)	1.01E-01 (15° C)	1.86E+01	1.31E-04	3.21E+00	2.46E+04	3.22E-03	7.72E-03	**2.90E+03**
Xylenes (total)	2.88E-03 (15° C)	9.34E-06 (25° C)	6.78E-02 (15° C)	3.72E+02	9.49E-05	5.05E+02	5.32E+06	9.72E+01	1.02E+02	8.00E-03
SVOCs										
2-Methylnaphthalene	2.00E-04 (15° C)	7.75E-06 (25° C)	4.96E-02 (15° C)	2.81E+03	7.68E-05	7.06E+01	9.20E+05	1.83E+03	1.84E+03	2.30E+00
Acetophenone	4.52E-06 (15° C)	8.73E-06 (25° C)	5.70E-02 (15° C)	5.77E+01	2.42E-04	1.77E+03	7.29E+06	1.32E+04	1.70E+04	1.20E+00
Anthracene	2.23E-05 (15° C)	7.74E-06 (25° C)	3.08E-02 (15° C)	2.97E+04	9.04E-05	5.30E+03	5.86E+07	1.11E+07	1.11E+07	2.10E-01
Benzaldehyde	1.04E-05 (15° C)	9.07E-06 (25° C)	6.85E-02 (15° C)	4.59E+01	1.78E-04	1.77E+03	9.91E+06	6.20E+03	8.45E+03	6.90E-01
Benzo(b)fluoranthene	2.49E-05 (15° C)	5.56E-06 (25° C)	2.15E-02 (15° C)	1.23E+06	6.36E-05	6.77E-02	1.07E+03	7.47E+03	7.47E+03	2.00E+00
Chrysene	2.26E-05 (15° C)	6.21E-06 (25° C)	2.36E-02 (15° C)	3.98E+05	7.27E-05	6.77E+00	9.32E+04	2.32E+05	2.32E+05	9.30E-01
Fluoranthene	4.99E-06 (15° C)	6.35E-06 (25° C)	2.87E-02 (15° C)	1.07E+05	5.30E-05	7.06E+02	1.33E+07	4.06E+07	4.06E+07	1.50E+00
Hexachlorobenzene	4.09E-04 (15° C)	5.91E-06 (25° C)	5.15E-02 (15° C)	5.50E+04	1.78E-04	3.07E-02	1.73E+02	3.30E+00	3.30E+00	**8.20E+00**
Naphthalene	2.27E-04 (15° C)	7.50E-06 (25° C)	5.61E-02 (15° C)	2.00E+03	7.63E-05	1.51E+01	1.98E+05	2.48E+02	2.50E+02	5.70E-01
Nitrobenzene	1.10E-05 (15° C)	8.60E-06 (25° C)	7.22E-02 (15° C)	6.46E+01	8.42E-05	1.01E+01	1.20E+05	1.00E+02	1.26E+02	9.60E+00
Phenanthrene	4.24E-06 (15° C)	7.47E-06 (25° C)	3.16E-02 (15° C)	2.95E+04	1.74E-04	1.51E+01	8.68E+04	8.57E+04	8.58E+04	1.10E+00
Pyrene	3.28E-06 (15° C)	7.24E-06 (25° C)	2.58E-02 (15° C)	1.05E+05	2.40E-04	5.30E+02	2.21E+06	1.00E+07	1.00E+07	1.60E+00
Metals										
Mercury (8)	4.38E-03 (15° C)	6.30E-06 (25° C)	2.92E-02 (15° C)	8.20E+01	4.47E-05	1.51E+00	3.38E+04	1.50E+01	1.50E+01	**9.13E+03**

TABLE B.7.7

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL BASED ON PROTECTION OF INDOOR AIR QUALITY
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Notes:

NV = No Value due to lack of toxicity data

Maximum detected concentration exceeds the SSS

(1) The applied chemical properties are obtained from the chemical properties database implemented in USEPA (2004). The Henry's Law constant and air diffusion coefficient were corrected for an average vadose zone temperature of 15°C. The reference temperature for the water diffusion coefficient is 25°C and, considering its low value, a correction to 15°C was considered negligible.

(2) The soil gas attenuation factor α is based on the solution for soil gas migration to building indoor air presented in Johnson and Ettinger [1991; Equation (21)], the vadose zone and building properties listed below, and the default pressure difference of 4 Pa between the vadose zone and the building (ΔP) as applied by USEPA (2002). The calculation of the soil gas attenuation factor was conducted using the Excel spreadsheet "SL-ADV-Feb04.xls" developed by USEPA (2004) and the following Site-specific vadose zone and building properties.

Vadose Zone Soil Properties:		
Moisture Content, θ_m (%)	10	Conservatively assumed moisture content value for a low lying sand soil.
Total Porosity, ε_T (%)	27.5	Average porosity value for sand soil type after Fetter (2001; Table 3.4).
Moisture-Filled Porosity, ε_m	0.166	Moisture-filled porosity, $\varepsilon_m = \theta_m /100*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at 15°C.
Vapor-Filled Porosity, ε_v	0.109	Vapor-filled porosity, $\varepsilon_v = \varepsilon_T / 100 - \varepsilon_m$
Dry Bulk Soil Density, ρ_{db} (g/cm³)	1.66	Default dry bulk density for sand soils, as presented in USEPA (2004).
Hydraulic Conductivity, K (cm/s)	1.00E-02	The average hydraulic conductivity of a sand soil as indicated in Fetter (2001).
Intrinsic Permeability, k_i (cm²)	1.16E-07	Intrinsic permeability, k_i=K μ_w / ρ_w g, where water density, ρ_w=999.099 kg/m^3 at 15°C, gravitational acceleration g=9.81 m/s^2, and the dynamic viscosity of water, μ_w=1.14e-3 kg/ms at 15°C (Fetter, 2001).
Relative Vapor Permeability, k_r (cm²)	0.369	Estimated after Parker et al. (1987) for a sand soil type as implemented in USEPA (2004) to account for the reduction in permeability due to the degree of vadose zone water saturation.
Effective Vapor Permeability, k_v (cm²)	4.29E-08	Determined from k_v=k_r*k_i.
Vadose Zone Temperature (°C)	15	Average measured groundwater temperature across the Site.
Fraction of Organic Carbon Content, f_{oc}	6.00E-03	Default fraction of organic carbon content, as presented in USEPA (2002c).
Distance from Source to Building, L_T (m)	0.83	Determined from average depth to volatile impacts in soil measured across the Site of 3.2 ft (0.98 m), less a 0.5 ft (0.15 m) floor slab thickness.
Vapor Viscosity of Air, μ_a at 15°C (g/cm s)	1.77E-04	Vadose zone temperature corrected vapor viscosity as implemented in USEPA (2004).
Building Properties:		
Below-Grade Area of Building Surfaces, A_B (m²)	100	Based on a 10 m by 10 m building with slab-on-grade construction [consistent with the typical or mean dimensions for a house applied in USEPA (2002b; Appendix G, Table G-3)].
Building Volume, V_B (m^3)	300	Based on a 10 m by 10 m building with an assumed ceiling height of 3 m.
Building Air Exchange Rate, T_{air} (1/hr)	0.83	Industrial indoor air exchange rate after Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, ASTM Designation: E1739-95 (ASTM, 1995).
Ratio of Crack Area to Below-Grade Area, η (%)	0.038	Default crack ratio value for slab-on-grade structures presented in USEPA (2002b; Appendix G).
Foundation Thickness, L_{crack} (cm)	15	Assumed based on a 15 cm (6 inch) floor slab thickness.

(3) Target indoor air criteria obtained from Table B.7.6.

(4) The Site-specific soil gas criteria beneath a Site building is calculated from C_{sg}=C_{tia} / α.

(5) Concentration sorbed to soil particles determined from the corresponding soil gas concentration assuming equilibrium conditions between the gas, aqueous, and sorbed phases using C_{sp}=C_{sg}*K_d/H where the Henry's Law Constant H=H_L/(T*R), T is the vadose temperature in degrees Kelvin, the universal gas constant R is 8.21E-05 atm m^3/mol K, and K_d=K_{oc}*f_{oc}.

(6) Bulk soil concentration comprised of the gas, aqueous, and sorbed phases determined from corresponding C_{sp} using phase relationships as follows: SSS_{soil}=C_{sp}/ρ_{db}*(ε_m/K_d+Hε_v/K_d+ρ_{db}) where ε_m and ε_v are the moisture and vapor filled porosities, respectively, and K_d=K_{oc}*f_{oc}.

(7) Soil concentration is the maximum detected concentration obtained from Table B.2.4.

(8) The reported K_{oc} value for mercury is in fact a K_d value obtained from USEPA (2002c), based on a pH of 7. All calculations account for this K_d value.

TABLE B.7.8

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER BASED ON PROTECTION OF INDOOR AIR QUALITY
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

					Site-Specific Standards for Groundwater, SSS_{gw}			
	Chemical Properties (1)			*Johnson & Ettinger Attenuation Factor, α (2)*	*Target Indoor Air Criteria C_{tia} (µg/m³) (3)*	*Soil Gas Criteria C_{sg} (µg/m³) (4)*	*Site-Specific Groundwater Standard SSS_{gw} (µg/L) (5)*	*Maximum Groundwater Concentration (µg/L) (6)*
Chemical of Potential Concern (COPC)	*Henry's Law Constant, H_L (atm m³/mol)*	*Water Diffusion Coefficient, D^{H2O} (cm²/s)*	*Air Diffusion Coefficient, D^{air} (cm²/s)*					
VOCs								
1,1-Dichloroethene	1.79E-02 (15° C)	1.04E-05 (25° C)	8.55E-02 (15° C)	3.67E-06	1.01E+03	2.75E+08	3.62E+05	4.10E+01
1,2,4-Trichlorobenzene	6.55E-04 (15° C)	8.23E-06 (25° C)	2.85E-02 (15° C)	6.64E-06	1.77E+01	2.66E+06	9.59E+04	4.20E+03
1,2-Dichlorobenzene	9.59E-04 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	1.04E-05	1.01E+03	9.70E+07	2.39E+06	2.50E+04
1,3-Dichlorobenzene	1.61E-03 (15° C)	7.86E-06 (25° C)	6.57E-02 (15° C)	8.31E-06	5.30E+02	6.37E+07	9.34E+05	2.50E+03
1,4-Dichlorobenzene	1.24E-03 (15° C)	7.90E-06 (25° C)	6.56E-02 (15° C)	9.35E-06	2.35E+00	2.52E+05	4.79E+03	**4.50E+04**
Benzene	3.45E-03 (15° C)	9.80E-06 (25° C)	8.36E-02 (15° C)	7.16E-06	1.83E+00	2.56E+05	1.75E+03	**9.80E+04**
Carbon tetrachloride	1.92E-02 (15° C)	8.80E-06 (25° C)	7.41E-02 (15° C)	3.10E-06	9.42E-01	3.04E+05	3.74E+02	**6.00E+02**
Chlorobenzene	2.08E-03 (15° C)	8.70E-06 (25° C)	6.94E-02 (15° C)	7.93E-06	3.00E+02	3.78E+07	4.29E+05	2.30E+05
Chloroform	2.36E-03 (15° C)	1.00E-05 (25° C)	9.88E-02 (15° C)	9.51E-06	6.14E-01	6.46E+04	6.47E+02	1.50E+02
cis-1,2-Dichloroethene	2.59E-03 (15° C)	1.13E-05 (25° C)	6.99E-02 (15° C)	8.13E-06	1.77E+02	2.17E+07	1.98E+05	2.40E+01
Cyclohexane	1.22E-01 (15° C)	9.00E-06 (25° C)	7.60E-02 (15° C)	2.37E-06	3.03E+04	1.28E+10	2.48E+06	1.70E+02
Methylene chloride	1.45E-03 (15° C)	1.17E-05 (25° C)	9.60E-02 (15° C)	1.28E-05	3.01E+01	2.36E+06	3.84E+04	7.90E+03
Tetrachloroethene (former)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	3.53E-06	2.48E+01	7.02E+06	1.58E+04	3.70E+02
Tetrachloroethene (current)	1.05E-02 (15° C)	8.20E-06 (25° C)	6.84E-02 (15° C)	3.53E-06	2.35E+00	6.67E+05	1.50E+03	3.70E+02
Toluene	3.89E-03 (15° C)	8.60E-06 (25° C)	8.27E-02 (15° C)	6.28E-06	2.52E+04	4.01E+09	2.44E+07	2.00E+02
Trichloroethene (former)	6.25E-03 (15° C)	9.10E-06 (25° C)	7.51E-02 (15° C)	4.89E-06	8.31E+00	1.70E+06	6.44E+03	1.60E+01
Trichloroethene (current)	6.25E-03 (15° C)	9.10E-06 (25° C)	7.51E-02 (15° C)	4.89E-06	1.28E-01	2.63E+04	9.95E+01	1.60E+01
Vinyl chloride	2.02E-02 (15° C)	1.23E-05 (25° C)	1.01E-01 (15° C)	4.18E-06	3.21E+00	7.68E+05	9.00E+02	**4.00E+03**
SVOCs								
2-Chlorophenol	1.97E-04 (15° C)	9.46E-06 (25° C)	4.76E-02 (15° C)	1.29E-05	8.83E+01	6.86E+06	8.24E+05	3.40E+02
Hexachloroethane	1.96E-03 (15° C)	6.80E-06 (25° C)	2.38E-03 (15° C)	7.00E-07	3.53E+00	5.05E+06	6.07E+04	2.80E+01
Naphthalene	2.27E-04 (15° C)	7.50E-06 (25° C)	5.61E-02 (15° C)	1.37E-05	1.51E+01	1.10E+06	1.15E+05	4.10E+01
Metals								
Mercury	4.38E-03 (15° C)	6.30E-06 (25° C)	2.92E-02 (15° C)	3.05E-06	1.51E+00	4.97E+05	2.68E+03	3.09E+02

TABLE B.7.8

CALCULATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER BASED ON PROTECTION OF INDOOR AIR QUALITY

RECREATIONAL LAND USE SCENARIO

OXYCHEM

DELAWARE CITY, DELAWARE

Notes:

NV = No Value due to lack of toxicity data

Maximum detected concentration exceeds the SSSs

(1) The applied chemical properties are obtained from the chemical properties database implemented in USEPA (2004). The Henry's Law constant and air diffusion coefficient were corrected for an average vadose zone temperature of 15°C. The reference temperature for the water diffusion coefficient is 25°C and, considering its low value, a correction to 15°C was considered negligible.

(2) The soil gas attenuation factor α is based on the solution for soil gas migration to building indoor air presented in Johnson and Ettinger [1991; Equation (21)], the vadose zone and building properties listed below, and the default pressure difference of 4 Pa between the vadose zone and the building (ΔP) as applied by USEPA (2002). The calculation of the soil gas attenuation factor was conducted using the Excel spreadsheet "GW-ADV-Feb04.xls" developed by USEPA (2004) and the following Site-specific vadose zone and building properties.

Vadose Zone Soil Properties:		
Moisture Content, θ_m (%)	10	Conservatively assumed moisture content value for a low lying sand soil.
Total Porosity, ε_T (%)	27.5	Average porosity value for sand soil type after Fetter (2001; Table 3.4).
Moisture-Filled Porosity, ε_m	0.166	Moisture-filled porosity, $\varepsilon_m = \theta_m /100*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at 15°C.
Vapor-Filled Porosity, ε_v	0.109	Vapor-filled porosity, $\varepsilon_v = \varepsilon_T / 100 - \varepsilon_m$
Dry Bulk Soil Density, ρ_{db} (g/cm³)	1.66	Default dry bulk density for sand soils, as presented in USEPA (2004).
Hydraulic Conductivity, K (cm/s)	1.00E-02	The average hydraulic conductivity of a sand soil as indicated in Fetter (2001).
Intrinsic Permeability, k_i (cm²)	1.16E-07	Intrinsic permeability, k_i=K μ_w / ρ_w g, where water density, ρ_w=999.099 kg/m^3 at 15°C, gravitational acceleration g=9.81 m/s^2, and the dynamic viscosity of water, μ_w=1.14e-3 kg/ms at 15°C (Fetter, 2001).
Relative Vapor Permeability, k_r (cm²)	0.369	Estimated after Parker et al. (1987) for a sand soil type as implemented in USEPA (2004) to account for the reduction in permeability due to the degree of vadose zone water saturation.
Effective Vapor Permeability, k_v (cm²)	4.29E-08	Determined from k_v=k_r*k_i.
Vadose Zone Temperature (°C)	15	Average measured groundwater temperature across the Site.
Distance from Source to Building, L_T (m)	4.42	Determined from the approximate depth to groundwater measured across the Site in 2006 of 15 ft (4.57 m) less a 0.5 ft (0.15 m) floor slab thickness.
Vapor Viscosity of Air, μ_a at 15°C (g/cm s)	1.77E-04	Vadose zone temperature corrected vapor viscosity as implemented in USEPA (2004).
Building Properties:		
Below-Grade Area of Building Surfaces, A_B (m²)	100	Based on a 10 m by 10 m building with slab-on-grade construction [consistent with the typical or mean dimensions for a house applied in USEPA (2002b; Appendix G, Table G-3)].
Building Volume, V_B (m^3)	300	Based on a 10 m by 10 m building with an assumed ceiling height of 3 m.
Building Air Exchange Rate, T_{air} (1/hr)	0.83	Industrial indoor air exchange rate after Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, ASTM Designation: E1739-95 (ASTM, 1995).
Ratio of Crack Area to Below-Grade Area, η (%)	0.038	Default crack ratio value for slab-on-grade structures presented in USEPA (2002b; Appendix G).
Foundation Thickness, L_{crack} (cm)	15	Assumed based on a 15 cm (6 inch) floor slab thickness.

(3) Target indoor air criteria obtained from Table B.7.6.

(4) The Site-specific soil gas criteria beneath a Site building is calculated from C_{sg}=C_{tia} / α.

(5) The Site-specific standard for groundwater was determined from the soil gas criteria assuming equilibrium conditions and Henry's Law; SSS_{gw}=C_{sg}*(T*R)/H_L where T is the vadose temperature in degrees Kelvin and the universal gas constant R is 8.206E-05 atm m^3/mol K.

(6) Groundwater concentration is the maximum detected concentration obtained from Table B.2.5.

TABLE B.7.9

DERIVATION OF SITE SPECIFIC STANDARD (SSS) FOR LEAD IN SOILS FOR THE FUTURE ADULT GOLFER, FUTURE GOLF COURSE EMPLOYEE, AND FUTURE CONSTRUCTION/UTILITY WORKER RECREATIONAL LAND USE SCENARIO OXYCHEM DELAWARE CITY, DELAWARE

Model Parameters	*Symbol*	*Units*	*Future Adult Golfer*	*Future Golf Course Employee*	*Future Construction/Utility Worker*	*Reference*
95th Percentile PbB in fetus	$PbB_{fetal,0.95}$	µg/dL	10	10	10	(1)
R (Mean ratio of fetal to maternal PbB)	$R_{fetal/maternal}$	unitless	0.9	0.9	0.9	(1)
Individual geometric standard deviation	GSD_i	unitless	2.11	2.11	2.11	(2)
Baseline blood lead value	$PbB_{adult,0}$	µg/dL	1.53	1.53	1.53	(2)
Biokinetic slope factor	BKSF	µg/dL per µg/day	0.4	0.4	0.4	(1)
Soil ingestion rate	IR_S	g/day	0.1	0.1	0.33	(3)
Soil Exposure Frequency	EF_S	days/yr	130	217	250	Scenario Specific
Absolute absorption fraction of lead in soil	AF_S	unitless	0.12	0.12	0.12	(1)
Averaging time	AT	days/yr	365	365	365	(1)

	Formula				Units
$PbB_{adult, central goal}$	$PbB_{adult, central goal} = PbB_{fetal,0.95} / (R_{fetal/maternal} \times GSD_i^{1.645})$	**3.25**	**3.25**	**3.25**	(µg/dL)
Risk-Based Site-Specific Standard (SSS)	$SSS = \frac{(PbB_{adult, central goal} - PbB_{adult, 0}) \times AT}{(BKSF \times IR_S \times AF_S \times EF_S)}$	1008	604	159	(µg/g)

Notes:

(1) USEPA, 2003:Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January 2003.

(2) USEPA, 2002. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phase 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). Office of Solid Waste and Emergency Response. OSWER #9285.7-52, March 2002.

(3) USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

TABLE B.8.1

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway (1) (Table Reference) Human Health Based SSSs (mg/kg)*				*Proposed SSSs*		
	1 (see Table B.7.1)	*2 (see Table B.7.2)*	*3 (see Table B.7.3)*	*4 (see Table B.7.4)*	*Minimum Calculated SSS Value (2) (mg/kg)*	*Basis*	*Maximum Detected Concentration (3) (mg/kg)*
Volatile Organic Compounds (VOCs)							
1,2,4-Trichlorobenzene	5.73E+03	3.43E+03	2.62E+03	NA	2.62E+03	Adult Golfer	1.30E+02
1,4-Dichlorobenzene	2.60E+02	1.96E+02	6.75E+01	NA	6.75E+01	Adult Golfer	1.00E+02
Cyclohexane	3.91E+05	1.62E+05	1.07E+05	3.66E+04	3.66E+04	Golf Course Employee	2.70E-02
Semi-Volatile Organic Compounds (SVOCs)							
Benzo(a)anthracene	2.42E+00	2.86E+00	3.38E+00	NA	2.42E+00	Child Soccer Player	8.30E-01
Benzo(a)pyrene	2.42E-01	2.86E-01	3.38E-01	2.43E-01	2.42E-01	Child Soccer Player	1.00E+00
Benzo(b)fluoranthene	2.42E+00	2.86E+00	3.38E+00	NA	2.42E+00	Child Soccer Player	2.00E+00
Hexachlorobenzene	3.25E+00	3.73E+00	1.43E+00	NA	1.43E+00	Adult Golfer	6.20E-01
Indeno(1,2,3-cd)pyrene	2.42E+00	2.86E+00	3.38E+00	NA	2.42E+00	Child Soccer Player	4.50E-01
Metals							
Aluminum	1.25E+06	1.30E+06	1.75E+06	1.02E+06	1.02E+06	Golf Course Employee	2.01E+04
Antimony	2.78E+02	3.42E+02	3.39E+02	NA	2.78E+02	Child Soccer Player	1.04E+01
Arsenic	4.90E+00	5.29E+00	2.55E+00	1.83E+00	1.83E+00	Golf Course Employee	1.10E+02
Beryllium	3.58E+02	5.22E+02	3.76E+02	NA	3.58E+02	Child Soccer Player	6.93E+01
Cobalt	2.43E+04	2.46E+04	5.90E+03	2.65E+03	2.65E+03	Golf Course Employee	1.82E+02
Copper	5.01E+04	5.28E+04	7.37E+04	4.42E+04	4.42E+04	Golf Course Employee	6.30E+03
Iron	8.77E+05	9.24E+05	1.29E+06	7.73E+05	7.73E+05	Golf Course Employee	1.26E+05
Lead	NV	NV	1.01E+03	6.04E+02	6.04E+02	Golf Course Employee (4)	1.06E+02 (5)
Manganese	1.24E+04	1.54E+04	1.42E+04	8.33E+03	8.33E+03	Golf Course Employee	4.20E+03
Mercury	2.69E+02	1.97E+02	1.77E+02	7.00E+01	7.00E+01	Golf Course Employee	9.13E+03
Nickel	1.24E+04	1.57E+04	1.48E+04	NA	1.24E+04	Child Soccer Player	6.74E+02
Thallium	8.77E+01	9.24E+01	1.29E+02	NA	8.77E+01	Child Soccer Player	7.20E-01
Vanadium	4.85E+02	6.38E+02	5.55E+02	NA	4.85E+02	Child Soccer Player	4.50E+01
Zinc	3.76E+05	3.96E+05	5.53E+05	NA	3.76E+05	Child Soccer Player	2.88E+04

TABLE B.8.1

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway (1) (Table Reference) Human Health Based SSSs (mg/kg)*				*Proposed SSSs*		
	1 (see Table B.7.1)	*2 (see Table B.7.2)*	*3 (see Table B.7.3)*	*4 (see Table B.7.4)*	*Minimum Calculated SSS Value (2) (mg/kg)*	*Basis*	*Maximum Detected Concentration (3) (mg/kg)*
PCBs							
Aroclor-1260	2.57E+00	3.06E+00	1.19E+00	8.57E-01	8.57E-01	Golf Course Employee	4.40E+00

Notes:

NA Not applicable.

[ ] Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

Receptor	***Medium***	***Pathway***
1 Child Soccer Player	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
2 Child Golfer	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
3 Adult Golfer	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
4 Golf Course Employee	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)

(2) Minimum calculated SSS value is the lowest of the calculated human health based SSS.

(3) See Table B.2.1 and/or Table B.2.2 for surface soil maximum detected concentrations.

(4) See Table B.7.9 for derivation of lead SSS.

TABLE B.8.2

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)			*Proposed SSSs*		
SOIL (mg/kg)	*5* *(see Table B.7.5)*	*6* *(see Table B.7.7)*	*Minimum Calculated SSS Value* [2] *(mg/kg)*	*Basis*	*Maximum Detected Concentration* [3] *(mg/kg)*
Volatile Organic Compounds (VOCs)					
1,2,4-Trichlorobenzene	1.48E+02	1.52E+02	1.48E+02	Construction/ Utility Worker	1.10E+03
1,2-Dichlorobenzene	NA	1.02E+03	1.02E+03	Indoor Air	1.10E+03
1,3-Dichlorobenzene	NA	1.00E+03	1.00E+03	Indoor Air	7.70E+01
1,4-Dichlorobenzene	1.32E+02	1.84E+00	1.84E+00	Indoor Air	2.00E+03
2-Butanone	NA	1.48E+04	1.48E+04	Indoor Air	3.10E-02
Acetone	NA	8.40E+03	8.40E+03	Indoor Air	1.70E-01
Benzene	2.37E+01	5.17E-02	5.17E-02	Indoor Air	4.50E+02
Carbon Disulfide	NA	1.37E+01	1.37E+01	Indoor Air	5.00E-03
Chlorobenzene	NA	5.00E+01	5.00E+01	Indoor Air	5.60E+02
Chloroform (Trichloromethane)	NA	1.65E-02	1.65E-02	Indoor Air	8.90E-01
Cyclohexane	5.38E+03	7.90E+01	7.90E+01	Indoor Air	3.40E-02
Methyl cyclohexane	5.84E+03	4.41E+01	4.41E+01	Indoor Air	5.40E-02
Methylene chloride	NA	6.75E-01	6.75E-01	Indoor Air	9.50E-02
Tetrachloroethene (former)	NA	6.20E-01	6.20E-01	Indoor Air	1.90E+00
Tetrachloroethene (current)	NA	5.02E-02	5.02E-02	Indoor Air	1.90E+00
Vinyl Chloride	9.52E+00	7.72E-03	7.72E-03	Indoor Air	2.90E+03
Xylenes (total)	NA	1.02E+02	1.02E+02	Indoor Air	8.00E-03
Semi-Volatile Organic Compounds (SVOCs)					
2-Methylnaphthalene	NA	1.84E+03	1.84E+03	Indoor Air	2.30E+00
Acetophenone	NA	1.70E+04	1.70E+04	Indoor Air	1.20E+00
Anthracene	NA	1.11E+07	1.11E+07	Indoor Air	2.10E-01
Benzaldehyde	NA	8.45E+03	8.45E+03	Indoor Air	6.90E-01
Benzo(a)pyrene	2.14E+00	NA	2.14E+00	Construction/ Utility Worker	1.00E+00
Benzo(b)fluoranthene	NA	7.47E+03	7.47E+03	Indoor Air	2.00E+00
Bis(2-ethylhexyl)phthalate	1.19E+03	NA	1.19E+03	Construction/ Utility Worker	1.30E+03
Chrysene	NA	2.32E+05	2.32E+05	Indoor Air	9.30E-01
Fluoranthene	NA	4.06E+07	4.06E+07	Indoor Air	1.50E+00
Hexachlorobenzene	7.68E+00	3.30E+00	3.30E+00	Construction/ Utility Worker	8.20E+00
Naphthalene	NA	2.50E+02	2.50E+02	Indoor Air	5.70E-01
Nitrobenzene	NA	1.26E+02	1.26E+02	Indoor Air	9.60E+00
Phenanthrene	NA	8.58E+04	8.58E+04	Indoor Air	1.10E+00
Pyrene	NA	1.00E+07	1.00E+07	Indoor Air	1.60E+00

TABLE B.8.2

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SOIL
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)			*Proposed SSSs*		
SOIL (mg/kg)	*5* *(see Table B.7.5)*	*6* *(see Table B.7.7)*	*Minimum Calculated SSS Value* [2] *(mg/kg)*	*Basis*	*Maximum Detected Concentration* [3] *(mg/kg)*
Metals					
Aluminum	1.02E+05	NA	1.02E+05	Construction/ Utility Worker	2.27E+04
Arsenic	1.29E+01	NA	1.29E+01	Construction/ Utility Worker	1.10E+02
Cobalt	5.64E+02	NA	5.64E+02	Construction/ Utility Worker	1.82E+02
Copper	1.20E+04	NA	1.20E+04	Construction/ Utility Worker	6.30E+03
Iron	2.10E+05	NA	2.10E+05	Construction/ Utility Worker	1.26E+05
Lead	1.59E+02	NA	1.59E+02	Construction/ Utility Worker [4]	7.39E+01 [5]
Manganese	1.08E+03	NA	1.08E+03	Construction/ Utility Worker	4.20E+03
Mercury	1.14E+01	1.50E+01	1.14E+01	Construction/ Utility Worker	9.13E+03
PCBs					
Aroclor-1260	7.62E+00	NA	7.62E+00	Construction/ Utility Worker	4.40E+00

Notes:

NA Not applicable.

Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

	Receptor	***Medium***	***Pathway***
1	Construction/Utility Worker	Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate)
2	Golf Course Employee	Soil (indoor air)	Direct Contact (inhalation of vapors)

(2) Minimum calculated SSS value is the lowest of the calculated human health based SSS.

(3) See Table B.2.3 and/or Table B.2.4 for soil maximum detected concentrations.

(4) See Table B.7.9 for derivation of lead SSS.

TABLE B.8.3

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) GROUNDWATER (µg/L)	*Calculated SSSs Per Exposure Pathway* [1] *(Table Reference) Human Health Based SSSs (µg/L) 1 (see Table B.7.8)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(µg/L)*	*Basis*	*Maximum Detected Concentration* [3] *(µg/L)*
Volatile Organic Compounds (VOCs)				
1,1-Dichloroethene	3.62E+05	3.62E+05	Indoor Air	4.10E+01
1,2,4-Trichlorobenzene	9.59E+04	9.59E+04	Indoor Air	4.20E+03
1,2-Dichlorobenzene	2.39E+06	2.39E+06	Indoor Air	2.50E+04
1,3-Dichlorobenzene	9.34E+05	9.34E+05	Indoor Air	2.50E+03
1,4-Dichlorobenzene	4.79E+03	4.79E+03	Indoor Air	4.50E+04
Benzene	1.75E+03	1.75E+03	Indoor Air	9.80E+04
Carbon tetrachloride	3.74E+02	3.74E+02	Indoor Air	6.00E+02
Chlorobenzene	4.29E+05	4.29E+05	Indoor Air	2.30E+05
Chloroform	6.47E+02	6.47E+02	Indoor Air	1.50E+02
cis-1,2-Dichloroethene	1.98E+05	1.98E+05	Indoor Air	2.40E+01
Cyclohexane	2.48E+06	2.48E+06	Indoor Air	1.70E+02
Methylene chloride	3.84E+04	3.84E+04	Indoor Air	7.90E+03
Tetrachloroethene (former)	1.58E+04	1.58E+04	Indoor Air	3.70E+02
Tetrachloroethene (current)	1.50E+03	1.50E+03	Indoor Air	3.70E+02
Toluene	2.44E+07	2.44E+07	Indoor Air	2.00E+02
Trichloroethene (former)	6.44E+03	6.44E+03	Indoor Air	1.60E+01
Trichloroethene (current)	9.95E+01	9.95E+01	Indoor Air	1.60E+01
Vinyl chloride	9.00E+02	9.00E+02	Indoor Air	4.00E+03
Semi-Volatile Organic Compounds (SVOCs)				
2-Chlorophenol	8.24E+05	8.24E+05	Indoor Air	3.40E+02
Hexachloroethane	6.07E+04	6.07E+04	Indoor Air	2.80E+01
Naphthalene	1.15E+05	1.15E+05	Indoor Air	4.10E+01

TABLE B.8.3

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR GROUNDWATER
RECREATIONAL LAND USE SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) GROUNDWATER (µg/L)	*Calculated SSSs Per Exposure Pathway* [1] *(Table Reference)* *Human Health Based SSSs (µg/L)* *1* *(see Table B.7.8)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(µg/L)*	*Basis*	*Maximum Detected Concentration* [3] *(µg/L)*
Metals				
Mercury	2.68E+03	2.68E+03	Indoor Air	3.09E+02

Notes:

Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

Receptor	***Pathway***
1 Golf Course Employee	Indoor Air (inhalation of vapors)

(2) Minimum calculated SSS value is the lowest calculated human health based SSS.

(3) See Table B.2.5 for groundwater maximum detected concentrations.

APPENDIX C

EXPOSURE ASSUMPTIONS FOR THE DEVELOPMENT OF SITE-SPECIFIC STANDARDS – VACANT (LAWN MAINTENANCE ONLY)

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(Following Text)

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TABLE C.8.1 SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE, VACANT (LAWN MAINTENANCE ONLY) SCENARIO

TABLE C.1.1

SELECTION OF EXPOSURE PATHWAY SCENARIOS,
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe	*Medium*	*Exposure Medium*	*Exposure Point*	*Receptor Population*	*Receptor Age*	*Exposure Route*	*Type of Analysis*	*Rationale for Selection or Exclusion of Exposure Pathway*
Future:	Surface Soil (0 to 2 ft bgs)	Surface Soil	Direct Contact	Trespasser	Adolescent	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while trespassing.
		Ambient Air	Direct Contact	Trespasser	Adolescent	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while trespassing.
		Surface Soil	Direct Contact	Lawn Maintenance Staff	Adult	Ingestion Dermal	Quant	Potential exposure to contaminated surface soil while working outside.
		Ambient Air	Direct Contact	Lawn Maintenance Staff	Adult	Inhalation of Particulates/ Vapors	Quant	Potential exposure to ambient air while working outside.
	Groundwater	Ambient Air	Direct Contact	Trespasser	Adolescent	Inhalation of Vapors	Qual	Potential exposure to ambient air while trespassing.
			Direct Contact	Lawn Maintenance Staff	Adult	Inhalation of Vapors	Qual	Potential exposure to ambient air while working outside.

TABLE C.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Volatile Organic Compounds															
120-82-1	1,2,4-Trichlorobenzene	0.003	K	130		mg/kg	SB-13; SC Pipeline Area; 0-2 ftbgs (08/18/98)	26/65	0.0008 - 2.7	130	1000	N	N/A	N/A		BSC
95-50-1	1,2-Dichlorobenzene	0.0066		79		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	25/65	0.0009 - 2.7	79	9200	N	N/A	N/A		BSC
107-06-2	1,2-Dichloroethane	0.11	J	0.11	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.11	31	C	N/A	N/A		BSC
541-73-1	1,3-Dichlorobenzene	0.0062		5.2		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	13/65	0.0008 - 2.7	5.2	310	N	N/A	N/A		BSC
106-46-7	1,4-Dichlorobenzene	0.0011	B	100		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	26/65	0.0009 - 2.7	100	120	C	N/A	N/A		BSC
78-93-3	2-Butanone (Methyl Ethyl Ketone)	0.002	J	0.022	J	mg/kg	SCPX-01-10; SC Pipeline Area; 1 ftbgs (05/18/04)	15/45	0.0009 - 2.7	0.022	61000	N	N/A	N/A		BSC
67-64-1	Acetone	0.007	B	0.17	K	mg/kg	SB-13-8; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	30/45	0.006 - 2.7	0.17	92000	N	N/A	N/A		BSC
71-43-2	Benzene	0.0011		1.3	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	9/51	0.0008 - 2.7	1.3	52	C	N/A	N/A		BSC
75-25-2	Bromoform	0.001		0.001		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.001	360	C	N/A	N/A		BSC
74-83-9	Bromomethane (Methyl Bromide)	0.27		0.27		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	1/41	0.0008 - 2.7	0.27	140	N	N/A	N/A		BSC
75-15-0	Carbon disulfide	0.002	J	0.0026	J	mg/kg	SCPX-04-10; SC Pipeline Area; 1 ftbgs (05/18/04)	2/35	0.0008 - 2.7	0.0026	10000	N	N/A	N/A		BSC
108-90-7	Chlorobenzene	0.001	J	38		mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	18/51	0.0009 - 2.7	38	2000	N	N/A	N/A		BSC
67-66-3	Chloroform (Trichloromethane)	0.017	K	0.017	K	mg/kg	SCPX-04-14; SC Pipline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.017	1000	N	N/A	N/A		BSC
110-82-7	Cyclohexane	0.0052		0.027	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	2/34	0.0008 - 2.7	0.027	--	N	N/A	N/A	X	AD
108-87-2	Methyl cyclohexane	0.016	K	0.016	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/34	0.0008 - 2.7	0.016	--	N	N/A	N/A		LDF
75-09-2	Methylene chloride	0.001	B	0.095		mg/kg	SB-13-2; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	33/51	0.001 - .7	0.095	380	C	N/A	N/A		BSC
127-18-4	Tetrachloroethene	0.004	J	0.012	J	mg/kg	WB-18; Waste Lake 2; 0-2 ftbgs (08/18/98)	12/51	0.0008 - 2.7	0.012	5.3	C	N/A	N/A		BSC
108-88-3	Toluene	0.007	J	0.007	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.007	8200	N	N/A	N/A		BSC
75-01-4	Vinyl chloride	0.0045	J	0.0045	K	mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.0008 - 2.7	0.0045	4	C	N/A	N/A		LDF
	Semi-volatile Organic Compounds															
120-83-2	2,4-Dichlorophenol	0.45		0.45		mg/kg	A-62S; SC Pipeline Area (11/18/04)	1/51	0.35 - 0.47	0.45	310	N	N/A	N/A		BSC
91-57-6	2-Methylnaphthalene	0.072	J	0.15	J	mg/kg	FLD-32; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	2/97	0.33 - 2.4	0.15	410	N	N/A	N/A		BSC
106-47-8	4-Chloroaniline	0.44		0.44		mg/kg	SCPX-04-14; SC Pipeline Area; 1 ftbgs (05/25/04)	1/41	0.35 - 0.47	0.44	410	N	N/A	N/A		BSC
208-96-8	Acenaphthylene	0.11	J	0.11	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	1/87	0.33 - 2.4	0.11	--	N	N/A	N/A		LDF
98-86-2	Acetophenone	0.15	J	1.2		mg/kg	SCPX-02-11; SC Pipeline Area; 1 ftbgs (05/19/04)	3/34	0.36 - 0.47	1.2	10000	N	N/A	N/A		BSC
120-12-7	Anthracene	0.086	J	0.17	J	mg/kg	FLD-06; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	4/97	0.33 - 2.4	0.17	31000	N	N/A	N/A		BSC
100-52-7	Benzaldehyde	0.2	J	0.69		mg/kg	SB-13-7; SC Pipeline Area; 0.5-2 ftbgs (01/10/02)	3/34	0.35 - 0.42	0.69	10000	N	N/A	N/A		BSC
56-55-3	Benzo(a)anthracene	0.047	J	0.83		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	0.83	3.9	C	N/A	N/A		BSC
50-32-8	Benzo(a)pyrene	0.048	J	1		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	22/97	0.33 - 2.4	1	0.39	C	N/A	N/A	X	ASC
205-99-2	Benzo(b)fluoranthene	0.065	J	2		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	21/97	0.33 - 2.4	2	3.9	C	N/A	N/A		BSC
191-24-2	Benzo(g,h,i)perylene	0.043	J	0.3	J	mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	9/97	0.33 - 2.4	0.3	410 (6)	N	N/A	N/A		BSC
208-08-9	Benzo(k)fluoranthene	0.041	J	1.7		mg/kg	FLD-25; Former Lay Down Area; 0-0.5 ftbgs (09/11/06)	19/97	0.33 - 2.4	1.7	39	C	N/A	N/A		BSC
117-81-7	bis(2-Ethylhexyl)phthalate	0.04	J	1.3		mg/kg	OBSL-CAP-10;Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	27/51	0.35 - 0.42	1.3	200	C	N/A	N/A		BSC
85-68-7	Butyl benzylphthalate	0.049	J	0.92	J	mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	5/51	0.35 - 0.47	0.92	20000	N	N/A	N/A		BSC
218-01-9	Chrysene	0.04	J	0.93		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	27/97	0.33 - 2.2	0.93	390	C	N/A	N/A		BSC
53-70-3	Dibenz(a,h)anthracene	0.085	J	0.15	J	mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	3/97	0.33 - 2.4	0.15	0.39	C	N/A	N/A		BSC
84-66-2	Diethyl phthalate	0.34	J	0.53		mg/kg	OBSL-CAP-12; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	6/41	0.37 - 0.47	0.53	82000	N	N/A	N/A		BSC
117-84-0	Di-n-octyl phthalate	0.12	J	0.32	J	mg/kg	OBSL-CAP-10; Old Brine Sludge Landfill; 0-0.5 ftbgs (05/10/06)	2/51	0.35 - 0.47	0.32	10000 (7)	N	N/A	N/A		BSC
206-44-0	Fluoranthene	0.04	J	1.5		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06) FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	32/97	0.33 - 2.2	1.5	4100	N	N/A	N/A		BSC
118-74-1	Hexachlorobenzene	0.051	J	0.62		mg/kg	WB-32; Waste Lake 2; 0-2 ftbgs (08/17/98)	6/65	0.35 - 0.47	0.62	1.8	C	N/A	N/A		BSC
193-39-5	Indeno(1,2,3-cd)pyrene	0.039	J	0.45		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	11/97	0.33 - 2.4	0.45	3.9	C	N/A	N/A		BSC
78-59-1	Isophorone	0.072	J	0.072	J	mg/kg	WB-19; Waste Lake 2; 0-2 ftbgs (08/20/98)	1/50	0.35 - 0.47	0.072	3000	C	N/A	N/A		BSC
91-20-3	Naphthalene	0.1	J	0.22	J	mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	2/97	0.33 - 2.4	0.22	2000	N	N/A	N/A		BSC
98-95-3	Nitrobenzene	0.1	J	3.1	K	mg/kg	SCPX-04-18; SC Pipeline Area; 1 ftbgs (05/25/04)	4/41	0.35 - 0.47	3.1	51	N	N/A	N/A		BSC
85-01-8	Phenanthrene	0.04	J	1.1		mg/kg	FLD-10; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	24/97	0.33 - 2.4	1.1	410 (6)	N	N/A	N/A		BSC
129-00-0	Pyrene	0.071	J	1.6		mg/kg	FLD-13; Former Lay Down Area; 0-0.5 ftbgs (05/08/06)	34/97	0.34 - 2.2	1.6	3100	N	N/A	N/A		BSC

TABLE C.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Metals															
7429-90-5	Aluminum	5120		20100	J	mg/kg	SC-4; SC Pipeline Area; 0-4 ftbgs (04/05/04)	54/54	--	20100	--	N	N/A	N/A	X	AD
7440-36-0	Antimony	0.19	L	10.4	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	41/59	0.18 - 5	10.4	41	N	N/A	N/A		BSC
7440-38-2	Arsenic	0.44		110		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	110	1.9	C	N/A	N/A	X	ASC (8)
7440-39-3	Barium	14.9		520		mg/kg	WB-04; Waste Lake 2; 0-2 ftbgs (10/18/93)	60/60	--	520	20000	N	N/A	N/A		BSC
7440-41-7	Beryllium	0.37		69.3		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	59/60	0.62	69.3	200	N	N/A	N/A		BSC
7440-43-9	Cadmium	0.051		6.4		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	39/60	0.013 - 0.62	6.4	100	N	N/A	N/A		BSC
7440-70-2	Calcium	146	J	30400		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	30400	--	N	N/A	N/A		NUT
7440-47-3	Chromium Total	6.5		99		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	99	150000	N	N/A	N/A		BSC
7440-48-4	Cobalt	2.2	B	182		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	182	--	N	N/A	N/A	X	AD
7440-50-8	Copper	2.7		6300		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	55/60	11 - 12	6300	4100	N	N/A	N/A	X	ASC
7439-89-6	Iron	6900		126000		mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	126000	72000	N	N/A	N/A	X	ASC
7439-92-1	Lead	2.6		3410		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	3410	800 (9)	N	N/A	N/A	X	ASC
7439-95-4	Magnesium	500		12100		mg/kg	PE-SBG-GRID-2; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	12100	--	N	N/A	N/A		NUT
7439-96-5	Manganese	40.6		4200	J	mg/kg	SS-10; Waste Lake 2; 0-1 ftbgs (09/13/93)	106/106	--	4200	2000	N	N/A	N/A	X	ASC
7439-97-6	Mercury	0.002		9131		mg/kg	C; Wastewater Treatment Plant; 1-2 ftbgs (08/01/96)	156/158	0.21 - 48	9131	3.31 (10)	N	N/A	N/A	X	ASC
7440-02-0	Nickel	4.1		674		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	106/106	--	674	2000	N	N/A	N/A		BSC
7440-09-7	Potassium	373	J	5590	J	mg/kg	PE-SBG-GRID 12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	54/54	--	5590	--	N	N/A	N/A		NUT
7782-49-2	Selenium	0.23	BN	3.2	N	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	38/106	0.18 - 0.62	3.2	510	N	N/A	N/A		BSC
7440-22-4	Silver	0.066	L	0.68	B	mg/kg	PE-SBG-GRID 3; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	8/60	0.048 - 60	0.68	510	N	N/A	N/A		BSC
7440-23-5	Sodium	17.4		8650		mg/kg	PE-SBG-GRID-12; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	8650	--	N	N/A	N/A		NUT
7440-28-0	Thallium	0.2		0.72	B	mg/kg	OBSL-CAP-5; Old Brine Sludge LF; 0-0.5 ftbgs (05/10/06)	12/60	0.19 - 180	0.72	7.2	N	N/A	N/A		BSC
7440-62-2	Vanadium	10.3	J	45		mg/kg	SCPX-02-17; Chlorine Pipeline Area; 1- ftbgs (05/19/04)	54/54	--	45	100	N	N/A	N/A		BSC
7440-66-6	Zinc	17.4		28800		mg/kg	PE-SBG-GRID-8; Sand Blast Grit Area; 0-0.5 ftbgs (10/23/01)	60/60	--	28800	31000	N	N/A	N/A		BSC

TABLE C.2.1

OCCURRENCE, DISTRIBUTION, AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL (0-2 FT BGS)
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil (0-2 ft bgs)
Exposure Medium: Soil

CAS Number	Chemical	Minimum Concentration (1,2)	Minimum Qualifier	Maximum Concentration (1,2)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits (2)	Maximum Concentration Used for Screening (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
	Polychlorinated Biphenyls														
11096-82-5	Aroclor-1260 (PCB-1260)	0.13		4.4		mg/kg	East Side of East Rectifier; Process Area; 1.17-1.67 ftbgs (05/25/06)	5/10	0.071 - 0.072	4.4	1.4 C	N/A	N/A	X	ASC

Notes:

(1) Minimum/maximum detected concentration.

(2) Based on data collected from sampling locations: SCPX-01-10, SCPX-01-17, SCPX-02-11, SCPX-02-17, SCPX-03-12, SCPX-03-17, FLD-01, FLD-02, FLD-02R, FLD-03, FLD-03R, FLD-04, FLD-04R, FLD-05, FLD-06, FLD-07, FLD-08, FLD-08R, FLD-09, FLD-10, FLD-11, FLD-12, FLD-13, FLD-14, FLD-15, FLD-16, FLD-17, FLD-17R, FLD-18, FLD-19, FLD-19, FLD-20, FLD-20R, FLD-21, FLD-22, FLD-23, FLD-24, FLD-25, FLD-26, FLD-27, FLD-28, FLD-29, FLD-30, FLD-31, FLD-32, FLD-33, FLD-34, FLD-35, OBSL-CAP-5, OBSL-CAP-10, OBSL-CAP-12, PE-RTR-DIRT-FROM-BRINE-RR, PE-GTB-BUILDING 1, Potable Water Leak, Sulfuric Acid Tank - East Side, Sulfuric Acid Tank - North Side, Sulfuric Acid Tank - Northwest Side, Sulfuric Acid Tank - Southwest Side, Temporary Hazardous Waste Pad 1, Temporary Hazardous Waste Pad 2, Below Electric Feed Tower, East Side of East Rectifier, East End Near Bldg., East End Near Rectifier, East Side of Transformer Pad, East Side of West Rectifier, South Side of Transformer Pad, West Side of East Rectifier, West Side of Oil Pumps, West Side of West Rectifier, PE-SBG-GRID 1, PE-SBG-GRID 2, PE-SBG-GRID 3, PE-SBG-GRID 4, PE-SBG-GRID 5, PE-SBG-GRID 6, PE-SBG-GRID 7, PE-SBG-GRID 8, PE-SBG-GRID 9, PE-SBG-GRID 10, PE-SBG-GRID 11, PE-SBG-GRID 12, PE-SBG-GRID 13, PE-SBG-GRID 14, PE-SBG-GRID 15, PE-SBG-GRID 16, PE-SBG-GRID 17, PE-SBG-GRID 18, PE-SBG-GRID 19, PE-SBG-GRID 20, SB-13, SB-13-1, SB-13-2, SB-13-3, SB-13-4, SB-13-5, SB-13-6, SB-13-7, SB-13-8, SB-13-9, SB-13-10, SC-1, SC-2, SC-3, SC-4, SC-5, SC-6, WL2-F1, WL2-F2, WL2-F3, WL2-F4, WL2-F5, WL2-F6, WL2-F7, WL2-F8, WL2-F9, WL2-F10, WL2-F11, WL2-F12, WL2-F13, WL2-F14, SS-07, SS-08, SS-09, SS-10, WB-04, WB-17, WB-28, WB-29, WB-26, WB-27, WB-28, WB-29, WB-30, WB-31, WB-32, WL3-CAP-2, WL3-CAP-7, WL3-CAP-12, PE-WWTP, A, A/B, B, C, D.

(3) Screening concentration is the maximum detected concentration.

(4) Region III Risk-Based Concentrations (R3-RBC) Table, Industrial Soil, October 16, 2007. Non-carcinogenic analytes were adjusted by a factor of 10, HI = 0.1.

(5) Rationale Codes
Selection Reason : Maximum detected above Screening Criterion (ASC)
Analyte Detected (AD)
Deletion Reason : Maximum detected below Screening Criterion (BSC)
Low Detection Frequency, less than 5% (LDF)
Essential Nutrient (NUT)

(6) No criterion for this analyte, therefore the lowest non-carcinogenic PAH (2-methylnaphthalene) criterion substituted.

(7) No criterion for this analyte, therefore di-n-butyl phthalate substituted.

(8) Maximum arsenic concentration is above the natural background level detected in Delaware soils, 11 mg/kg (DNREC, 2007), thus arsenic is selected as a COPC.

(9) Criterion established by U.S. EPA using IUEBK model, therefore value was not adjusted.

(10) Consistent with USEPA Region III Comment #1 of USEPA's email dated October 19, 2007 and modified as presented in Table 3.1.

Definitions:

C = Carcinogenic; based on USEPA classification system
N = Non-Carcinogenic; based on USEPA classification system
-- = Not Available
N/A = Not Applicable
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Associated value is estimated.
B = Associated analyte detected in the method blank.
K = High bias.
L = Low bias.
N = Sample recovery not within control limits.

TABLE C.4.1

EXPOSURE ASSUMPTIONS FOR FUTURE TRESPASSER EXPOSURE TO SURFACE SOIL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil/ Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	*Parameter Code*	*Parameter Definition*	*Units*	*Expsoure Assumption*	*Exposure Assumption Rationale/ Reference*
Ingestion	IR	Ingestion Rate of Soil	mg/day	100	USEPA, 2002
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	BW	Body Weight	kg	50	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	ABS	Absorption Factor	%/100	1	Professional Judgement (4)
Dermal	SA	Skin Surface Area Available for Contact	cm^2	3,688	USEPA, 1997 (5)
	CF	Conversion Factor	kg/mg	1.00E-06	--
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	BW	Body Weight	kg	50	USEPA, 1997 (3)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.4	USEPA, 2002
	ABS	Absorption Factor	%/100	chemical-specific	USEPA, 2004; USEPA, 1995 (6)
Inhalation	FT	Fraction of Time Exposed	unitless	4/24	Professional Judgement (7)
	EF	Exposure Frequency	days/year	28	Professional Judgement (1)
	ED	Exposure Duration	years	10	Professional Judgement (2)
	AT-C	Averaging Time (cancer)	days	25,550	USEPA, 1989
	AT-N	Averaging Time (non-cancer)	days	3,650	USEPA, 1989
	PEF	Particulate Emission Factor	m^3/kg	5.25E+08	Refer to Table C.4.3
	VF	Volatilization Factor	m^3/kg	chemical-specific	Refer to Table C.4.4

Notes:

(1) Professional Judgement; adolescent will trespass for 1 day/week from April to October, for a total of 28 days (RME).
(2) Trespasser is a 9 through 18 year old therefore the exposure duration is 10 years.
(3) Body weight is the average of 13 yr old mean body weights, Table 7-3 of Exposure Factor Handbook, Volume 1.
(4) Professional Judgement; assumed 100% absorption for conservatism.
(5) Skin surface area is the average of 13-14 yr old mean total surface areas assuming 25% of total body area is exposed, Tables 6-6 and 6-7 of Exposure Factor Handbook, Volume 1.
(6) Published numbers include: Arsenic (3%), DDT (3%), PAHs (13%), PCBs (14%), SVOCs (10%), VOCs VP < benzene VP (3%), VOCs VP > benzene VP (0.05%), Metals (1%).
(7) Professional Judgement; adolescent will trespass for 4 hours.

References:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
USEPA, 1995: Assessing Dermal Guidance Exposure from Soil, Region III Technical Guidance Manual Risk Assessment, EPA/903-K-95-003, December 1995.
USEPA, 1997: Exposure Factors Handbook. Volume. 1: General Factors. EPA/600/P-95/002Fa. August 1997.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004: RAGs Volume 1, Human Health Evaluation Manual, Part E: Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004.

TABLE C.4.3

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SURFACE SOIL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

PEF: Soil-to-Air Particulate Emission Factor

$$PEF = Q/C_{wind} \times \frac{3600}{0.036 \times (1 - V) \times \left(U_m / U_t\right)^3 \times F(x)}$$

				Reference	*Units*	*Value*
Where:	PEF	=	soil-to-air particulate emission factor	Equation 4-8, USEPA, 2002	m^3/kg	5.25E+08
	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	V	=	fraction of vegetative cover	USEPA, 2002	unitless	0.5
	U_m	=	mean annual windspeed	USEPA, 2002	m/s	4.69
	U_t	=	equivalent threshold value of windspeed at 7 m	USEPA, 2002	m/s	11.32
	F(x)	=	function dependent on U_m/U_t	USEPA, 2002	unitless	0.194

Q/C_{wind}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{wind} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{wind}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23
	"A"	=	constant	USEPA, 2002 (1)	unitless	14.0111
	Area	=	areal extent of the site or contamination	(2)	acres	146
	"B"	=	constant	USEPA, 2002 (1)	unitless	19.6154
	"C"	=	constant	USEPA, 2002 (1)	unitless	225.3397

Note:

(1) Based on Zone 8 - Philadelphia, Pennsylvania.

(2) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).

Reference:

USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.

TABLE C.4.4

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	Units	Trespasser: Cyclohexane	Trespasser: Mercury
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	7.65E+02	3.71E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	3.15E+08	3.15E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units		
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	8.20E+00	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm^2/s	8.00E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm^2/s	9.00E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	9.60E-01	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units		
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm^3/g	9.60E-01	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.60E+02	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.
(2) Based on Zone 8 - Philadelphia, Pennsylvania.
(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(6) Average porosity of a sand soil applied.
(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE C.4.4

DERIVATION OF VOLATILIZATION FACTOR FOR SURFACE SOIL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

VF: Soil-to-Air Volatilization Factor

$$VF = Q/C_{vol} \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2)$$

				Reference	*Units*	*Lawn Maintenance Staff* Cyclohexane	Mercury
Where:	VF	=	soil-to-air volatilization factor	Equation 4-8, USEPA, 2002	m^3/kg	1.21E+03	5.86E+04
	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	T	=	exposure interval	USEPA, 2002	s	7.88E+08	7.88E+08
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66

Q/C_{vol}: Inverse of Mean Conc - Centre of Square Source

$$Q/C_{vol} = A \times \exp \frac{(\ln Area - B)^2}{C}$$

Where:	Q/C_{vol}	=	inverse of mean conc - centre of square source	Exhibit D-3, USEPA, 2002	$(g/m^2\text{-sec})/(kg/m^3)$	36.23	36.23
	"A"	=	constant	USEPA, 2002 (2)	unitless	14.0111	14.0111
	Area	=	areal extent of the site or contamination	(3)	acres	146	146
	"B"	=	constant	USEPA, 2002 (2)	unitless	19.6154	19.6154
	"C"	=	constant	USEPA, 2002 (2)	unitless	225.3397	225.3397

D_A: Apparent Diffusivity

$$D_A = \frac{\left[\left(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

					Units		
Where:	D_A	=	apparent diffusivity	Equation 4-8, USEPA, 2002	cm^2/s	2.01E-03	8.58E-07
	Θ_a	=	air-filled porosity	(4)	unitless	0.109	0.109
	Θ_w	=	water-filled porosity	(5)	unitless	0.166	0.166
	n	=	total soil porosity	Fetter, 2001: Table 3.4 (6)	unitless	2.75E-01	2.75E-01
	ρ_{db}	=	soil dry bulk density	USEPA, 2004a (1)	g/cm^3	1.66	1.66
	H'	=	dimensionless Henry's Law Constant	USEPA, 2002; USEPA, 2004b	unitless	8.20E+00	4.67E-01
	D_i	=	diffusivity in air	USEPA, 2002; USEPA, 2004b	cm^2/s	8.00E-02	3.07E-02
	D_w	=	diffusivity in water	USEPA, 2002; USEPA, 2004b	cm^2/s	9.00E-06	6.30E-06
	K_d	=	soil-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	9.60E-01	8.20E+01

Kd: Soil-Water Partition Coefficient

$$K_d = K_{oc} \times f_{oc}$$

					Units		
Where:	K_d	=	soil-water partition coefficient	USEPA, 2002 (7)	cm^3/g	9.60E-01	8.20E+01
	K_{oc}	=	soil organic carbon-water partition coefficient	USEPA, 2002; USEPA, 2004b	cm^3/g	1.60E+02	--
	f_{oc}	=	organic content of soil	USEPA, 2002	g/g	0.006	0.006

Note:

(1) Default dry bulk density for sand soils applied.
(2) Based on Zone 8 - Philadelphia, Pennsylvania.
(3) Approximate acreage of portion of Site under consideration for the development of human health based Site-specific Standards (SSSs).
(4) Vapor-filled porosity, $\Theta_a = n / 100 - \Theta_w$
(5) Conservatively assumed a moisture content of 10 percent for a low-lying sand soil. Moisture-filled porosity was then calculated as, $\Theta_m = 0.1*(\rho_{db}/\rho_w)$, where water density, ρ_w=999.099 kg/m^3 at the average Site groundwater temperature of 15°C.
(6) Average porosity of a sand soil applied.
(7) Value for mercury is based on pH 7.

Reference:

Fetter, C.W., 2001: Applied Hydrogeology, Fourth Edition, Prentice Hall, Upper Saddle River, N.J.
USEPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Office of Emergency and Remedial Response, OSWER 9355.4-24, December 2002.
USEPA, 2004a: User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.
USEPA, 2004b: Physical Chemical Data for Volatile Organic Compounds, Region IX, October 2004.

TABLE C.5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Oral RfD Value*	*Oral RfD Units*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal RfD (2)*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfD: Target Organ*	*Dates of RfD: Target Organ (3) (MM/DD/YY)*
VOCs										
Cyclohexane	chronic	--	--	--	--	--	--	--	--	--
SVOCs										
Benzo(a)pyrene	chronic	--	--	--	--	--	--	--	--	--
Metals										
Aluminum	chronic	1.00E+00	mg/kg-d	100%	1.00E+00	mg/kg-d	--	--	R9-PRG	10/01/04
Arsenic	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	skin discoloration	3	IRIS	04/16/08
Cobalt	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	--	--	R9-PRG	10/01/04
Copper	chronic	4.00E-02	mg/kg-d	100%	4.00E-02	mg/kg-d	--	--	R9-PRG	10/01/04
Iron	chronic	7.00E-01	mg/kg-d	100%	7.00E-01	mg/kg-d	--	--	R3-RBC	10/16/07
Lead	chronic	--	--	--	--	--	--	--	--	--
Manganese	chronic	2.00E-02	mg/kg-d	4%	8.00E-04	mg/kg-d	central nervous system	3	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/kg-d	100%	3.00E-04	mg/kg-d	autoimmune system	1000	IRIS	04/16/08
PCBs										
Aroclor-1260	chronic	--	--	--	--	--	--	--	--	--

Notes:

-- = Not Available

N/A = Not Applicable

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended by USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal RfD = Oral RfD x (ABS_{GI}/100), consistent with Equation 4.3 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.
Region III Risk-Based Concentrations (R3-RBC) Table, October 16, 2007. USEPA peer-reviewed value.

TABLE C.5.2

NON-CANCER TOXICITY DATA -- INHALATION ROUTE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Chronic/ Subchronic*	*Value Inhalation RfC*	*Units*	*Primary Target Organ*	*Combined Uncertainty/Modifying Factors*	*Sources of RfC:RfD: Target Organ*	*Dates (1) (MM/DD/YY)*
VOCs							
Cyclohexane	chronic	6.00E+00	mg/m^3	developmental toxicity	300	IRIS	04/16/08
SVOCs							
Benzo(a)pyrene	--	--	--	--	--	--	--
Metals							
Aluminum	chronic	5.00E-03	mg/m^3	--	--	R9-PRG	10/01/04
Arsenic	--	--	--	--	--	--	--
Cobalt	chronic	2.00E-05	mg/m^3	--	--	R9-PRG	10/01/04
Copper	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--
Manganese	chronic	5.00E-05	mg/m^3	central nervous system	1000	IRIS	04/16/08
Mercury	chronic	3.00E-04	mg/m^3	autoimmune system	30	IRIS	04/16/08
PCBs							
Aroclor-1260	--	--	--	--	--	--	--

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April 16, 2008.
Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004. Provisional values supplied by NCEA.

TABLE C.6.1

CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Oral Cancer Slope Factor*	*Oral to Dermal Adjustment Factor (ABS_{GI}) (1)*	*Absorbed Dermal Cancer Slope Factor (2)*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (3) (MM/DD/YY)*
VOCs							
Cyclohexane	--	--	--	--	--	--	--
SVOCs							
Benzo(a)pyrene (adolescent)	2.19E+01	100%	2.19E+01	(mg/kg-day) $^{-1}$	B2	USEPA	03/01/05
Benzo(a)pyrene (adult)	7.30E+00	100%	7.30E+00	(mg/kg-day) $^{-1}$	B2	IRIS	04/16/08
Metals							
Aluminum	--	--	--	--	--	--	--
Arsenic	1.50E+00	100%	1.50E+00	(mg/kg-day) $^{-1}$	A	IRIS	04/16/08
Cobalt	--	--	--	--	--	--	--
Copper	--	--	--	--	D	--	--
Iron	--	--	--	--	--	--	--
Lead	--	--	--	--	B2	--	--
Manganese	--	--	--	--	D	--	--
Mercury	--	--	--	--	D	--	--
PCBs							
Aroclor-1260	2.00E+00	100%	2.00E+00	(mg/kg-day) $^{-1}$	B2	IRIS	04/16/08

Notes:

-- = Not Available

(1) Percent gastrointestinal (GI) absorption (ABS_{GI}) as presented in Exhibit 4-1 of USEPA, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005, July 2004. If the GI absorption is equal to or greater than 50 percent, a default value of 100 percent was used as recommended USEPA (2004). For parameters not presented in Exhibit 4-1, a default value of 100 percent has been assumed.

(2) Absorbed Dermal CSF = Oral CSF / (ABS_{GI}/100), consistent with Equation 4.2 of USEPA (2004).

(3) IRIS, Integrated Risk Information System Database, April 16, 2008.
USEPA, Guidelines for Carcinogenic Risk Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, March 2005. For adolescents, default age-dependent adjustment factor of 3 is applied for carcinogens that act via a mutagenic mode of action.

EPA Weight of Evidence Classification :

A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE C.6.2

CANCER TOXICITY DATA -- INHALATION ROUTE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC)	*Unit Risk*	*Units*	*Weight of Evidence/ Cancer Guideline Description*	*Source*	*Date (1) (MM/DD/YY)*
VOCs					
Cyclohexane	--	--	--	--	--
SVOCs					
Benzo(a)pyrene	--	--	B2	--	--
Metals					
Aluminum	--	--	--	--	--
Arsenic	4.30E+00	$(mg/m^3)^{-1}$	A	IRIS	04/16/08
Cobalt	2.80E+00	$(mg/m^3)^{-1}$	--	R9-PRG	10/01/04
Copper	--	--	D	--	--
Iron	--	--	--	--	--
Lead	--	--	B2	--	--
Manganese	--	--	D	--	--
Mercury	--	--	D	--	--
PCBs					
Aroclor-1260	5.70E-01	$(mg/m^3)^{-1}$	B2	IRIS	04/16/08

Notes:
-- = Not Available
(1) IRIS, Integrated Risk Information System Database, April 16, 2008.
Region IX - Preliminary Remediation Goals (R9-PRGs), October 1, 2004.
Provisional values supplied by NCEA.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE C.7.1

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	*CSF oral 1/(mg/kg-d)*	*CSF dermal 1/(mg/kg-d)*	*URF inhalation 1/(mg/m^3)*	*RfD oral (mg/kg-d)*	*RfD dermal (mg/kg-d)*	*RfC inhalation (mg/m^3)*	*Relative Absorption Factor - Oral carc. (%/100)*	*Relative Absorption Factor - Dermal carc. (%/100)*	*VF (m^3/kg)*	*Trespasser TR Adult (µg/g)*	*Trespasser THQ Adult (µg/g)*	*Site-Specific Soil Standard SSS$_{ss}$ (1) (µg/g)*	*Maximum Soil Concentration (µg/g) (2)*
VOCs													
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	7.65E+02	NV	3.59E+05	3.59E+05	2.70E-02
SVOCs													
Benzo(a)pyrene	2.19E+01	2.19E+01	--	--	--	--	1.00E+00	1.30E-01	NA	7.14E-01	NV	7.14E-01	**1.00E+00**
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	5.53E+06	5.53E+06	2.01E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	2.11E+01	1.36E+03	2.11E+01	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	1.03E+05	9.98E+04	9.98E+04	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	2.27E+05	2.27E+05	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	3.98E+06	3.98E+06	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	2.74E+04	2.74E+04	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	3.71E+04	NV	5.76E+02	5.76E+02	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	7.44E+00	NV	7.44E+00	4.40E+00

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table C.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

Trespasser Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS$_{ss}$	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table C.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table C.5.1
Unit Risk Factor (1/(mg/m^3))	URF	chemical-specific	Refer to Table C.6.2
Reference Concentration (mg/m^3)	RfC	chemical-specific	Refer to Table C.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table C.4.1
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table C.4.1
Surface Area Exposed (cm^2/day)	SA	3,688	Refer to Table C.4.1
Adherence Factor (mg/cm^2)	AF	0.4	Refer to Table C.4.1
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table C.4.1
Fraction of Time Exposed (unitless)	FT	4/24	Refer to Table C.4.1
Exposure Frequency (days/year)	EF	28	Refer to Table C.4.1
Exposure Duration (years)	ED	10	Refer to Table C.4.1
Body Weight (kg)	BW	50	Refer to Table C.4.1
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table C.4.1
Averaging Time - carc. (days)	ATc	25,550	Refer to Table C.4.1
Averaging Time - noncarc. (days)	ATnc	3,650	Refer to Table C.4.1
Particulate Emission Factor (m^3/kg)	PEF	5.25E+08	Refer to Table C.4.3
Volatilization Factor (m^3/kg)	VF	chemical-specific	Refer to Table C.4.4

TABLE C.7.2

DERIVATION OF SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL - LAWN MAINTENANCE PERSONNEL ORAL, DERMAL, AND INHALATION EXPOSURE
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Concern (COC)	*CSF oral 1/(mg/kg-d)*	*CSF dermal 1/(mg/kg-d)*	*URF inhalation 1/(mg/m³)*	*RfD oral (mg/kg-d)*	*RfD dermal (mg/kg-d)*	*RfC inhalation (mg/m³)*	*Relative Absorption Factor - Oral carc. (%/100)*	*Relative Absorption Factor - Dermal carc. (%/100)*	*VF (m³/kg)*	*Lawn Maintenance Personnel TR Adult (µg/g)*	*Lawn Maintenance Personnel THQ Adult (µg/g)*	*Site-Specific Soil Standard SSS_{ss} (1) (µg/g)*	*Maximum Soil Concentration (µg/g) (2)*
VOCs													
Cyclohexane	--	--	--	--	--	6.00E+00	1.00E+00	3.00E-02	1.21E+03	NV	4.54E+05	4.54E+05	2.70E-02
SVOCs													
Benzo(a)pyrene	7.30E+00	7.30E+00	--	--	--	--	1.00E+00	1.30E-01	NA	1.51E+00	NV	1.51E+00	1.00E+00
Metals													
Aluminum	--	--	--	1.00E+00	1.00E+00	5.00E-03	1.00E+00	1.00E-02	NA	NV	6.57E+06	6.57E+06	2.01E+04
Arsenic	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	--	1.00E+00	3.00E-02	NA	1.14E+01	1.83E+03	1.14E+01	**1.10E+02**
Cobalt	--	--	2.80E+00	2.00E-02	2.00E-02	2.00E-05	1.00E+00	1.00E-02	NA	3.29E+04	1.13E+05	3.29E+04	1.82E+02
Copper	--	--	--	4.00E-02	4.00E-02	--	1.00E+00	1.00E-02	NA	NV	2.74E+05	2.74E+05	6.30E+03
Iron	--	--	--	7.00E-01	7.00E-01	--	1.00E+00	1.00E-02	NA	NV	4.79E+06	4.79E+06	1.26E+05
Lead	--	--	--	--	--	--	1.00E+00	1.00E-02	NA	NV	NV	NV	1.06E+02 (3)
Manganese	--	--	--	2.00E-02	8.00E-04	5.00E-05	1.00E+00	1.00E-02	NA	NV	5.33E+04	5.33E+04	4.20E+03
Mercury	--	--	--	3.00E-04	3.00E-04	3.00E-04	1.00E+00	1.00E-02	5.86E+04	NV	7.17E+02	7.17E+02	**9.13E+03**
PCBs													
Aroclor-1260	2.00E+00	2.00E+00	5.70E-01	--	--	--	1.00E+00	1.40E-01	NA	5.31E+00	NV	5.31E+00	4.40E+00

Notes:

-- = Not Available
NA = Not Applicable
NV = No Value
Maximum detected concentration exceeds the SSS
(1) The selected Site-Specific Standard is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.
(2) Soil concentration is the maximum detected concentration obtained from Table C.2.1.
(3) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

Lawn Maintenance Personnel Exposure Assumptions

Site-Specific Standard in Surface Soil (mg/kg)	SSS_{ss}	calculated	
Target Risk Level (unitless)	TR	1.0E-06	
Target Hazard Level (unitless)	THQ	1	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	Refer to Table C.6.1
Reference Dose Factor (mg/kg-day)	RfD	chemical-specific	Refer to Table C.5.1
Unit Risk Factor (1/(mg/m³))	URF	chemical-specific	Refer to Table C.6.2
Reference Concentration (mg/m³)	RfC	chemical-specific	Refer to Table C.5.2
Ingestion Rate (mg/day)	IR	100	Refer to Table C.4.2
Relative Absorption Factor - Oral (%/100)	RAFo	chemical-specific	Refer to Table C.4.2
Surface Area Exposed (cm²/day)	SA	3,300	Refer to Table C.4.2
Adherence Factor (mg/cm²)	AF	0.2	Refer to Table C.4.2
Relative Absorption Factor - Dermal (%/100)	RAFd	chemical-specific	Refer to Table C.4.2
Fraction of Time Exposed (unitless)	FT	4/24	Refer to Table C.4.2
Exposure Frequency (days/year)	EF	35	Refer to Table C.4.2
Exposure Duration (years)	ED	25	Refer to Table C.4.2
Body Weight (kg)	BW	70	Refer to Table C.4.2
Conversion Factor (kg/mg)	CF	1.0E-06	Refer to Table C.4.2
Averaging Time - carc. (days)	ATc	25,550	Refer to Table C.4.2
Averaging Time - noncarc. (days)	ATnc	9,125	Refer to Table C.4.2
Particulate Emission Factor (m³/kg)	PEF	5.25E+08	Refer to Table C.4.3
Volatilization Factor (m³/kg)	VF	chemical-specific	Refer to Table C.4.4

TABLE C.8.1

SUMMARY OF FINAL SITE-SPECIFIC STANDARDS (SSSs) FOR SURFACE SOIL
VACANT (LAWN MAINTENANCE ONLY) SCENARIO
OXYCHEM
DELAWARE CITY, DELAWARE

Chemical of Potential Concern (COPC) SOIL (mg/kg)	*Calculated SSSs Per Exposure Pathway* [1] *(Table Reference) Human Health Based SSSs (mg/kg)* 1 *(see Table C.7.1)*	2 *(see Table C.7.2)*	*Proposed SSSs* *Minimum Calculated SSS Value* [2] *(mg/kg)*	*Basis*	*Maximum Detected Concentration* [3] *(mg/kg)*
Volatile Organic Compounds (VOCs)					
Cyclohexane	3.59E+05	4.54E+05	3.59E+05	Trespasser	2.70E-02
Semi-Volatile Organic Compounds (SVOCs)					
Benzo(a)pyrene	7.14E-01	1.51E+00	7.14E-01	Trespasser	1.00E+00
Metals					
Aluminum	5.53E+06	6.57E+06	5.53E+06	Trespasser	2.01E+04
Arsenic	2.11E+01	1.14E+01	1.14E+01	Lawn Maintenance Personnel	1.10E+02
Cobalt	9.98E+04	3.29E+04	3.29E+04	Lawn Maintenance Personnel	1.82E+02
Copper	2.27E+05	2.74E+05	2.27E+05	Trespasser	6.30E+03
Iron	3.98E+06	4.79E+06	3.98E+06	Trespasser	1.26E+05
Lead	--	--	--	--	1.06E+02 [4]
Manganese	2.74E+04	5.33E+04	2.74E+04	Trespasser	4.20E+03
Mercury	5.76E+02	7.17E+02	5.76E+02	Trespasser	9.13E+03
PCBs					
Aroclor-1260	7.44E+00	5.31E+00	5.31E+00	Lawn Maintenance Personnel	4.40E+00

Notes:

Maximum detected concentration exceeds the SSS.

(1) Exposure Pathway

	Receptor	***Medium***	***Pathway***
1	Trespasser	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate).
2	Lawn Maintenance Personnel	Surface Soil	Direct Contact (incidental ingestion, dermal contact, and inhalation of vapors and/or particulate).

(2) Minimum calculated SSS value is the lowest of the calculated human health based SSS.

(3) See Table C.2.1 for soil maximum detected concentrations.

(4) Arithmetic mean lead concentration in Site surface soil, as indicated in Table A.3.1 of Appendix A.

APPENDIX D

VAPOR INTRUSION MODELING

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1.0 INTRODUCTION

This Appendix presents the estimation of Site-specific standards (SSSs) for volatile chemicals of potential concern (COPCs) in soil and groundwater at the Oxychem Site (Site) in Delaware City, Delaware. The SSSs are developed to be protective of human health from soil and groundwater vapor migration to the indoor air of an overlying building.

The SSSs for soil and groundwater were estimated using the Johnson and Ettinger (1991) model (J&E Model) as implemented by the United States Environmental Protection Agency (USEPA) (USEPA, 2004). The SSSs were developed following the approach applied by the USEPA in their document entitled, "*Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*" (Subsurface Vapor Intrusion Guidance) (USEPA, 2002).

The methodology for developing the SSSs is presented in Section 2.0. Summaries of the Site-specific input parameters applied and the Site-specific soil and groundwater criteria results are presented in Section 3.0. All references cited in this Appendix are listed in Section 4.0.

2.0 METHODOLOGY

The soil and groundwater SSSs were developed using the approach applied by the USEPA (2002), which is based on the J&E Model. Johnson and Ettinger (1991) present a heuristic model for estimating the degree of attenuation occurring as volatile contaminants in soil vapor migrate upward through the vadose zone, enter an overlying building, and mix with the indoor air of the building. The degree of attenuation is quantified through the calculation of an attenuation factor, α, after Johnson and Ettinger (1991; Equation 21).

The methodologies applied to estimate SSSs for Site soil and groundwater using the J&E Model are described in Sections 2.1 and 2.2, respectively. A description of several conservative features inherent to the J&E Model is provided in Section 2.3.

2.1 DERIVATION OF ESTIMATED SOIL SSSs

The SSSs derived for the volatile COPCs identified in soil under both the Industrial and the Recreational Land Use scenarios were calculated in a multi-step process. First, the concentration sorbed to soil particles was determined from the allowable target indoor air concentrations (see Table A.7.4 of Appendix A and Table B.7.6 of Appendix B). The concentration sorbed to soil particles was then used to determine an allowable soil gas concentration at the location of the soil impact. The allowable soil gas concentration was converted to a Site-specific standard for soil SSS_{soil} using equilibrium partitioning, or phase relationships.

First, the target indoor air concentrations (see Table A.7.4 of Appendix A and Table B.7.6 of Appendix B of the main report) were applied to predict the Site-specific soil gas criteria beneath a site building, C_{sg}, as follows:

$$C_{sg} = C_{tia} \times \alpha$$

Where:

C_{sg} - The calculated Site-specific soil gas criteria (µg/ m^3);

C_{tia} - The calculated allowable risk-based target indoor air concentration (see Table A.7.4 of Appendix A and Table B.7.6 of Appendix B of the main report) [micrograms per cubic metre (µg/m^3)];

α - The Site-specific calculated soil gas attenuation factor, which relates the indoor air concentration to the concentration in soil gas directly above the source based on the heuristic model developed by Johnson and Ettinger (1991; Equation 21). The soil gas attenuation factor accounts for the advective-diffusive migration of contaminants in soil gas through the vadose zone soil and building foundation, and the subsequent mixing of contaminants with building indoor air.

Next, the Site-specific soil gas criteria were used to determine the concentration of each COPC adsorbed to soil particles according to the following equation:

$$C_{sp} = C_{sg} \times CF \times \frac{K_{oc} \times f_{oc}}{H}$$

where:

C_{sp} - The calculated contaminant concentration adsorbed to soil particles (µg/g);

K_{oc} - Compound-specific organic carbon partitioning coefficient [millilitres per gram (mL/g)];

f_{oc} - Fraction of organic carbon content for the vadose zone soil (unitless);

H - compound-specific dimensionless Henry's Law constant equal to $H_L/(R \times T)$, where H_L is the dimensioned Henry's Law constant [atmospheres cubic metres per mole (atm m^3/mol)], R is the Universal Gas Law constant [8.206×10^{-3} atmospheres cubic metres per mole Kelvin (atm m^3/mol K)], and T is the vadose zone temperature in Kelvin; and

CF - Units conversion factor of 10^{-6} cubic metres per millilitre (m^3/mL).

The calculated sorbed concentration C_{sp} was converted to a calculated Site-specific standard for soil, SSS_{soil} , using equilibrium partitioning, or phase relationships (USEPA, 1996), along with Site-specific vadose zone soil data for porosity, moisture content, and dry bulk soil density. The conversion of C_{sp} to SSS_{soil} was obtained from:

$$SSS_{soil} = C_{sp} / \rho_{db} \times \left(\varepsilon_m / k_d + H\varepsilon_v / k_d + \rho_{db}\right)$$

where:

SSS_{soil} - The calculated soil Site-specific standard (µg/g);

C_{sp} - The calculated contaminant concentration adsorbed to soil particles (µg/g);

ρ_{db} - The dry bulk soil density [grams per cubic centimetre (g/cm^3)];

ε_m - The moisture, or water, filled soil porosity;

ε_v - The vapor, or soil gas, filled soil porosity; and

k_d - The soil water partitioning coefficient equal to $K_{oc} \times f_{oc}$ (mL/g).

The derivation of the Site-specific soil gas attenuation factor for the soil to indoor air pathway was conducted through the application of the J&E Model for soil incorporated into a Microsoft Excel spreadsheet by the USEPA (USEPA, 2004; "SL-ADV-Feb04.xls, Version 3.1"). The Site-specific compound, vadose zone soil, and building properties applied in the derivation of the soil gas attenuation factor, and thus the estimation of soil SSSs, at the Site are presented in Section 3.0.

2.2 DERIVATION OF ESTIMATED GROUNDWATER SSSs

The SSSs derived for the volatile COPCs identified in groundwater (see Table A.2.4 of Appendix A and Table B.2.5 of Appendix B of the main report) were applied to estimate indoor air EPCs as follows:

$$SSS_{gw} = \frac{C_{tia}}{\alpha \times H \times CF_2}$$

Where:

SSS_{gw} - the Site-specific standard for groundwater [micrograms per litre (µg/L)]; and

CF_2 - Units conversion factor of 1,000 litres per cubic metre (L/m^3).

The derivation of the Site-specific soil gas attenuation factor for the groundwater to indoor air pathway was conducted through the application of the J&E Model for groundwater incorporated into the Microsoft Excel spreadsheet developed by the USEPA (USEPA, 2004; "GW-ADV-Feb04.xls, Version 3.1"). The Site-specific compound, vadose zone soil, and building properties applied in the derivation of the soil gas attenuation factor, and thus the estimation of groundwater SSSs, at the Site are presented in Section 3.0.

2.3 CONSERVATIVE FEATURES OF J&E MODEL

It is important to note that the J&E Model used to develop the SSSs includes several conservative assumptions. The key conservative aspects incorporated into the development of the estimated SSSs are described below:

- the J&E Model assumes that all contaminant vapors below a building migrate vertically upward into the building and do not move laterally, or in three-dimensions, around the building to vent to the atmosphere;
- the J&E Model assumes that no contaminant vapors migrate around the sides of buildings through preferential pathways, such as granular foundation bedding material, to vent to the atmosphere; and
- the estimated indoor air concentrations are developed assuming a constant and continuous source of COPCs in soil gas. Source depletion due to naturally occurring biological or chemical degradation of contaminants is not considered; and

All of the conservative aspects described above combine to produce a higher estimate of indoor air EPCs than is actually expected to occur.

3.0 CALCULATION OF SOIL AND GROUNDWATER SITE-SPECIFIC STANDARDS

Under the Industrial Land Use scenario, the SSSs were developed based on the dimensions of the water treatment facility proposed for the Site. Under the Recreational Land Use scenario, the SSSs were developed based on the typical or mean dimensions of a house. SSSs were calculated in accordance with the Johnson and Ettinger (1991) model using Site-specific compound, vadose zone soil, and building properties. The details of the vadose zone conditions applied in the estimation of the SSSs are described in Section 3.1. The details of the building properties applied in the estimation of the SSSs are described in Section 3.2. The compound-specific inputs applied in the J&E Model are described in Section 3.3.

3.1 VADOSE ZONE CONDITIONS

The Site-specific vadose zone soil physical properties applied in the development of the soil and groundwater SSSs consist of the following:

- soil moisture content, θ_m :

  A moisture content of 10.0 percent was conservatively applied, typical for a low lying sand soil;

- dry bulk soil density, δ_{db} :

  A dry bulk soil density of 1.66 g/cm^3 was applied, based on the default value for a sand soil as indicated in USEPA (2004);

- porosity, ε_T :

  A porosity of 27.5 percent was applied, consistent with the average porosity for a sand soil, as indicated in Fetter (2001; Table 3.4);

- hydraulic conductivity (K), which is converted to a vadose zone effective vapor permeability, k_V :

  A hydraulic conductivity value of 1.0 x 10^{-2} cm/s corresponds to the typical hydraulic conductivity for a sand soil, as indicated in Fatter (2001). The applied hydraulic conductivity value was converted to an intrinsic permeability k_i using the equation $k_i = K\,\mu_w / \delta_w g$, where the water density (δ_w) equals 999.099 kg/m^3 at 15°C, the gravitational acceleration (g) equals 9.81 m/s^2, and the dynamic viscosity of water (μ_w) equals 1.14×10^{-3} kg/ms at 15°C (Fetter, 2001). A relative vapor permeability, k_r, was determined after Parker et al. (1987) for a sand soil type as implemented in USEPA (2004). The effective vapour permeability is equal to the product of k_i and k_r; and

- fraction of organic carbon content, f_{oc} (applied for the soil criteria only):

  A value of 0.6 percent was applied based on the default fraction of organic carbon indicated in USEPA (2002).

3.2 BUILDING PROPERTIES

Industrial Land Use Scenario

The building properties applied in the estimation of the SSSs under the Industrial Land Use scenario were based on a 9.1 meter by 9.1 meter (30 feet by 30 feet) building footprint with slab-on-grade construction, consistent with the approximate directions of the water treatment facility to be constructed at the Site. The applied building properties consisted of the following:

- below grade building surface area, A_B :
  A below grade building surface area of 83 square meters (m^2) was applied, based on a 9.1 meter long by 9.1 meter wide building with slab-on-grade construction;
- building volume, V_B :
  A building volume of 505 cubic meters (m^3) was applied, based on a 9.1 meter long by 9.1 meter wide building with an assumed ceiling height of 6.1 meters;
- building indoor air exchange rate, T_{air} :
  A building indoor air exchange rate value of 0.83 building volumes per hour was applied, consistent with the industrial indoor air exchange rate reported in the American Society for Testing and Materials (ASTM) Standard Guide in Risk-Based Corrective Action at Petroleum Release Sites (ASTM, 1995);
- foundation thickness, L_{crack} :

  A default foundation thickness of 15 cm was applied, consistent with Johnson and Ettinger (1991);
- distance from the building floor to the source, L_T :
  For the soil to indoor air pathway, a distance of 0.72 meters was applied, based on the average depth to impact at the Site of 0.87 meters (2.9 feet), as presented in Table D.1, less a floor slab thickness of 0.15 meters (0.5 feet). For the groundwater to indoor air pathway, the depth to groundwater at the Site was found to range from 0.5 ft bgs to 22 ft bgs, with an average depth of 12 ft bgs. For conservatism, the depth to groundwater at the Site was approximated as 4.57 meters (15 feet). A distance of

4.42 meters was therefore applied, based on the approximate depth to groundwater of 4.57 meters less a floor slab thickness of 0.15 meters;

- ratio of building crack area to building below-grade area, η :
  A ratio of 0.00038 (0.038 percent) was applied, consistent with the default crack ratio value for slab-on-grade structures presented in USEPA (2002; Appendix G, Table G-3); and
- vadose zone/building pressure differential, ΔP :
  A pressure differential value of 4 Pascal (Pa) was applied consistent the default pressure differential presented in USEPA (2002; Appendix G, Table G-3).

Recreational Land Use Scenario

The building properties applied in the estimation of the SSSs under the Recreational Land Use scenario were based on a 10 meter by 10 meter building footprint with slab-on-grade construction, as indicated by USEPA (2002). The applied building properties consisted of the following:

- below grade building surface area, A_B :
  A below grade building surface area of 100 square meters (m^2) was applied, based on a 10 meter long by 10 meter wide building with slab-on-grade construction, consistent with the default or mean values for a house as indicated in USEPA (2002);
- building volume, V_B :
  A building volume of 300 cubic meters (m^3) was applied, based on a 10 meter long by 10 meter wide building with an assumed ceiling height of 3.0 meters, consistent with the default or mean values for a house as indicated in USEPA (2002);
- building indoor air exchange rate, T_{air} :
  A building indoor air exchange rate value of 0.83 building volumes per hour was applied, consistent with the industrial indoor air exchange rate reported in the American Society for Testing and Materials (ASTM) Standard Guide in Risk-Based Corrective Action at Petroleum Release Sites (ASTM, 1995);
- foundation thickness, L_{crack} :

  A default foundation thickness of 15 cm was applied, consistent with Johnson and Ettinger (1991);
- distance from the building floor to the source, L_T :
  For the soil to indoor air pathway, a distance of 0.72 meters was applied, based on the average depth to impact at the Site of 0.87 meters (2.9 feet), as presented in

Table D.1, less a floor slab thickness of 0.15 meters (0.5 feet). For the groundwater to indoor air pathway, the depth to groundwater at the Site was found to range from 0.5 ft bgs to 22 ft bgs with an average depth of 12 ft bgs. For conservatism, the depth to groundwater at the Site was approximated as 4.57 meters (15 feet). A distance of 4.42 meters was therefore applied, based on the approximate depth to groundwater of 4.57 meters less a floor slab thickness of 0.15 meters;

- ratio of building crack area to building below-grade area, η :
  A ratio of 0.00038 (0.038 percent) was applied, consistent with the default crack ratio value for slab-on-grade structures presented in USEPA (2002; Appendix G, Table G-3); and
- vadose zone/building pressure differential, ΔP :
  A pressure differential value of 4 Pascal (Pa) was applied consistent the default pressure differential presented in USEPA (2002; Appendix G, Table G-3).

3.3 COMPOUND PROPERTIES

The compound properties applied in the estimation the soil and groundwater SSSs consist of a Henry's Law constant, a water diffusion coefficient, and an air diffusion coefficient. The applied compound properties for Site COPCs were obtained from the chemical properties database developed in USEPA (2004). The Henry's Law constants and air diffusion coefficients for each compound were corrected to a vadose zone temperature of 15 degrees Celsius. This temperature corresponds to the average groundwater temperature measured across the Site during groundwater sampling events conducted between 2001 and 2006, as indicated in Table D.2.

3.4 ESTIMATED SITE-SPECIFIC STANDARDS RESULTS

The estimated soil SSSs for the Industrial Land Use scenario are presented in Table A.7.5 of Appendix A. The estimated groundwater SSSs for the Industrial Land Use scenario are presented in Table A.7.6 of Appendix A. The estimated soil SSSs for the Recreational Land Use scenario are presented in Table B.7.7 of Appendix B. The estimated groundwater SSSs for the Recreational Land Use scenario are presented in Table B.7.8 of Appendix B. The applied vadose zone soil, building, and chemical properties are summarized in the aforementioned tables. Soil and groundwater SSSs were estimated only for the volatile COPCs identified in Site soil and groundwater. The estimated SSSs are protective of potential health risks/hazards posed by the indoor air inhalation exposure pathway.

4.0 REFERENCES

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, ASTM Designation: E1739-95, West Conshohocken, PA.

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Johnson, P.C. and R.A. Ettinger, 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings, Environmental Science and Technology, 25(8), pp. 1445-145.

Parker, J.C., R.J. Lenhard, and T. Kuppusamy, 1987. A Parametric Model for Constitutive Properties Governing Multiphase Flow in Porous Media, Water Resources Research, Vol. 23, No. 4, pp. 618-624.

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USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, February 22.

TABLE D.1

SUMMARY OF DEPTH TO VOLATILE IMPACTS IN VADOSE ZONE SOIL
OXYCHEM
DELAWARE CITY, DELAWARE

Sample ID	*Sample Description*	*Sample Date*	*Site Area*	*Depth to Volatile Impact (ft bgs)*
SCPX-03-17	--	05/25/04	Chlorine Pipeline Area	1
SCPX-04-14	--	05/25/04	Chlorine Pipeline Area	1
WB-14A	Chemfix Test Unit Area (SWMU 12)	09/22/93	Chemfix Test Unit Area	2 - 4
WB-14A	Chemfix Test Unit Area (SWMU 12)	09/22/93	Chemfix Test Unit Area	2 - 4
A-67D	GW in Vicinity of Process Area (Area 9)	07/20/05	Vicinity of Process Area	14 - 16
FLD-01	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-02	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-02	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0.5 - 1
FLD-02	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	2.5 - 3
FLD-02R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-02R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	2 - 2.5
FLD-03	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-04	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-04R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-04R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	2 - 2.5
FLD-04R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	4 - 4.5
FLD-05	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-06	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-07	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-07	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0.5 - 1
FLD-07	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	2.5 - 3
FLD-08	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-08R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-08R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	2 - 2.5
FLD-08R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	4 - 4.5
FLD-09	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-10	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-10	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0.5 - 1
FLD-11	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-12	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-13	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0 - 0.5
FLD-13	Former Lay Down Area (Area 10)	05/08/06	Former Lay Down Area	0.5 - 1
FLD-13	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	2.5 - 3
FLD-14	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-15	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-16	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-17	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-17R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-18	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-18	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0.5 - 1
FLD-18	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	2.5 - 3
FLD-19	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5

TABLE D.1

SUMMARY OF DEPTH TO VOLATILE IMPACTS IN VADOSE ZONE SOIL
OXYCHEM
DELAWARE CITY, DELAWARE

Sample ID	*Sample Description*	*Sample Date*	*Site Area*	*Depth to Volatile Impact (ft bgs)*
FLD-20	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-20R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-20R	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	2 - 2.5
FLD-21	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0 - 0.5
FLD-21	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	0.5 - 1
FLD-21	Former Lay Down Area (Area 10)	05/09/06	Former Lay Down Area	2.5 - 3
FLD-23	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-23	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	5.5 - 6
FLD-24	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-25	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-25	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	4 - 4.5
FLD-26	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	4 - 4.5
FLD-27	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	2 - 2.5
FLD-28	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-29	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-30	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-31	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-32	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-33	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-34	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
FLD-35	Former Lay Down Area (Area 10)	09/11/06	Former Lay Down Area	0 - 0.5
OBSL-CAP-1(	Old Brine Sludge Landfill (SWMU 4)	05/10/06	Old Brine Sludge LF	0 - 0.5
OBSL-CAP-1:	Old Brine Sludge Landfill (SWMU 4)	05/10/06	Old Brine Sludge LF	0 - 0.5
SB-02	Old Brine Sludge Landfill (SWMU 4)	11/01/93	Old Brine Sludge LF	2 - 4
WB-12	Old Brine Sludge Landfill (SWMU 4)	09/23/93	Old Brine Sludge LF	4 - 6
WB-12	Old Brine Sludge Landfill (SWMU 4)	09/23/93	Old Brine Sludge LF	8 - 10
WB-13	Old Brine Sludge Landfill (SWMU 4)	09/23/93	Old Brine Sludge LF	10 - 12
WB-13	Old Brine Sludge Landfill (SWMU 4)	09/23/93	Old Brine Sludge LF	4 - 6
WB-13	Old Brine Sludge Landfill (SWMU 4)	09/23/93	Old Brine Sludge LF	6 - 8
PE-RTR-DIRT	Process Area (Area 5)	10/12/01	Process Area	0 - 0.5
PE-SCL-Sewe	Process Area (Area 5)	01/08/04	Process Area	4
PE-SCL-Sewe	Process Area (Area 5)	01/20/04	Process Area	4
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	1.5
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	1.5
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	1.5
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	2.5
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	3.5
PE-GTB-BUIL	Process Area (Area 5)	10/14/03	Process Area	1.5
Pipe Support	Process Area (Area 5)	12/12/01	Process Area	3
Sulfuric Acid	Process Area (Area 5)	08/20/98	Process Area	2
Sulfuric Acid	Process Area (Area 5)	08/20/98	Process Area	2
Sulfuric Acid	Process Area (Area 5)	08/20/98	Process Area	2
Sulfuric Acid	Process Area (Area 5)	08/20/98	Process Area	2

TABLE D.1

SUMMARY OF DEPTH TO VOLATILE IMPACTS IN VADOSE ZONE SOIL
OXYCHEM
DELAWARE CITY, DELAWARE

Sample ID	*Sample Description*	*Sample Date*	*Site Area*	*Depth to Volatile Impact (ft bgs)*
Sulfuric Acid	Process Area (Area 5)	08/20/98	Process Area	2
Temporary H	Process Area (Area 5)	11/19/98	Process Area	1
Temporary H	Process Area (Area 5)	11/25/98	Process Area	1
East Side of E	Process Area (Area 5)	05/25/06	Process Area	1.17 - 1.67
East Side of W	Process Area (Area 5)	05/25/06	Process Area	1.17 - 1.67
West Side of I	Process Area (Area 5)	05/25/06	Process Area	0.33 - 1
West Side of (	Process Area (Area 5)	05/25/06	Process Area	0.25 - 1
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
PE-SBG-GRID	Sand Blast Grit Area (SWMU 18)	10/23/01	Sand Blast Grit Area	0 - 0.5
SB-12	SC Pipeline Area (Area 1)	08/13/98	Chlorine Pipeline Area	12 - 14
SB-13	SC Pipeline Area (Area 1)	08/18/98	Chlorine Pipeline Area	0 - 2
SB-13-3	SC Pipeline Area (Area 1)	01/10/02	Chlorine Pipeline Area	0.5 - 2
SB-13-8	SC Pipeline Area (Area 1)	01/10/02	Chlorine Pipeline Area	0.5 - 2
SB-13-9	SC Pipeline Area (Area 1)	01/10/02	Chlorine Pipeline Area	0.5 - 2
SC-4	SC Pipeline Area (Area 1)	02/19/02	Chlorine Pipeline Area	11 - 12
SC-4	SC Pipeline Area (Area 1)	04/05/04	Chlorine Pipeline Area	0 - 4
SC-5	SC Pipeline Area (Area 1)	02/19/02	Chlorine Pipeline Area	4 - 8
SC-5	SC Pipeline Area (Area 1)	04/05/04	Chlorine Pipeline Area	0 - 4
SC-6	SC Pipeline Area (Area 1)	02/19/02	Chlorine Pipeline Area	12 - 16
SC-8	SC Pipeline Area (Area 1)	02/19/02	Chlorine Pipeline Area	4 - 8
SB-01	Waste Lake 1 (SWMU 1)	10/28/93	Waste lake 1	10 - 12
SB-01	Waste Lake 1 (SWMU 1)	10/28/93	Waste lake 1	8 - 10
WL2-F3	Waste Lake 2 (SWMU 2)	06/16/06	Waste Lake 2	0 - 0.25
WL2-F4	Waste Lake 2 (SWMU 2)	06/21/06	Waste Lake 2	0 - 0.25
WL2-F5	Waste Lake 2 (SWMU 2)	06/21/06	Waste Lake 2	0 - 0.25
WL2-F6	Waste Lake 2 (SWMU 2)	06/20/06	Waste Lake 2	0 - 0.25
WL2-F7	Waste Lake 2 (SWMU 2)	06/20/06	Waste Lake 2	0 - 0.25
WL2-F9	Waste Lake 2 (SWMU 2)	06/16/06	Waste Lake 2	0 - 0.25
WL2-F10	Waste Lake 2 (SWMU 2)	06/16/06	Waste Lake 2	0 - 0.25

TABLE D.1

SUMMARY OF DEPTH TO VOLATILE IMPACTS IN VADOSE ZONE SOIL
OXYCHEM
DELAWARE CITY, DELAWARE

Sample ID	*Sample Description*	*Sample Date*	*Site Area*	*Depth to Volatile Impact (ft bgs)*
WL2-F11	Waste Lake 2 (SWMU 2)	06/21/06	Waste Lake 2	0 - 0.25
WL2-F12	Waste Lake 2 (SWMU 2)	06/21/06	Waste Lake 2	0 - 0.25
SS-08	Waste Lake 2 (SWMU 2)	09/13/93	Waste Lake 2	0 - 1
SS-10	Waste Lake 2 (SWMU 2)	09/13/93	Waste Lake 2	0 - 1
SB-04	Waste Lake 2 (SWMU 2)	10/25/93	Waste Lake 2	2 - 4
SB-05	Waste Lake 2 (SWMU 2)	10/27/93	Waste Lake 2	4 - 6
WB-03	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	10 - 12
WB-03	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	6 - 8
WB-04	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	0 - 2
WB-04	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	6 - 8
WB-05	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	10 - 12
WB-05	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	4 - 6
WB-05	Waste Lake 2 (SWMU 2)	10/18/93	Waste Lake 2	6 - 8
WB-06	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	2 - 4
WB-06	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	4 - 6
WB-06	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	6 - 8
WB-07	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	2 - 4
WB-07	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	4 - 6
WB-07	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	6 - 8
WB-08	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	2 - 4
WB-08	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	4 - 6
WB-08	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	8 - 10
WB-09	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	2 - 4
WB-09	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	4 - 6
WB-09	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	6 - 8
WB-09	Waste Lake 2 (SWMU 2)	10/19/93	Waste Lake 2	8 - 10
WB-14-1998	Waste Lake 2 (SWMU 2)	08/19/98	Waste Lake 2	6 - 8
WB-15	Waste Lake 2 (SWMU 2)	08/25/98	Waste Lake 2	8 - 10
WB-16	Waste Lake 2 (SWMU 2)	08/19/98	Waste Lake 2	6 - 8
WB-17	Waste Lake 2 (SWMU 2)	08/19/98	Waste Lake 2	0 - 2
WB-17	Waste Lake 2 (SWMU 2)	08/19/98	Waste Lake 2	6 - 8
WB-18	Waste Lake 2 (SWMU 2)	08/18/98	Waste Lake 2	0 - 2
WB-18	Waste Lake 2 (SWMU 2)	08/18/98	Waste Lake 2	8 - 10
WB-19	Waste Lake 2 (SWMU 2)	08/20/98	Waste Lake 2	8 - 10
WB-20	Waste Lake 2 (SWMU 2)	08/24/98	Waste Lake 2	8 - 10
WB-22	Waste Lake 2 (SWMU 2)	08/19/98	Waste Lake 2	2 - 4
WB-23	Waste Lake 2 (SWMU 2)	08/20/98	Waste Lake 2	4 - 6
WB-25	Waste Lake 2 (SWMU 2)	08/24/98	Waste Lake 2	4 - 6
WB-26	Waste Lake 2 (SWMU 2)	08/20/98	Waste Lake 2	0 - 2
WB-27	Waste Lake 2 (SWMU 2)	08/17/98	Waste Lake 2	0 - 2
WB-27	Waste Lake 2 (SWMU 2)	08/17/98	Waste Lake 2	6 - 8
WB-28	Waste Lake 2 (SWMU 2)	08/17/98	Waste Lake 2	4 - 6
WB-29	Waste Lake 2 (SWMU 2)	08/17/98	Waste Lake 2	4 - 6

TABLE D.1

SUMMARY OF DEPTH TO VOLATILE IMPACTS IN VADOSE ZONE SOIL
OXYCHEM
DELAWARE CITY, DELAWARE

Sample ID	*Sample Description*	*Sample Date*	*Site Area*	*Depth to Volatile Impact (ft bgs)*
WB-30	Waste Lake 2 (SWMU 2)	09/23/93	Waste Lake 2	6 - 8
WB-31	Waste Lake 2 (SWMU 2)	08/14/98	Waste Lake 2	0 - 2
WB-31	Waste Lake 2 (SWMU 2)	08/14/98	Waste Lake 2	2 - 4
WB-32	Waste Lake 2 (SWMU 2)	09/23/93	Waste Lake 2	8 - 10
SB-08	Waste Lake 3 (SWMU 3)	10/20/93	Waste Lake 3	8 - 10
SB-09	Waste Lake 3 (SWMU 3)	10/20/93	Waste Lake 3	4 - 6
WB-11	Waste Lake 3 (SWMU 3)	09/22/93	Waste Lake 3	12 - 14
WB-11	Waste Lake 3 (SWMU 3)	09/22/93	Waste Lake 3	6 - 8
PE-WWTP	Wastewater Treatment Plant (SWMU 13)	10/01/95	Wastewater Treatment Plant	3 - 4
PE-WWTP	Wastewater Treatment Plant (SWMU 13)	10/01/95	Wastewater Treatment Plant	0 - 0.5
A	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	0 - 0.5
A	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	1 - 2
A/B	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	1 - 2
B	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	0 - 0.5
B	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	1 - 2
C	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	0 - 0.5
C	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	1 - 2
D	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	0 - 0.5
D	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	1 - 2
E	Wastewater Treatment Plant (SWMU 13)	08/01/96	Wastewater Treatment Plant	2 - 3
			AVERAGE DEPTH TO VOLATILE IMPACTS (ft bgs):	**2.85**
			AVERAGE DEPTH TO VOLATILE IMPACTS (m bgs):	**0.87**

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-6	WG-7462-111405-RAM-003	11/14/2005	16.1
A-6	WG-7462-051606-RAM-003	5/16/2006	12.8
A-6	WG-7462-051606-RAM-03	5/16/2006	12.8
A-6	WG-7462-111506-RAM-003	11/15/2006	15.8
A-6A	GW-112901-7462-RAM-012	11/29/2001	15.1
A-6A	WG-7462-111504-DJT-018	11/15/2004	16.1
A-6A	WG-7462-062205-046	6/22/2005	13.2
A-6A	GW-7462-082406-RM-03	8/24/2006	16.1
A-7A	GW-112901-7462-RAM-013	11/29/2001	16.1
A-7A	WG-7462-111504-DJT-013	11/15/2004	16.8
A-7A	WG-7462-062205-045	6/22/2005	14.3
A-7A	WG-7462-111405-RAM-002	11/14/2005	17.4
A-7A	WG-7462-051606-RAM-002	5/16/2006	13.6
A-7A	WG-7462-051606-RAM-02	5/16/2006	13.6
A-7A	GW-7462-082406-RM-01	8/24/2006	18.0
A-7A	WG-7462-111506-RAM-002	11/15/2006	16.5
A-8	GW-113001-7462-RAM-014	11/30/2001	16.6
A-11A	GW-112701-7462-RAM-003	11/27/2001	15.4
A-11A	WG-7462-061605-032	6/16/2005	15.5
A-12	GW-112701-7462-RAM-004	11/27/2001	15.7
A-12	WG-7462-062205-043	6/22/2005	14.1
A-13	GW-112801-7462-RAM-006	11/28/2001	15.6
A-13	WG-7462-111504-DJT-012	11/15/2004	16.8
A-13	WG-7462-062205-044	6/22/2005	16.5
A-13	WG-7462-111405-RAM-002	11/14/2005	17.1
A-13	WG-7462-051606-RAM-001	5/16/2006	14.9
A-13	WG-7462-051606-RAM-01	5/16/2006	14.9
A-13	GW-7462-082406-RM-02	8/24/2006	16.7
A-13	WG-7462-111506-RAM-001	11/15/2006	15.3
A-14	GW-112801-7462-RAM-007	11/28/2001	15.3
A-14	WG-7462-111504-DJT-017	11/15/2004	18.0
A-14	WG-7462-062205-049	6/22/2005	13.8
A-14	WG-7462-111505-RAM-006	11/15/2005	16.4
A-14	WG-7462-051606-RAM-006	5/16/2006	12.6
A-14	WG-7462-051606-RAM-06	5/16/2006	12.6
A-14	GW-7462-082406-RM-04	8/24/2006	16.8
A-14	WG-7462-111506-RAM-006	11/15/2006	15.5
A-15	GW-112801-7462-RAM-008	11/28/2001	14.8
A-15	WG-7462-111504-DJT-014	11/15/2004	14.4
A-15	WG-7462-062205-050	6/22/2005	15.2
A-15	WG-7462-111505-RAM-007	11/15/2005	15.6
A-15	WG-7462-051606-RAM-004	5/16/2006	14.7
A-15	WG-7462-051606-RAM-04	5/16/2006	14.7
A-15	GW-7462-082406-RM-05	8/24/2006	16.8
A-15	WG-7462-111506-RAM-005	11/15/2006	15.1

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-16	GW-112901-7462-RAM-009	11/29/2001	15.2
A-16	WG-7462-111604-DJT-020	11/16/2004	14.9
A-16	WG-7462-061705-039	6/17/2005	16.3
A-16	WG-7462-062205-052	6/22/2005	17.1
A-16	WG-7462-111505-RAM-004	11/15/2005	16.2
A-16	WG-7462-051606-RAM-07	5/17/2006	15.9
A-16	WG-7462-051706-RAM-007	5/17/2006	15.9
A-16	GW-7462-082406-RM-06	8/24/2006	16.5
A-16	WG-7462-111506-RAM-008	11/16/2006	15.6
A-16	WG-7462-111506-RAM-009	11/16/2006	15.6
A-17	WG-7462-111404-DJT-009	11/14/2004	14.8
A-17	WG-7462-031505-DJT-006	3/15/2005	14.0
A-17	WG-7462-061305-002	6/13/2005	16.6
A-17	GW-7462-1005-43	10/13/2005	15.5
A-17	WG-7462-120705-006	12/7/2005	14.2
A-17	WG-7462-022106-001	2/21/2006	15.8
A-17	WG-7462-051806-RAM-16	5/18/2006	15.3
A-17	GW-7462-082806-RM-20	8/28/2006	17.1
A-18	GW-120301-7462-RAM-017	12/3/2001	14.6
A-18	WG-7462-061705-040	6/17/2005	15.8
A-20	GW-120401-7462-RAM-022	12/4/2001	12.8
A-20	WG-7462-061705-041	6/17/2005	14.2
A-20	GW-7462-1005-37	10/13/2005	14.6
A-23	GW-112901-7462-RAM-011	11/29/2001	14.5
A-23	WG-7462-111504-DJT-015	11/15/2004	15.3
A-23	WG-7462-062205-051	6/22/2005	14.2
A-23	WG-7462-111505-RAM-008	11/15/2005	15.3
A-23	WG-7462-051606-RAM-005	5/16/2006	13.4
A-23	WG-7462-051606-RAM-05	5/16/2006	13.4
A-23	GW-7462-082406-RM-07	8/24/2006	15.7
A-23	WG-7462-111506-RAM-004	11/15/2006	15.2
A-24	GW-112901-7462-RAM-010	11/29/2001	15.1
A-24	WG-7462-111604-DJT-021	11/16/2004	14.7
A-24	WG-7462-062205-053	6/22/2005	16.5
A-24	WG-7462-111505-RAM-005	11/15/2005	17.2
A-24	WG-7462-051606-RAM-08	5/17/2006	16.4
A-24	WG-7462-051706-RAM-008	5/17/2006	16.4
A-24	GW-7462-082506-RM-15	8/25/2006	18.0
A-24	WG-7462-111506-RAM-010	11/16/2006	16.2
A-25D	GW-121101-7462-RAM-038	12/11/2001	12.9
A-25D	GW-7462-020504-RAM-011	2/5/2004	11.8
A-25D	GW-7462-051204-MJW-013	5/12/2004	17.6
A-25D	GW-7462-081804-RAM-010	8/18/2004	15.1
A-25D	WG-7462-111704-DJT-035	11/17/2004	12.6
A-25D	WG-7462-031805-DJT-028	3/18/2005	12.5
A-25D	WG-7462-061605-030	6/16/2005	14.1

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-25D	GW-7462-1005-29	10/12/2005	13.8
A-25D	WG-7462-120605-003	12/6/2005	12.7
A-25D	WG-7462-022306-026	2/23/2006	12.7
A-25D	WG-7462-053106-RAM-43	5/31/2006	14.9
A-25D	GW-7462-083006-RM-42	8/30/2006	14.6
A-25S	GW-121101-7462-RAM-039	12/11/2001	13.4
A-26D	GW-112701-7462-RAM-001	11/27/2001	15.1
A-26D	WG-7462-062205-056	6/22/2005	16.7
A-26OB	WG-7462-062205-054	6/22/2005	16.9
A-26S	GW-112701-7462-RAM-002	11/27/2001	15.2
A-26S	WG-7462-062205-055	6/22/2005	16.2
A-27D	GW-121001-7462-RAM-036	12/10/2001	13.5
A-27D	WG-7462-031705-DJT-020	3/17/2005	13.9
A-27D	WG-7462-061505-016	6/15/2005	15.4
A-27D	GW-7462-1005-15	10/12/2005	14.9
A-27D	WG-7462-120705-007	12/7/2005	14.2
A-27D	WG-7462-022206-009	2/22/2006	14.4
A-27D	WG-7462-052406-RAM-28	5/24/2006	15.7
A-27D	GW-7462-082806-RM-25	8/28/2006	16.4
A-27D	GW-7462-111406-MJW-004	11/14/2006	15.3
A-27S	GW-121001-7462-RAM-037	12/10/2001	13.8
A-27S	GW-7462-020404-RAM-008	2/4/2004	14.0
A-27S	GW-7462-051204-MJW-010	5/12/2004	15.1
A-27S	GW-7462-081804-RAM-007	8/18/2004	15.6
A-27S	WG-7462-111604-DJT-024	11/16/2004	15.1
A-27S	WG-7462-031605-DJT-009	3/16/2005	13.9
A-27S	WG-7462-061505-018	6/15/2005	14.4
A-27S	GW-7462-1005-14	10/12/2005	14.6
A-27S	WG-7462-120705-009	12/7/2005	14.9
A-27S	WG-7462-022206-008	2/22/2006	13.9
A-27S	WG-7462-052406-RAM-25	5/24/2006	14.4
A-27S	GW-7462-082806-RM-24	8/28/2006	16.0
A-27S	GW-7462-111406-MJW-05	11/14/2006	16.0
A-29OB	WG-7462-062305-063	6/23/2005	16.3
A-29S	WG-7462-062305-065	6/23/2005	14.7
A-30D	WG-7462-062305-067	6/23/2005	14.3
A-30OB	WG-7462-062305-066	6/23/2005	16.2
A-31D	GW-113001-7462-RAM-015	11/30/2001	15.3
A-31D	WG-7462-062305-068	6/23/2005	20.0
A-31OB	GW-113001-7462-RAM-016	11/30/2001	15.3
A-31OB	WG-7462-062305-070	6/23/2005	15.7
A-32D	WG-7462-062305-061	6/23/2005	13.3
A-32OB	WG-7462-062305-062	6/23/2005	12.8
A-32S	WG-7462-062305-060	6/23/2005	13.1
A-33D	GW-120301-7462-RAM-018	12/3/2001	15.8
A-33D	WG-7462-111204-DJT-002	11/12/2004	14.1

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-33D	WG-7462-031505-DJT-001	3/15/2005	13.4
A-33D	WG-7462-061405-009	6/14/2005	16.0
A-33D	GW-7462-1005-06	10/11/2005	15.6
A-33D	WG-7462-120605-001	12/6/2005	13.9
A-33D	WG-7462-022206-011	2/22/2006	13.4
A-33D	WG-7462-051706-RAM-11	5/17/2006	15.8
A-33D	GW-7462-082506-RM-13	8/25/2006	16.4
A-33S	GW-120301-7462-RAM-020	12/3/2001	15.7
A-33S	WG-7462-111204-DJT-001	11/12/2004	14.7
A-33S	WG-7462-031505-DJT-002	3/15/2005	11.9
A-33S	WG-7462-061405-008	6/14/2005	16.4
A-33S	GW-7462-1005-05	10/11/2005	15.6
A-33S	WG-7462-120605-002	12/6/2005	14.4
A-33S	WG-7462-022206-012	2/22/2006	14.4
A-33S	WG-7462-051706-RAM-10	5/17/2006	15.3
A-33S	GW-7462-082506-RM-14	8/25/2006	16.8
A-34D	GW-120601-7462-RAM-030	12/6/2001	19.3
A-34D	WG-7462-062405-078	6/24/2005	17.8
A-34S	GW-120601-7462-RAM-031	12/6/2001	20.0
A-34S	WG-7462-062405-077	6/24/2005	16.7
A-35D	GW-120601-7462-RAM-032	12/6/2001	16.6
A-35D	WG-7462-062405-081	6/24/2005	17.2
A-35S	GW-120601-7462-RAM-033	12/6/2001	16.7
A-35S	WG-7462-062405-088	6/24/2005	15.4
A-36D	GW-121001-7462-RAM-034	12/10/2001	14.0
A-36D	WG-7462-061305-004	6/13/2005	15.6
A-36D	GW-7462-1005-07	10/11/2005	15.8
A-36D	WG-7462-120705-005	12/7/2005	14.9
A-36D	WG-7462-022106-003	2/21/2006	14.5
A-36D	WG-7462-051806-RAM-13	5/18/2006	15.2
A-36D	GW-7462-082506-RM-09	8/25/2006	17.3
A-36S	GW-121001-7462-RAM-035	12/10/2001	15.1
A-36S	GW-7462-020304-RAM-005	2/3/2004	14.9
A-36S	GW-7462-051104-MJW-005	5/11/2004	16.3
A-36S	GW-7462-081004-RAM-001	8/10/2004	16.5
A-36S	WG-7462-111604-DJT-022	11/16/2004	17.1
A-36S	WG-7462-031605-DJT-014	3/16/2005	14.0
A-36S	WG-7462-061305-003	6/13/2005	15.6
A-36S	GW-7462-1005-08	10/11/2005	16.4
A-36S	WG-7462-120705-004	12/4/2005	15.7
A-36S	WG-7462-022106-004	2/21/2006	14.9
A-36S	WG-7462-051706-RAM-12	5/17/2006	14.5
A-36S	GW-7462-082506-RM-08	8/25/2006	17.2
A-37D	GW-120401-7462-RAM-023	12/4/2001	13.5
A-37D	GW-7462-020504-RAM-012	2/5/2004	11.6
A-37D	GW-7462-051304-MJW-014	5/13/2004	14.8

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-37D	GW-7462-081804-RAM-008	8/18/2004	15.8
A-37D	WG-7462-111804-DJT-038	11/18/2004	13.3
A-37D	WG-7462-031705-DJT-022	3/17/2005	11.1
A-37D	WG-7462-061405-013	6/14/2005	16.5
A-37D	GW-7462-1005-33	10/13/2005	14.7
A-37D	WG-7462-120805-028	12/8/2005	12.7
A-37D	WG-7462-022306-024	2/23/2006	11.5
A-37D	WG-7462-053106-RAM-42	5/31/2006	14.7
A-37D	GW-7462-083106-RM-49	8/31/2006	15.6
A-37S	GW-120401-7462-RAM-024	12/4/2001	14.1
A-37S	GW-7462-020504-RAM-014	2/5/2004	8.3
A-37S	GW-7462-051304-MJW-016	5/13/2004	13.2
A-37S	GW-7462-081804-RAM-009	8/18/2004	19.4
A-37S	WG-7462-111804-DJT-037	11/18/2004	13.9
A-37S	WG-7462-031705-DJT-023	3/17/2005	7.0
A-37S	WG-7462-061605-031	6/16/2005	15.2
A-37S	GW-7462-1005-32	10/13/2005	18.4
A-37S	WG-7462-120805-029	12/8/2005	12.2
A-37S	WG-7462-022306-028	2/23/2006	7.4
A-37S	WG-7462-060106-RAM-47	6/1/2006	15.4
A-37S	GW-7462-083106-RM-48	8/31/2006	19.3
A-38D	GW-120401-7462-RAM-025	12/4/2001	13.9
A-38D	WG-7462-062305-071	6/23/2005	14.9
A-39D	GW-120501-7462-RAM-026	12/5/2001	14.5
A-39D	GW-7462-020304-RAM-007	2/3/2004	12.2
A-39D	GW-7462-051104-MJW-008	5/11/2004	16.2
A-39D	GW-7462-081904-RAM-014	8/19/2004	16.4
A-39D	WG-7462-111304-DJT-006	11/13/2004	14.5
A-39D	WG-7462-031605-DJT-013	3/16/2005	15.5
A-39D	WG-7462-061605-029	6/16/2005	15.2
A-39D	GW-7462-1005-25	10/12/2005	15.5
A-39D	WG-7462-120805-018	12/8/2005	14.2
A-39D	WG-7462-022306-020	2/23/2006	13.3
A-39D	WG-7462-053006-RAM-37	5/30/2006	15.9
A-39D	GW-7462-083006-RM-35	8/30/2006	15.7
A-39OB	GW-120501-7462-RAM-027	12/5/2001	18.3
A-39OB	WG-7462-061605-027	6/16/2005	18.6
A-39OB	WG-7462-062205-057	6/22/2005	18.9
A-39S	GW-120501-7462-RAM-028	12/5/2001	16.0
A-39S	GW-7462-020304-RAM-006	2/3/2004	13.8
A-39S	GW-7462-051104-MJW-007	5/11/2004	16.0
A-39S	GW-7462-081904-RAM-015	8/19/2004	16.5
A-39S	WG-7462-111304-DJT-007	11/13/2004	15.4
A-39S	WG-7462-031605-DJT-012	3/16/2005	14.7
A-39S	WG-7462-061605-028	6/16/2005	17.8
A-39S	GW-7462-1005-26	10/12/2005	15.8

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-39S	WG-7462-120805-019	12/8/2005	14.6
A-39S	WG-7462-022306-019	2/23/2006	14.7
A-39S	WG-7462-053006-RAM-38	5/30/2006	15.8
A-39S	GW-7462-083006-RM-36	8/30/2006	15.9
A-40D	GW-7462-031402-RAM-001	3/14/2002	17.2
A-40D	WG-7462-111804-DJT-040	11/18/2004	16.4
A-40D	WG-7462-062405-082	6/24/2005	16.0
A-41S	GW-7462-031402-RAM-004	3/14/2002	15.2
A-42D	GW-7462-031402-RAM-002	3/14/2002	15.4
A-42S	GW-7462-031402-RAM-003	3/14/2002	15.3
A-44	GW-7462-020204-RAM-003	2/2/2004	13.7
A-44	GW-7462-051004-MJW-002	5/10/2004	15.7
A-44	GW-7462-081004-RAM-005	8/10/2004	16.9
A-44	WG-7462-111604-DJT-025	11/16/2004	15.6
A-44	WG-7462-031505-DJT-007	3/15/2005	12.6
A-44	WG-7462-061305-005	6/13/2005	16.9
A-44	GW-7462-1005-01	10/11/2005	15.4
A-44	WG-7462-120705-011	12/7/2005	14.6
A-44	WG-7462-022106-006	2/21/2006	13.7
A-44	WG-7462-051906-RAM-18	5/19/2006	14.5
A-44	GW-7462-082806-RM-21/-22	8/28/2006	17.5/17.5
A-44	GW-7462-111406-MJW-03	11/14/2006	16.1
A-45	GW-7462-020204-RAM-002	2/2/2004	14.4
A-45	GW-7462-051104-MJW-004	5/11/2004	17.4
A-45	GW-7462-081004-RAM-002	8/10/2004	16.7
A-45	WG-7462-111204-DJT-003	11/12/2004	13.4
A-45	WG-7462-031605-DJT-010	3/16/2005	13.4
A-45	WG-7462-061305-001	6/13/2005	17.5
A-45	GW-7462-1005-12	10/11/2005	15.0
A-45	WG-7462-120805-017	12/8/2005	12.4
A-45	WG-7462-022106-002	2/21/2006	14.0
A-45	WG-7462-051906-RAM-20	5/19/2006	14.9
A-45	GW-7462-082806-RM-26	8/28/2006	15.9
A-46	GW-7462-020204-RAM-001	2/2/2004	14.0
A-46	GW-7462-051004-MJW-001	5/10/2004	17.0
A-46	GW-7462-051104-MJW-001	5/11/2004	16.0
A-46	GW-7462-081004-RAM-004	8/10/2004	17.9
A-46	WG-7462-111204-DJT-004	11/12/2004	14.4
A-46	WG-7462-031605-DJT-011	3/16/2005	14.9
A-46	WG-7462-061405-007	6/14/2005	16.4
A-46	GW-7462-1005-04	10/10/2005	15.5
A-46	WG-7462-120805-016	12/8/2005	14.3
A-46	WG-7462-022106-005	2/21/2006	14.9
A-46	WG-7462-051806-RAM-15	5/18/2006	16.1
A-46	GW-7462-082806-RM-18	8/28/2006	17.1
A-47	GW-7462-081204-RAM-012	8/12/2004	17.9

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-47	WG-7462-111404-DJT-011	11/14/2004	12.8
A-47	WG-7462-031705-DJT-024	3/17/2005	12.2
A-47	WG-7462-061505-020	6/15/2005	18.0
A-47	GW-7462-1005-28	10/12/2005	14.0
A-47	WG-7462-120805-020	12/8/2005	13.3
A-47	WG-7462-022306-027	2/23/2006	13.4
A-47	WG-7462-053006-RAM-36	5/30/2006	15.4
A-47	GW-7462-083006-RM-38	8/30/2006	15.0
A-48	WG-7462-062405-085	6/24/2005	17.7
A-49	WG-7462-111804-DJT-039	11/18/2004	17.9
A-49	WG-7462-031505-DJT-003	3/15/2005	14.2
A-49	WG-7462-061405-014	6/14/2005	15.2
A-49	GW-7462-1005-02	10/11/2005	17.3
A-49	WG-7462-120705-010	12/7/2005	16.0
A-49	WG-7462-022206-013	2/22/2006	15.0
A-49	WG-7462-051906-RAM-17	5/19/2006	14.8
A-49	GW-7462-082806-RM-19	8/28/2006	17.6
A-49	GW-7462-111406-MJW-01	11/14/2006	17.6
A-50	GW-7462-020204-RAM-004	2/2/2004	16.3
A-50	GW-7462-051104-MJW-003	5/11/2004	18.4
A-50	GW-7462-081104-RAM-006	8/11/2004	17.9
A-50	GW-7462-081804-RAM-006	8/18/2004	19.2
A-50	WG-7462-031605-DJT-008	3/16/2005	14.5
A-50	WG-7462-061405-015	6/14/2005	16.5
A-50	GW-7462-1005-03	10/11/2005	16.3
A-50	WG-7462-022206-014	2/22/2006	14.4
A-50	WG-7462-051906-RAM-21	5/19/2006	15.8
A-50	GW-7462-082806-RM-23	8/28/2006	18.4
A-50	GW-7462-111406-MJW-002	11/14/2006	17.1
A-51	WG-7462-062405-087	6/24/2005	18.3
A-52	WG-7462-061705-038	6/17/2005	18.0
A-52	GW-7462-1005-50	10/14/2005	15.1
A-52	GW-7462-082506-RM-16	8/25/2006	21.3
A-53	WG-7462-062405-079	6/24/2005	15.9
A-54	WG-7462-062405-074	6/24/2005	14.6
A-55	WG-7462-062405-073	6/24/2005	14.8
A-56	GW-7462-081204-RAM-013	8/12/2004	16.9
A-56	WG-7462-111604-DJT-026	11/16/2004	14.3
A-56	WG-7462-031705-DJT-025	3/17/2005	12.9
A-56	WG-7462-061405-012	6/14/2005	16.1
A-56	GW-7462-1005-27	10/12/2005	14.1
A-56	WG-7462-120805-021	12/8/2005	13.0
A-56	WG-7462-022306-023	2/23/2006	13.0
A-56	WG-7462-053006-RAM-35	5/30/2006	15.5
A-56	GW-7462-083006-RM-37	8/30/2006	14.8
A-57	WG-7462-062405-076	6/24/2005	14.3

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample *Location*	***Sample*** *Identification*	***Sample*** *Date*	*Groundwater Temperature (°C)*
A-58	WG-7462-111704-DJT-033	11/17/2004	13.7
A-58	WG-7462-031705-DJT-021	3/17/2005	11.9
A-58	WG-7462-061405-011	6/14/2005	15.6
A-58	GW-7462-1005-30	10/12/2005	14.0
A-58	WG-7462-120805-027	12/8/2005	11.6
A-58	WG-7462-022306-030	2/23/2006	12.2
A-58	WG-7462-053106-RAM-41	5/31/2006	14.6
A-58	GW-7462-083006-RM-39/-40	8/30/2006	15.3/15.3
A-59D	WG-7462-062405-089	6/24/2005	20.1
A-59D	GW-7462-1005-40	10/13/2005	14.2
A-59S	WG-7462-111704-DJT-032	11/17/2004	12.6
A-59S	WG-7462-031805-DJT-026	3/18/2005	10.6
A-59S	WG-7462-061705-036	6/17/2005	14.6
A-59S	GW-7462-1005-41	10/13/2005	14.4
A-59S	WG-7462-120805-025	12/8/2005	12.5
A-59S	WG-7462-022406-033	2/24/2006	12.2
A-59S	WG-7462-060106-RAM-45	6/1/2006	16.7
A-60D	WG-7462-062405-083	6/24/2005	18.5
A-60D	GW-7462-1005-36	10/13/2005	16.4
A-60D	GW-7462-083106-RM-46	8/31/2006	14.1
A-60S	WG-7462-111704-DJT-031	11/17/2004	13.0
A-60S	WG-7462-031705-DJT-017	3/17/2005	10.3
A-60S	WG-7462-061705-037	6/17/2005	13.5
A-60S	GW-7462-1005-38	10/13/2005	13.7
A-60S	WG-7462-120805-023	12/8/2005	12.7
A-60S	WG-7462-022406-034	2/24/2006	12.3
A-60S	WG-7462-060106-RAM-44	6/1/2006	15.3
A-60S	GW-7462-083106-RM-47	8/31/2006	14.9
A-61S	WG-7462-111704-DJT-030	11/17/2004	13.8
A-61S	WG-7462-031705-DJT-018	3/17/2005	10.3
A-61S	WG-7462-061705-034	6/17/2005	13.1
A-61S	GW-7462-1005-39	10/13/2005	14.2
A-61S	WG-7462-120805-026	12/8/2005	12.5
A-61S	WG-7462-060106-RAM-46	6/1/2006	15.4
A-61S	GW-7462-083106-RM-50	8/31/2006	14.7
A-62D	WG-7462-111604-DJT-028	11/16/2004	12.6
A-62D	WG-7462-031505-DJT-005	3/15/2005	10.4
A-62D	WG-7462-061605-025	6/16/2005	21.0
A-62D	GW-7462-1005-09	10/11/2005	16.0
A-62D	WG-7462-120705-014	12/7/2005	4.5
A-62D	WG-7462-022206-017	2/22/2006	9.6
A-62D	WG-7462-052406-RAM-22	5/24/2006	14.6
A-62D	GW-7462-083106-RM-44	8/31/2006	18.0
A-62S	WG-7462-111704-DJT-029	11/17/2004	8.0
A-62S	WG-7462-031505-DJT-004	3/15/2005	7.5
A-62S	WG-7462-061605-024	6/16/2005	21.5

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample Location	*Sample Identification*	*Sample Date*	*Groundwater Temperature (°C)*
A-62S	GW-7462-1005-34	10/13/2005	17.3
A-62S	WG-7462-120705-013	12/7/2005	5.4
A-62S	WG-7462-022206-015	2/22/2006	7.6
A-62S	WG-7462-052406-RAM-23	5/24/2006	14.1
A-62S	GW-7462-083106-RM-45	8/31/2006	20.0
A-66D	GW-7462-1005-19	10/12/2005	14.9
A-66D	WG-7462-052406-RAM-30	5/24/2006	14.8
A-66D	GW-7462-082906-RM-29	8/29/2006	16.6
A-66D	GW-7462-111506-MJW-07	11/15/2006	15.3
A-66S	GW-7462-1005-17	10/12/2005	15.4
A-66S	WG-7462-052406-RAM-29	5/24/2006	14.1
A-66S	GW-7462-082906-RM-30	8/29/2006	16.9
A-66S	GW-7462-111506-MJW-06	11/15/2006	16.1
A-67D	GW-7462-1005-18	10/12/2005	15.5
A-67D	WG-7462-052606-RAM-34	5/26/2006	15.5
A-67D	GW-7462-082906-RM-27	8/29/2006	16.8
A-67D	GW-7462-111506-MJW-09	11/15/2006	15.7
A-67S	GW-7462-1005-16	10/12/2005	18.0
A-67S	WG-7462-052606-RAM-33	5/26/2006	15.1
A-67S	GW-7462-082906-RM-28	8/29/2006	19.1
A-67S	GW-7462-111506-MJW-08	11/15/2006	17.7
A-68D	GW-7462-1005-23	10/12/2005	15.5
A-68D	GW-7462-082906-RM-31	8/29/2006	17.1
A-68S	GW-7462-1005-24	10/12/2005	15.5
A-68S	GW-7462-082906-RM-32	8/29/2006	17.6
A-69	GW-7462-1005-44	10/14/2005	18.1
A-69	GW-7462-083106-RM-51	8/31/2006	19.0
A-69	GW-7462-111606-MJW-11	11/16/2006	16.0
A-69	GW-7462-111606-MJW-12	11/16/2006	16.0
A-70	GW-7462-1005-49	10/14/2005	18.3
A-70	GW-7462-111606-MJW-15	11/16/2006	16.3
A-71	GW-7462-111606-MJW-10	11/16/2006	16.9
A-73	GW-7462-082506-RM-11/-12	8/25/2006	16.4/16.4
A-74	GW-7462-082506-RM-10	8/25/2006	15.1
A-75	GW-7462-1005-48	10/14/2005	19.5
A-75	GW-7462-083006-RM-34	8/30/2006	18.9
A-75	GW-7462-111606-MJW-13	11/16/2006	15.8
A-76	GW-7462-1005-22	10/12/2005	14.8
A-77	GW-7462-1005-20	10/12/2005	13.1
A-78	GW-7462-1005-45	10/14/2005	14.4
A-79	GW-7462-1005-47	10/14/2005	14.6
B-5	GW-112801-7462-RAM-005	11/28/2001	14.4
R-110	GW-120501-7462-RAM-029	12/5/2001	14.5
R-110	GW-7462-020404-RAM-009	2/4/2004	11.8
R-110	GW-7462-051204-MJW-011	5/12/2004	15.2
R-110	GW-7462-081204-RAM-011	8/12/2004	16.6

TABLE D.2

SUMMARY OF GROUNDWATER TEMPERATURES
OXYCHEM
DELAWARE CITY, DELAWARE

Sample *Location*	***Sample*** *Identification*	***Sample*** *Date*	*Groundwater Temperature (°C)*
R-110	WG-7462-111604-DJT-027	11/16/2004	14.8
R-110	WG-7462-031605-DJT-015	3/16/2005	11.0
R-110	WG-7462-061505-021	6/15/2005	17.3
R-110	GW-7462-1005-31	10/13/2005	15.2
R-110	WG-7462-120805-030	12/8/2005	12.6
R-110	WG-7462-022306-022	2/23/2006	10.5
R-110	WG-7462-053006-RAM-39	5/30/2006	18.2
R-110	GW-7462-083006-RM-41	8/30/2006	17.1
R-112	GW-120301-7462-RAM-021	12/3/2001	15.0
R-112	GW-7462-020404-RAM-010	2/4/2004	13.5
R-112	GW-7462-051204-MJW-012	5/12/2004	16.0
R-112	GW-7462-081904-RAM-016	8/19/2004	16.7
R-112	WG-7462-111404-DJT-010	11/14/2004	14.2
R-112	WG-7462-031605-DJT-016	3/16/2005	12.8
R-112	WG-7462-061505-019	6/15/2005	15.0
R-112	GW-7462-1005-13	10/11/2005	14.8
R-112	WG-7462-120805-031	12/8/2005	13.0
R-112	WG-7462-022306-021	2/23/2006	13.7
R-112	WG-7462-051806-RAM-14	5/18/2006	15.9
R-112	GW-7462-082506-RM-17	8/25/2006	15.5
TG-1 (INFLUENT)	WG-7462-120805-032	12/8/2005	15.1
TG-1 (INFLUENT)	WG-7462-022306-031	2/23/2006	12.3
TG-1 (INFLUENT)	WG-7462-052506-RAM-31	5/25/2006	20.4
TG-2 (EFFLUENT)	WG-7462-120805-033	12/8/2005	17.5
TG-2 (EFFLUENT)	WG-7462-022306-032	2/23/2006	17.2
TG-2 (EFFLUENT)	WG-7462-052506-RAM-32	5/25/2006	20.4
AVERAGE GROUNDWATER TEMPERATURE (°C):			**15.2**