Health Consultation

Evaluation of Current and Future Soil Exposures at a Former
Explosives Manufacturing Facility: On-Site Restricted Use Area Part 2

DUPONT – LOUVIERS SITE

VILLAGE OF LOUVIERS, DOUGLAS COUNTY, COLORADO

EPA FACILITY ID: COD007060981

Prepared by the
Colorado Department of Public Health and Environment

JUNE 29, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

Evaluation of Current and Future Soil Exposures at a Former
Explosives Manufacturing Facility: On-Site Restricted Use Area Part 2

DUPONT-LOUVIERS SITE

VILLAGE OF LOUVIERS, DOUGLAS COUNTY, COLORADO

EPA FACILITY ID: COD007060981

Prepared By:

Colorado Department of Public Health and Environment
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Summary and Statement of Issues 3
Purpose 4
Background 5
Site History *5*
Site Description *6*
Demographics *6*
Community Health Concerns 7
Discussion 7
Environmental Data *7*
Contaminants of Potential Concern Selection *11*
Exposure Evaluation *12*
Current and Future Land-Use 12
Conceptual Site Model 13
Public Health Implications *14*
Child Health Considerations 18
Conclusions 18
Recommendations 19
Public Health Action Plan 19
References 21
Additional Tables and Figures 23
Appendices 48
Appendix A. Additional Exposure Assessment Information *48*
Appendix B. Toxicological Evaluation *52*

Summary and Statement of Issues

INTRODUCTION The Colorado Cooperative Program for Environmental Health Assessments and the Agency for Toxic Substances and Disease Registry's top priority is to ensure that all stakeholders have the best health information possible to protect the community from current and future health hazards associated with the DuPont-Louviers site in Douglas County, Colorado.

The DuPont-Louviers site is a former explosives manufacturing facility that operated during most of the 20th century. The site spans over 1,500 acres, and the former explosives manufacturing facilities were located on 310 acres, which is surrounded by a security fence. The available information suggests that individuals are currently trespassing onto the site.

The Hazardous Waste and Waste Management Division of the Colorado Department of Public Health and Environment requested that CCPEHA conduct a health consultation to evaluate the potential public health hazards associated with site-related contamination that remains on the property. Due to the size and varying former land-uses, the evaluation was split into a series of health consultations focusing on specific areas of the site. This health consultation addresses 9 areas of the former explosives manufacturing area at the DuPont-Louviers site. Two health consultations have already been completed on this site. The first health consultation focused on unrestricted use areas outside of the security fence on DuPont property and the second health consultation focused on highly contaminated restricted use areas inside the security fence.

The primary environmental medium of concern in this health consultation is soil because individuals can come into contact with contaminants found in surface and sub-surface soil at the site. Three primary groups of people have been identified that could come into contact with soil contaminants inside of the security fence at the DuPont-Louviers site: 1) current and future trespassers, 2) future construction workers, and 3) future industrial workers. However, the only exposure pathway that is possible at this time is trespassers that come into contact with soil contamination. Future potential exposures to construction workers and industrial workers are also evaluated because the area inside of the security fence on the DuPont property could be developed into industrial/commercial properties in the future following ongoing corrective action.

OVERVIEW	CCPEHA and ATSDR have reached one conclusion regarding exposure of current and future trespassers, future construction workers, and future industrial workers to soil contamination in the portions of the former manufacturing area located inside of the security fence at the DuPont-Louviers site.
CONCLUSION	Accidentally eating surface soil in all areas evaluated in this investigation is not expected to harm trespassers, construction workers, and industrial workers.
BASIS FOR DECISION	This conclusion was reached because their are low levels of soil contaminants (arsenic, benz(a)anthracene and benzo(a)pyrene) in these areas or the likelihood of exposure to soil contaminants is low (lead). This indicates that the amount of soil potentially swallowed by trespassers, industrial workers, and construction workers through incidental soil ingestion is associated with a low increased risk for developing cancer and non-cancer health effects.
NEXT STEPS	Arsenic is a known human carcinogen. To be prudent of public health, DuPont should reduce exposure to arsenic in the area so that the estimated cancer risks are at the background level for arsenic or at the CDPHE long-term cancer risk goal of one in a million. In addition, a land-use restriction of SWMU 31L should be considered in the Environmental Covenant to protect the developing fetus of female construction workers from lead exposure.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. Please call Thomas Simmons at 303-692-2961 for more information on the DuPont-Louviers site health consultation.

Purpose

The overall purpose of this health consultation is to evaluate the potential health hazards from exposure to soil contamination by current and future trespassers, construction workers, and industrial workers in the remaining portions of the former manufacturing area (area inside of the security fence) at the DuPont-Louviers site. Due to the size, varying potential for exposure, and degrees of contamination found at the site, the health

evaluation was divided into three health consultation documents. The initial health consultation focused on the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) outside of the former manufacturing area (outside of security fence), which are easily accessible to the public. A follow-up health consultation addressed the most contaminated SWMUs and AOCs inside of the security fence at the DuPont-Louviers site. This document focuses on the remaining SWMUs within the security fence that are relatively less contaminated and have not been evaluated in the preceding health consultations.

Background

Background information on the site has been detailed in a variety of documents conducted for site assessment and remediation at the DuPont-Louviers site. The information presented below is a synopsis of the pertinent background material for this health consultation. For more detailed site background information, refer to the Environmental Site Assessment (DuPont 1991), the RCRA Facility Investigation Reports (DuPont 2002, DuPont 2004), and the Human Health Risk Assessment document performed by DuPont (DuPont 2008).

Site History

E. I. DuPont de Nemours and Company (DuPont) and Explosives Technologies International (ETI) operated a commercial chemical explosives manufacturing facility near the village of Louviers, Douglas County, Colorado from 1908 to November 1989. The DuPont-Louviers site was acquired by DuPont in 1906 and dynamite production began in 1908. Dynamite production continued until May 1971 with a total production of approximately 1 billion pounds of dynamite. Other explosives manufactured at the plant over the years include pentaerythritol tetranitrate (PETN) as well as emulsion-type blasting agents and oxidizers. Ingredients for making explosives including nitroglycerin (NG), nitric acid, and sulfuric acid were also manufactured onsite using basic raw materials such as nitrate ore. In January 1988, the site was purchased by ETI who operated the plant until November 1989. At this point, all manufacturing activities ceased, and the property reverted to DuPont ownership in January 1990.

Solid explosive wastes were produced at the site as a byproduct of the manufacturing process. These wastes were stored in a U.S. Bureau of Firearms and Tobacco approved storage magazine and were typically burned or destroyed to render them non-hazardous. Non-hazardous and non-burnable wastes (such as metals and building materials) were deposited in onsite landfills, which were typically located in natural ravines. Most of the original buildings in the former manufacturing have been removed and/or burned to the ground. However, some foundations, building rubble, and pavement are still visible. The main office building, two warehouses, and an explosives storage magazine are the only buildings that have been left in place. Under voluntary cooperation with the Colorado Department of Public Health and Environment (CDPHE), DuPont developed a workplan to assess soil, surface water, and groundwater conditions at the site (June 1990). In 1998, DuPont entered into a Compliance Order on Consent with the CDPHE. Since this time, investigation and remediation has been underway.

Site Description

The DuPont-Louviers site is located approximately 25 miles south of Denver, Colorado near the Village of Louviers on a 1,520-acre parcel. The site is located along both sides of Plum Creek and north, west, and south of the Village of Louviers. DynoNobel and Plum Valley Estates bound the site to the west. To the north, a gravel pit exists and to the south is an open space area. The local topography consists of an overall hilly terrain with swales and creeks ranging from 5,570 feet to 5,800 feet above mean sea level. Water drains from the site toward Plum Creek to the northeast. Plum Creek is a tributary of the South Platte River.

The site currently consists of four main areas:

- Former explosives manufacturing area (355 acres),
- Conservation easement (349 acres),
- Areas outside the security fence that are not part of the conservation easement (310 acres), and
- Donated property for open space preservation (506 acres).

The perimeter of the DuPont-Louviers site is surrounded by a four-foot cattle fence. Inside the perimeter fence, the former manufacturing area is secured by a seven-foot security fence. A part-time security guard patrols the site to control access by trespassers.

Following preliminary investigations at the site, possible or known sources of contamination were broken into areas referred to as Solid Waste Management Units (SWMUs). In 1990, DuPont developed a work plan in conjunction with the CDPHE to address site closure and removal of site wastes located in SWMUs. Initially, 20 SWMUs were thought to exist at the DuPont-Louviers site. Following the Environmental Site Assessment Investigation conducted in 1991, additional SWMUs were added to the list of areas designated for assessment and remediation prior to closure. In addition, 3 Areas of Concern (AOC) have also been designated for assessment and remediation. Figure 1 shows the location of each SWMU and AOC at the DuPont-Louviers site.

Demographics

Louviers, Colorado was initially established as a company town for the DuPont-Louviers site. Many former DuPont employees still reside in the Village of Louviers, however, in recent years it appears that new residents have also moved into the area. According to the 2000 decennial census, the current population is 237 with nearly equal portions of males and females. The median age of the population is 43.8 years, which is slightly older than the national median of 35.3 years. Of the 237 individuals living in the Village of Louviers, 94.8% have attained at least a high school diploma and 38.3% have earned a bachelor’s degree or higher. According to the Census Bureau, no respondents claimed they spoke a language other than English.

Community Health Concerns

As part of the Compliance Order on Consent for the DuPont-Louviers site, DuPont was required to submit a plan for communicating with the community and creating a mechanism for the community to express their opinions and concerns regarding site activities. The original "Public Involvement Plan" was published in 1999 and was updated in 2004 following a large turnover in the population of Louviers. A total of 51 stakeholder interviews were conducted by representatives from the state health department and DuPont between 1999-2004. From these interviews, no major community concerns were noted. No one expressed any specific health concerns. Since no one expressed health concerns, the community is provided opportunity to express any new concerns through annual community meetings. This opportunity will be continually provided in the future. Some people expressed concern about potential impacts to groundwater and their drinking water from site-related contamination. This concern has been addressed. Many people were concerned with the source of water that would be used for remedial activities because of the shortage of water in Douglas County already. This concern is associated with ongoing limited groundwater resources and is not site related. One person expressed concerns regarding site remediation activities affecting air quality. This concern will be addressed in the future at the time of remediation.

Discussion

The overall goal of the public health consultation process is to determine if site-related contamination poses a public health hazard and to make recommendations to protect public health if need be. The first steps include an examination of the currently available environmental data and how individuals could be exposed to contaminants of potential concern (COPCs). If exposure pathways to COPCs exist, exposure doses are estimated and compared to health-based guidelines established by the ATSDR and EPA. This is followed by an in-depth evaluation if the estimated exposure doses exceed health-based guidelines.

Environmental Data

Soil, groundwater, and surface water data have been collected from the DuPont-Louviers site during the RCRA facility closure process. Soil is the primary environmental medium evaluated in this health consultation because either no contamination has been found (surface water) or no exposure pathway exists (groundwater). Soil borings were completed using a hand auger or Geoprobe®, and samples were collected from surface and sub-surface depths at most SWMUs and AOCs at the DuPont-Louviers site. The soil samples were sent to Severn Trent Laboratory in Denver, CO for analysis of various constituents depending upon the location, former use, and the likely contaminants that could be present in that particular location. Soil sampling activities specific to the SWMUs examined in this evaluation are discussed in greater detail below.

Solid Waste Management Unit 8

SWMU 8, also known as Landfill #2, is located within the limits of the former powder line near the central portion of the former manufacturing area. The landfill was used to

dispose of non-burnable plant wastes, powder line parts, crushed drums, various building materials, and emulsions used to make explosives.

The RFI investigation conducted in SWMU 8 consisted of two phases carried out between 2002 and 2003. Nine soil borings were completed in and around SWMU 8 and a total of 16 soil samples were collected (Figure 2). The initial 13 samples collected were analyzed for VOCs, SVOCs, nitrates/nitrites, metals, and explosives. Three follow-up soil samples were analyzed for barium. Overall, arsenic, barium, chromium, lead, mercury, nitrate/nitrite, and selenium were detected as shown in Table 1. Barium was detected in one sample at a concentration of 10,000 mg/kg. During the follow-up sampling, barium was detected; however, at much lower concentrations (max = 440 mg/kg). All other metals were detected at relatively low concentrations. Three VOCs (1,2-Dichloroethane, methylene chloride, and tetrachloroethylene) were also detected at low concentrations. No SVOCs, PETN, or NG were detected.

Solid Waste Management Unit 9

SWMU 9 is an erosional gully located within the former acid production area that was essentially used as a landfill. Employee interviews indicate that Fasloc (product developed by DuPont for locking bolts into the ceilings and walls of mines that contains limestone and epoxy), parts of Biazzi nitrator (used for NG production), non-PCB electrical equipment, asbestos, paint, cement, and brick scrap were disposed of in SWMU 9. SWMU 9 was filled with the debris, covered with soil, and landscaped by the time the initial site investigation began.

During the Phase I RFI, conducted in 2002, 5 borings were completed in and around SWMU 9 (Figure 3). Surface (0-2) and subsurface (6-8) samples were collected from each boring. One native soil samples was also collected from boring S09-01 at a depth of 15.5 ft. bgs. Sampling results indicate the presence of arsenic, barium, chromium, lead, mercury, and nitrates/nitrites at low concentrations. Four soil samples also indicated the presence of the SVOCs butyl benzyl ether, chrysene, fluoranthene, phenathrene, or pyrene at low concentrations. Benzene and styrene were also detected at low concentrations in the subsurface sample collected from location S09-05. A summary of the detected compounds is shown in Table 1.

Solid Waste Management Unit 10

SWMU 10 is another landfill located in the far northern portion of the former manufacturing area. The landfill was used to dispose of non-burnable plant wastes, decontaminated cement and piping, scrap metal, non-PCB electrical equipment, empty drums, Styrofoam, paint, and asbestos.

During assessment activities in 1993, workers encountered 9 canvas bags filled with PETN. Six of the bags were removed and disposed. The remaining 3 PETN bags were left in place for safety reasons, wetted, and covered with plastic and clean sand fill. Additional assessment activities (RFI) occurred in September 2001 and September 2005. Since PETN was discovered within SWMU 10, no soil borings were completed within the landfill. The main objective of the RFI was to delineate the vertical and horizontal extent of contamination. During the first phase of the RFI, five borings were completed

around SWMU 10 as shown in Figure 4. Soil samples were collected from various depths from the surface (0-2 ft. bgs.) to the subsurface (approximately 60 ft. bgs.). The samples were analyzed for VOCs, SVOCs, metals, nitrates/nitrites, NG, and PETN. As shown in Table 1, a number of metals were detected in the soil samples at the surface and at depth; however, all metals were detected at relatively low concentrations. Acetone and bis(2-ethylhexyl)phthalate were also detected at low concentrations. One sample contained 2,4-DNT at a concentration of 1.6 mg/kg.

Three additional borings were completed in the second phase of the RFI, which was conducted in September 2005. The focus of the phase II investigation was to examine the vertical extent of potential contamination stemming from SWMU 10. Seven soil samples were collected from depths 4-6, 8-10, 10-12, and 14-16 ft. bgs. The samples were analyzed for VOCs, SVOCs, metals, nitrates, and explosives. Again, a large number of metals were detected at low concentrations. Acetone was the only VOC detected in the soil data utilized for this evaluation (up to 16 ft. bgs.) and the concentration was very low (Table 1). No SVOCs or explosives were discovered during this round of sampling.

Solid Waste Management Unit 12

SWMU 12, also known as landfill #6, is located in the southern portion of the site near the main office building (Figure 1). The landfill is approximately 100 ft. long, 20 ft. wide, and 15 ft. deep. SWMU 12 was used between 1982-1985 to dispose of ash, metal, wood, glass, rebar, pipe, steel, an aluminum tank, and burned materials. The area of the landfill has been described as flat and heavily vegetated (DuPont 1991).

Previous investigations conducted at SWMU 12 indicated that metals and SVOCs were not present above background sampling. Two VOCs, toluene and methyl ethyl ketone, were present at very low concentrations. Nitrates were also detected at low concentrations. During the Phase I RFI, conducted in 2003, three soil borings were completed around SWMU 12 to delineate any potential contamination associated with the landfill (Figure 5). All of the borings were completed around SWMU 12 in areas that had not been previously investigated. Soil samples were collected from depths of 0-2, 6-8, and 12-14 ft. bgs. The samples were field screened for VOCs and explosives prior to sending them to the lab for analysis of lead and pH. The concentration of lead in SWMU 12 did not exceed 110 mg/kg in all of the soil samples (Table 1).

Solid Waste Management Unit 14

SWMU 14 was used as an equalization pond for water stemming from the acid manufacturing line and boiler blowdown prior to discharge to Plum Creek (via National Pollutant Discharge Elimination System outfall). SWMU 14 is currently dry and overgrown with vegetation. The original pond measured approximately 60 ft. long and 80 ft. wide. The pond was utilized from 1972-1989 when plant operations ceased.

In 2003, during the Phase I RFI, one soil boring was completed in the center of the pond to depths of 12-14 and 18-20 ft. bgs. (Figure 6). The samples were only analyzed for lead since lead exceeded residential screening values in previous sampling activities (Table 1).

Solid Waste Management Unit 18
SWMU 18 is an area that contained the emulsion separation tanks (or boats) used to separate fuel oil from ammonium nitrate solution. During the time of operation, occasional pump malfunctions overflowed the tanks and resulted in small ponds in this area. In 2001, the baffle tanks were removed and transported to the onsite decontamination area where they await decontamination and recycling.

During the Phase I RFI, nine soil borings were completed and samples were taken from various depths from surface to 19 ft. bgs. (Figure 7). A total of 12 samples were analyzed for TPH (diesel and gas range), benzene, ethylbenzene, toluene, PETN, and nitrates/nitrites. All of these constituents were detected in at least one soil sample from SWMU 18 with the exception of PETN and benzene (Table 1).

Solid Waste Management Unit 31E
SWMU 31 E contains the new Plant Laboratory and Powerhouse. Both facilities were moved to the current location around 1970. The Plant Laboratory is located within the main office building, and the Powerhouse is located just outside. Both facilities are still in use.

During the Phase I RFI, conducted in 2001, ten soil borings were completed in and around SWMU 31E. Soil samples were collected from 0-2, 6-8, and 12-14 ft. bgs. depending upon the sampling location (Figure 8). A total of eighteen samples were collected and analyzed for VOCs, SVOCs, PETN, NG, and metals. Arsenic, barium, chromium, lead, and mercury were all detected at relatively low concentrations. In addition, bis(2-ethylhexyl)phthalate was also detected (Table 1).

Solid Waste Management Unit 31L
SWMU 31L is the former NG Neutralizer Drains, which were located in the NG Neutralizing House. SWMU 31L is located near the center of the former manufacturing area and adjacent to the NG Ditch (SWMU 6). The building itself was a wooden two-story structure with one level having a wooden floor and the other level having concrete flooring. Both floor surfaces were covered with lead to contain NG spills. Probable wastes at SWMU 31L include NG, caustics, and lead.

During the Phase I RFI, 5 soil borings were completed in the middle and sides of the former location of the NG Neutralizing House (Figure 9). Soil samples were collected from 0-2 ft. bgs. at three locations, 6-8 ft. bgs. at all five boring locations, and at 12-14 ft. bgs. at three locations. A total of 11 samples were analyzed for pH, NG, and lead. In boring location 3, PETN was also analyzed. Lead was detected in 10 of the soil samples collected at a concentration range of 0.82 mg/kg – 2,840 mg/kg. PETN was also detected in both samples at boring location 3, at 9.2 mg/kg and 10.0 mg/kg. NG was not detected in any sample (Table 1).

Solid Waste Management Unit 31O
SWMU 31O consists of the old powerhouse drains within the former powerhouse, which is located just east of the main gate to the facility. The size of the old powerhouse is approximately 85 ft. long and 89 ft. wide. Engineering diagrams show one floor drain on

the east wall of the building. Rain drains at each corner, and a terra cotta pipe running below the floor in a north-south direction through the center of the building. The drains are shown exiting the building on the east and north sides. The likely contaminants present at SWMU 31O include boiler fuel (oil and/or coal) and solvents used for cleaning and repairs.

Ten soil borings were completed in and around the location of the old powerhouse building, during the phase I RFI (Figure 10). Soil samples were collected from 0-2 ft. bgs. and 6-8 ft. bgs. at all boring locations and at 12-14 ft. bgs. at 6 locations. A total of 26 samples were analyzed for VOCs, SVOCs, TPHs, and metals. Tetrachloroethylene, the only VOC detected, was detected in one sample at a very low concentration. Six PAHs were detected at low concentration including benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene. In addition, one other SVOC, bis(2-ehtylhexyl)phthalate was also detected at a low concentration. Arsenic, barium, chromium, lead, and mercury were detected at unremarkable concentrations. Table 1 includes a summary of all detected compounds in SWMU 31O.

Contaminants of Potential Concern Selection

To identify contaminants of potential concern (COPCs), the available environmental data was screened with comparison values established by the ATSDR and EPA. The comparison values (CVs) used in this evaluation are derived for residential exposure scenarios (i.e. residential exposure to surface soil). The comparison values used in this evaluation are based on 350 days exposure per year over a period of 30 years with built-in orders of protection beyond what is considered safe levels of exposure (Table 1). Using these CVs is considered conservative and protective of the individuals under consideration in this evaluation. Therefore, if the maximum concentration of a particular contaminant is below the CV, it is dropped from further evaluation. If the maximum concentration of the contaminant is above the CV, it is generally retained for further analysis as a COPC. However, exceeding the CV does not indicate that a health hazard exists, only that additional evaluation is warranted.

Overall, the number of COPCs is relatively small in comparison to the number of analytes sampled in the soil samples collected from inside the security fence. Of the nine SWMUs under consideration in this evaluation, arsenic, barium, benz(a)anthracene, benzo(a)pyrene, and lead were the only contaminants that exceeded the residential CV. This information is summarized below in Table 2. Diesel range organics and gasoline were also detected in three SWMUs; however, these compounds were not selected as COPCs because risks due to these compounds are evaluated by analyzing individual VOCs and SVOCs that are found in these products (e.g., benzene, toluene, ethylbenzene, xylene, and PAHs).

Table 2. COPC Selection Summary

Area	Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	CV Source
SWMU 8	Arsenic	7.8	0.39	EPA RSL-cancer
SWMU 9	Arsenic	18	0.39	EPA RSL-cancer
SWMU 10	Arsenic	5.7	0.39	EPA RSL-cancer
	2,4-Dinitrotoluene	1.6	1.6	EPA RSL-cancer
SWMU 31E	Arsenic	6.5	0.39	EPA RSL-cancer
SWMU 31L	Lead	2840	400.0	EPA OSWER-non-cancer
SWMU 31O	Arsenic	10.6	0.39	EPA RSL-cancer
	Benz(a)anthracene	0.44	0.15	EPA RSL-cancer
	Benzo(a)pyrene	0.4	0.015	EPA RSL-cancer

Terms:
CV = Comparison Value
EPA RSL = Environmental Protection Agency's Regional Screening Levels
EPA OSWER: Environmental Protection Agency's Office of Solid Waste and Emergency Response

Exposure Evaluation

The exposure evaluation examines current and future land-use at the site to develop a conceptual site model that describes how people could come into contact with site-related wastes. Simply having contamination in the environment does not indicate there is a public health hazard. Therefore, it is necessary to determine if and how individuals can be exposed to the contamination. As mentioned previously, this health consultation focuses on portions of the former explosives manufacturing area at the DuPont-Louviers site.

Current and Future Land-Use

Currently, there is a very limited amount of activity and personnel at the DuPont-Louviers site. Explosives manufacturing ceased in 1989. Since this time, DuPont has been dismantling structures and implementing the RCRA facility closure process in conjunction with the State health department (CDPHE). An onsite laboratory connected to the main office building is one of the few remaining structures at the DuPont-Louviers site. Environmental investigation and remediation are the primary activities that are currently taking place. The individuals conducting the environmental investigation and remediation are trained professionals that are not considered in this evaluation because there is an inherent risk to these workers and health and safety plans are in place to protect them (including the use of personal protective equipment). Break-ins and vandalism indicate that trespassers have bypassed the security fence and gained access to the former manufacturing area. Therefore, the current exposure scenario under consideration in this evaluation is individuals who trespass into the former manufacturing area.

Future land-use of the area within the security fence will remain industrial/commercial. An environmental covenant will be placed on the future development of the former manufacturing area to prevent residential development. Thus, no residential exposure scenario will exist in the future. Once all remedial activity of the former manufacturing

area is complete, the area may be developed into industrial and/or commercial properties. Environmental covenants will be established to restrict the use of shallow groundwater in the area around the DuPont-Louviers site because some contamination has been found in the alluvial aquifer (primarily nitrates). In addition, the covenant will restrict activities at SWMUs where waste (i.e. landfills) and subsurface soil contamination may remain after all the corrective action process has been completed. Therefore, it appears that future exposure scenarios would possibly include industrial and commercial workers. It is also assumed that the current trespassing scenario is not likely to change in the immediate future, but it is possible that the trespassing scenario may change after industrial/commercial development takes place.

Conceptual Site Model

Current Exposures

At this time only one exposure scenario is thought to occur at the DuPont-Louviers site and that is trespassing. The available information suggests that young people trespass onto portions of the property by climbing over the perimeter fence and gaining access to the area located outside of the former manufacturing area (security fenced portion). It is also possible that some of these same individuals access the former manufacturing area (within security fence). Trespassers could come into contact with site-related contamination in surface soil that has been affected by former operations. The probable routes of exposure to surface soil are incidental ingestion and dermal contact during play and hand-mouth activity. However, incidental ingestion is considered the major route of exposure for the COPCs evaluated in this health consultation.

There are people living near the site, but it does not appear that these residents come into contact with site-related contamination. The areas of soil contamination are not close to residential properties and it does not appear that soil contaminants are, or could be, transported to the residential properties by wind or some other mechanism. As noted previously, some contamination has been found in groundwater, which could be of concern if people were drinking it. However, there are no residential wells tapped into the shallow alluvial groundwater downgradient of the DuPont-Louviers site and an environmental covenant is to be put into place restricting the use of this water for any future development. In addition, the Village of Louviers water supply is a groundwater well located upgradient of the DuPont Louviers site. This well has been sampled and no site-related contamination was discovered. Therefore, a current residential exposure scenario to groundwater and soil was not evaluated further.

Future Exposures

Because of the uncertainties associated with future land-use, all potential future exposures are considered hypothetical that may or may not occur at some point in the future. Three hypothetical exposure scenarios were used to evaluate the potential future health risks of soil contamination at the site (inside security fence): trespassing, industrial, and construction work. As mentioned, it is not expected that the trespassing scenario will change in the near future. Thus, the same exposure factors that were used to assess the current trespassing exposure scenario were used to evaluate the future trespassing exposure scenario.

The former manufacturing area may be developed into industrial/commercial properties once all of the remedial activity has been completed. One of the primary purposes of this evaluation is to determine if further corrective action is necessary to protect current and future public health. If the portion of the DuPont-Louviers facility is developed for industrial/commercial use in the future, construction/excavation workers will be necessary. Construction/excavation workers were evaluated independently because of the nature of their work, which may include very "soil intrusive" activities as well as exposure to contaminants at depth. In addition, industrial workers are also a future possibility. Industrial workers could be exposed to contaminants in surface soil in the same manner as the other receptors; however, the exposure assumptions are slightly different for this group of individuals. As mentioned above, because of the environmental covenant restricting the use of this water for any future development, future potential exposures to groundwater are not evaluated at this time.

Table 3. Conceptual Site Model

Source	Point of Exposure	Affected Environmental Medium	Potentially Exposed Populations	Timeframe of Exposure	Route of Exposure
Industrial Waste	SWMU 8	Surface and Subsurface soils	Trespassers	Current (Complete), Future (Potential)	Incidental Ingestion and Dermal Exposure to Surface Soil*
	SWMU 9				
	SWMU 10		Construction Workers	Future (Potential)	Incidental Ingestion and Dermal Exposure to Surface and Subsurface
	SWMU 12				
	SWMU 14		Industrial Workers	Future (Potential)	Soil Incidental Ingestion and Dermal Exposure to Surface Soil
	SWMU 18				
	SWMU 31E				
	SWMU 31L				
	SWMU 31O				

*Note: Dermal contact exposure pathway is not evaluated because the incidental ingestion is considered the major exposure pathway and is evaluated in this health consultation.

Public Health Implications

Evaluating the public health implications of current and future exposure to soil contaminants located in the former manufacturing area of the DuPont-Louviers site is a multi-step process. For all contaminants that exceed the comparison value (COPC), exposure doses are estimated for non-cancer and cancer endpoints (if the COPC is a carcinogen). The estimated exposure doses are then compared with non-cancer health-based guidelines and the acceptable cancer risk range to evaluate if adverse health effects are likely from contacting soil contaminants inside of the security fence. If the estimated exposure dose is higher than the health-based reference levels, further evaluation is conducted. Because the areas of contamination inside the security fence are separate and vary in COPCs and levels of COPCs, exposure doses were estimated for each receptor in each SWMU.

To estimate exposure doses, one must make assumptions such as how much soil will be accidentally ingested over a period of time. These assumptions, or exposure factors, can be based on scientific literature, site-specific information, or professional judgment. The actual exposure factors may be higher or lower than the exposure factors used in this evaluation, which means that the actual health risk may also be higher or lower than what is presented in this document. In addition, many factors determine individual responses to chemical exposures. These factors include the dose, duration, and individual factors such as age, gender, diet, family traits, lifestyle, and state of health. For these reasons, this evaluation cannot determine the actual health risk to any one particular individual. Rather, this evaluation provides estimates of risk using conservative and reasonable exposure factor assumptions. The same exposure factors were used for each area evaluated in this health consultation. More information regarding the exposure factors used in this document and the toxic potential of risk driving chemicals is available in Appendix A and Appendix B, respectively.

SWMU 8

Arsenic and barium exceeded the residential CVs in soil and were selected as COPCs in soil at SWMU 8. Non-cancer exposure doses were estimated for each receptor with one exception of barium doses for construction workers. The calculated exposure point concentration of barium for construction workers is below the residential screening value. Therefore, barium in soil at SWMU 8 is not likely to harm construction workers and was not evaluated further. In addition, each non-cancer exposure dose for trespassers, industrial workers, and construction workers is below the health-based guideline for both arsenic and barium (Table 2). This indicates that the amount of arsenic and barium potentially swallowed by all users is associated with a low risk of developing non-cancer adverse health effects.

The U.S. Department of Health and Human Services, the EPA, and the International Agency for Research on Cancer (IARC) have determined that inorganic arsenic is a known human carcinogen. As such, the possibility of developing cancer from exposure to arsenic in soil should also be evaluated. Theoretical cancer risks were estimated for each receptor in SWMU 8. Theoretical cancer risks are evaluated by comparing the estimated risk to a theoretical cancer risk range that is generally considered acceptable. The acceptable cancer risk range spans from 1 excess cancer case per 1,000,000 (low-end) to 100 excess cancer cases per 1,000,000 (high-end). Alternatively, this can be expressed as $1 * 10^{-6}$ (low-end) to $1 * 10^{-4}$ (high-end). As shown in Table 5, all of theoretical cancer risks that were estimated for exposure to arsenic in soil at SWMU 8 are at, or below, the low-end of the acceptable cancer risk range. The highest theoretical cancer risk was estimated for industrial workers at 4 excess cancer cases per million people exposed ($4.1 * 10^{-6}$). This indicates that the amount of arsenic potentially swallowed through incidental ingestion of soil during various activities by trespassers and industrial workers is associated with a low increased risk of developing cancer.

SWMU 9

Arsenic was the only contaminant that exceeded the residential CVs in soil at SWMU 9 and was retained as a COPC. All of the estimated non-cancer exposure doses of arsenic

are below the health-based guideline, which indicates that adverse health effects are not likely to occur from exposure to soil in SWMU 9 (Table 4). Theoretical cancer risks were also estimated for all of the potential receptors identified in this evaluation (Table 5). The highest theoretical cancer risk was estimated for industrial workers at 3 excess cancer cases per 1,000,000 exposed individuals ($3.0 * 10^{-6}$). The estimated cancer risks for trespassers and construction workers are lower than the acceptable cancer risk range. This indicates that the amount of arsenic potentially swallowed through incidental ingestion of soil during various activities by trespassers, construction workers, and industrial workers is associated with a low increased risk of developing cancer and non-cancer health effects.

SWMU 10

In SWMU 10, arsenic and 2,4-DNT were the only contaminants that exceeded the comparison value and were selected as COPCs. However, 2,4-DNT was only detected in one sample at a concentration equal to the residential CV (1.6 mg/kg), but significantly below the EPA industrial worker CV of 5.5 mg/kg. Therefore, 2,4-DNT was not considered further since exposure to 2,4-DNT at this level is not likely to result in adverse health effects for the receptors under consideration in this evaluation (i.e. non-residents). All of the estimated non-cancer exposure doses for arsenic are below the health-based guideline (Table 4). In addition, the highest theoretical cancer risk that was estimated for industrial workers is 3 excess cancer cases per 1,000,000 exposed individuals ($3.0 * 10^{-6}$), which is at the low end of the acceptable cancer risk range (Table 5). The estimated cancer risks for trespassers and construction workers are lower than the acceptable cancer risk range.

This indicates that the amount of arsenic potentially swallowed through incidental ingestion of soil during various activities by trespassers, construction workers, and industrial workers is associated with a low increased risk of developing cancer and non-cancer health effects.

SWMU 31E

Arsenic was the only contaminant that exceeded the residential comparison value and was selected as a COPC in SWMU 31E soil. All non-cancer exposure doses were below the health-based guideline (Table 4). Similarly, all of estimated cancer risks are below a level of significant concern (i.e., at the low end or below the acceptable cancer risk range) (Table 5). The highest theoretical cancer risk was estimated for industrial workers at 3.4 excess cancer cases per one million exposed individuals ($3.4 * 10^{-6}$). This indicates that the amount of arsenic potentially swallowed through incidental ingestion of soil during various activities by trespassers, construction workers, and industrial workers is associated with a low increased risk of developing cancer and non-cancer health effects.

SWMU 31 L

Lead exceeded the residential screening value of 400 mg/kg in subsurface soil of SWMU 31L and was selected as a COPC. Although the mean concentration of 306 mg/kg for lead is below the residential CV, the maximum detected concentration of 2,840 mg/kg at the 6-8 ft depth interval is above the residential (400 mg/kg) as well as worker (780 mg/kg) screening values. Exposure to subsurface soil (6-8 ft. bgs.) in one localized area

seems somewhat unlikely. However, because of the high level of lead in this spot, a land-use restriction should be considered in the environmental covenant to protect the developing fetus of female construction workers.

Elsewhere in SWMU 31L at 0-2 feet depth interval, the concentration of lead ranges from 6.4 mg/kg to 185 mg/kg (below the screening value). Therefore, further evaluation of lead exposure in surface soil at SWMU 31L for trespassers and industrial workers is not required.

SWMU 31O

Three contaminants exceeded the residential screening value in SWMU 31O and were selected as COPCs: arsenic, benz(a)anthracene, and benzo(a)pyrene. Benz(a)anthracene and benzo(a)pyrene belong to a class of compounds referred to as polycyclic aromatic hydrocarbons. Both compounds are considered likely carcinogens. However, non-cancer health-based guidelines have not been established for benz(a)anthracene and benzo(a)pyrene. As such, only carcinogenic health effects can be evaluated for these compounds. The estimated non-cancer exposure doses for arsenic in soil at SWMU 31O are below the health-based guideline for all receptors (Table 4). Theoretical cancer risks were estimated for all three COPCs. All of the estimated cancer risks are below the acceptable cancer risk range (Table 5). When individuals are exposed to multiple carcinogenic compounds, the theoretical cancer risks for each contaminant can be combined to evaluate a cumulative theoretical cancer risk. The combined theoretical cancer risks are also below the acceptable cancer risk range for trespassers and construction workers but are at the low end of the acceptable cancer risk range for industrial workers. As shown in Table 5, the highest combined theoretical cancer risk was estimated for industrial workers at 3.5 excess cancer cases per one million individuals ($3.5 * 10^{-6}$). This indicates that the amount of arsenic, benz(a)anthracene, and benzo(a)pyrene potentially swallowed through incidental ingestion of soil during various activities by trespassers, construction workers, and industrial workers is associated with a low increased risk of developing cancer and non-cancer health effects.

Uncertainty

This is not intended to be an in-depth discussion of all uncertainties. Rather, the focus is to highlight the major assumptions and limitations that are specific to this evaluation. In general, the uncertainties inherent in any risk assessment are likely to over- or underestimate exposures and health hazards. The magnitude of this uncertainty is generally unknown. Some of the major uncertainties of this evaluation are briefly noted below.

- The assumption of 100% metal bioavailability arsenic-contaminated soils. This is a conservative assumption based on what is known of the reduced bioavailability of metals in soils.

- Many of the surface soil samples were collected from a depth interval of 0-2 feet below ground surface. These samples may not be representative of actual exposures to soil at the surface and may under- or over-estimate the actual health risks.

- Soil ingestion was considered the major pathway of exposure in this evaluation. Therefore, risks were not evaluated through the dermal contact exposure pathway. This may slightly underestimate total risk from combined exposure pathways without impacting the conclusions of this health consultation.

- Many metals are naturally occurring in the soils of Colorado. This is particularly relevant for arsenic. The concentrations found in some areas are consistent with background levels found elsewhere onsite. Thus, the risks associated with arsenic in some areas may not be attributable to site-related contamination.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and behavioral differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

In this evaluation, no child exposure scenarios were evaluated since it is unlikely that children (ages 0-6) will be in the former manufacturing area now or in the future. However, the concentration of lead at the 6-8 ft. depth interval in SWMU 31 L could harm the developing fetus of female construction workers.

Conclusions

CCPEHA and ATSDR have reached the following conclusion regarding current/future exposures by trespassers and future exposures by construction and industrial workers to soil contaminants in the areas of the former explosives manufacturing facilities under investigation in this evaluation (SWMUs 8, 9, 10, 12, 14, 18, 31E, 31L and 31O) at the DuPont-Louviers site:

Accidentally eating surface soil in all areas evaluated in this investigation is not expected to harm trespassers, construction workers, and industrial workers. This conclusion was reached because the theoretical cancer risks of arsenic, benz(a)anthracene, and benzo(a)pyrene for trespassers, construction workers, and industrial workers are at the low end of the acceptable cancer risk range. In addition, the non-cancer hazards for arsenic and barium are below levels of health concern (i.e., safe dose"). This indicates that the amount of contaminants potentially swallowed by trespassers, industrial workers,

and construction workers through incidental soil ingestion is associated with a low increased risk for developing cancer and non-cancer health effects.

It should be noted that elevated levels of lead are found in subsurface soil (6-8 ft. bgs.) at one localized spot in SWMU 31 L that could be potentially harmful to the developing fetus of female construction workers. Although exposure to subsurface soil in one localized area seems unlikely, a land-use restriction in this area should be considered in DuPont's Environmental Covenant.

Recommendations

Based upon CCPEHA's review of the environmental data, exposure pathways, and potential public health implications of exposure to soil contaminants located inside of the security fence on the DuPont-Louviers property, the following actions are appropriate and protective of current and future users of the site.

DuPont should:

- To the extent possible, reduce exposure to arsenic in all areas of this evaluation to achieve background levels of arsenic or CDPHE's target cancer risk level of $1 * 10^{-6}$.
- Consider a land-use restriction in SMWU 31L to control or limit exposure to lead in subsurface soil at 6-8 ft. depth interval to protect the developing fetus of future female construction workers.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by CCPEHA and other governmental agencies at the site. The purpose of the public health action plan is to ensure that this public health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, eating, or touching hazardous substances in the environment. Included is a commitment on the part of CCPEHA to follow up on this plan to be sure that it is implemented.

Public health actions that have or will be implemented:

- As necessary, CCPEHA will review any additional data collected from the DuPont-Louviers site and evaluate the public health implications of the new data.

- Upon request, CCPEHA will provide assistance to DuPont and State environmental officials on sampling plans and analysis.

- CCPEHA will provide the appropriate level of health education on the findings of this health consultation to stakeholders and the community.

Author and Reviewers

Thomas Simmons
Health Assessor
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2961
Fax: 303-782-0904
E-mail: tom.simmons@state.co.us

CDPHE Designated Reviewer:

Raj Goyal Ph.D
Principal Investigator
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2634
Fax: 303-782-0904
E-mail: raj.goyal@state.co.us

ATSDR Designated Reviewer:

Jennifer Freed MPH
Technical Project Officer
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

Agency for Toxic Substances and Disease Registry (ATSDR 2005). *Public Health Assessment Guidance Manual*, Revised January 2005. Available on the Internet at: http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html , accessed August 2009.

Agency for Toxic Substances and Disease Registry (ATSDR 2007a). *Toxicological Profile for Arsenic*, August 2007. Available on the Internet at: http://www.atsdr.cdc.gov/toxprofiles/tp2.html , Accessed August 2009.

Agency for Toxic Substances and Disease Registry (ATSDR 2007b). *Toxicological Profile for Lead*, August 2007. Available on the Internet at: http://www.atsdr.cdc.gov/toxprofiles/tp13.html , Accessed August 2009.

DuPont Corporate Remediation Group (DuPont 1991). *Environmental Site Assessment Phase I DuPont-Louviers Site*, March 1991.

DuPont Corporate Remediation Group (DuPont 2002). *Phase I RCRA Facilities Investigation Report Part I Volume 1*, September 2002.

DuPont Corporate Remediation Group (DuPont 2004). *Phase I RFI Report DuPont-Louviers Site Part II Volume 1*, July 2004.

DuPont Corporate Remediation Group (DuPont 2008). *Human Health Baseline Risk Assessment DuPont-Louviers Site*, January 2007, Revised March 2008.

Goodman, A.G., Goodman, L.S., and Gilman, A. (1980). *The pharmacological basis of therapeutics*, Sixth edition, pp. 819-833.

World Health Organization, International Agency for Research and Cancer (IARC 1980). *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Some Metals and Metallic Compounds, Volume 23.* Available on the Internet at: http://monographs.iarc.fr/ENG/Monographs/vol23/volume23.pdf, Accessed January 2010.

NTP. 2005. Report on carcinogens. 11 ed. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. http://ntp-server.niehs.nih.gov/ntp/roc/toc11.html. February 15, 2004.

U.S. Environmental Protection Agency, (EPA 1993). *Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure (Draft)*, November 1993.

U.S. Environmental Protection Agency, National Center for Environmental Assessment (EPA 1997). *Exposure Factors Handbook*, August 1997. Available on the Internet at: http://www.epa.gov/ncea/efh/report.html, Accessed August 2009.

U.S. Environmental Protection Agency, Office of Emergency and Remedial Response (EPA 1989). *Risk Assessment Guidance for Superfund*, December 1989.

U.S. Environmental Protection Agency, (EPA 2007). *User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) Windows® 32-bit version*, May 2007. Available on the Internet at: http://www.epa.gov/superfund/lead/products/ugieubk32.pdf, Accessed August 2009.

U.S. Environmental Protection Agency, Region 9 (EPA 2008). *Regional Screening Level Tables*, last update September 2008. Available on the Internet at: http://www.epa.gov/region09/superfund/prg/, Accessed August 2009.

U.S. Environmental Protection Agency (EPA 2009). *Integrated Risk Information System*, last update January 2009. Available on the Internet at: http://cfpub.epa.gov/ncea/iris/index.cfm, Accessed June 2009.

Additional Tables and Figures

Table 1. Summary of Detected Compounds in Surface and Subsurface Soil (DuPont-Louviers Site)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 8	Arsenic	0-2	2.3 – 7.8	2.9	6	100%	0.39[2]	X
	Arsenic	6-8	1.6 – 3.3	2.2	7	100%	0.39[2]	X
	Barium	0-2	47 – 10,000	1,234	9	100%	10,000[1]	X
	Barium	6-8	12 – 790	156	7	100%	10,000[1]	
	Chromium	0-2	5.5 – 14.0	9.3	6	100%	280[2]	
	Chromium	6-8	2.2 – 13	6.3	7	100%	280[2]	
	1,2-Dichloroethane	0-2	ND – 0.0054	N/a	6	16.7%	0.45[2]	
	1,2-Dichloroethane	6-8	ND	N/a	7	0%	0.45[2]	
	Lead	0-2	4.5 – 82	27.7	6	100%	400	
	Lead	6-8	3.3 – 11	6.4	7	100%	400	
	Mercury	0-2	ND – 0.058	N/a	6	33.3%	4.3[2]	
	Mercury	6-8	ND	N/a	7	0%	4.3[2]	
	Methylene Chloride	0-2	ND – 0.0096	N/a	6	16.7%	11[2]	
	Methylene Chloride	6-8	ND	N/a	7	0%	11[2]	
	Nitrate/Nitrite/Nitrogen	0-2	ND - 110	27.8	6	83.3%	5,000[1]	
	Nitrate/Nitrite/Nitrogen	6-8	ND – 60	29.5	7	85.7%	5,000[1]	
	Selenium	0-2	ND	N/a	6	0%	300[1]	
	Selenium	6-8	ND – 1.7	N/a	7	14.3%	300[1]	
	Tetrachloroethene	0-2	ND – 0.054	N/a	6	33.3%	0.57[2]	
	Tetrachloroethene	6-8	ND – 0.031	N/a	7	14.3%	0.57[2]	
SWMU 9	Arsenic	0-2	3.2 – 7.1	4.64	5	100%	0.39[2]	X
	Arsenic	6-8	1.9 – 18	8.1	6	100%	0.39[2]	X
	Barium	0-2	94 – 180	132.8	5	100%	10,000[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 9 (contd.)	Barium	6-8	38 – 120	72.7	6	100%	10,000[1]	
	Benzene	0-2	ND	N/a	5	0%	1.1[2]	
	Benzene [a]	6-8	ND – 2.8	N/a	6	16.7%	1.1[2]	X
	Butyl Benzyl Phthalate	0-2	ND	N/a	5	0%	260[2]	
	Butyl Benzyl Phthalate	6-8	ND – 14.0	N/a	6	16.7%	260[2]	
	Chromium	0-2	6.8 – 10	8.14	5	100%	280[2]	
	Chromium	6-8	1.9 – 15	9.65	6	100%	280[2]	
	Chrysene	0-2	ND – 0.41	N/a	5	40%	15[2]	
	Chrysene	6-8	ND	N/a	6	0%	15[2]	
	Fluoranthene	0-2	ND – 0.76	0.59	5	60%	2,000[1]	
	Fluoranthene	6-8	ND	N/a	6	0%	2,000[1]	
	Lead	0-2	110 – 370	284	5	100%	400[3]	
	Lead	6-8	9.1 – 160	44.4	6	100%	400[3]	
	Mercury	0-2	ND – 0.12	0.08	5	60%	4.3[2]	
	Mercury	6-8	ND – 0.04	N/a	6	16.7%	4.3[2]	
	Nitrate/Nitrite/Nitrogen	0-2	ND – 4.1	2.9	5	60%	5,000[1]	
	Nitrate/Nitrite/Nitrogen	6-8	ND	N/a	6	0%	5,000[1]	
	Phenanthrene	0-2	ND – 0.58	N/a	5	20%	NA	
	Phenanthrene	6-8	ND	N/a	6	0%	NA	
	Pyrene	0-2	ND – 0.69	N/a	5	40%	1,700[1]	
	Pyrene	6-8	ND	N/a	6	0%	1,700[1]	
	Styrene	0-2	ND	N/a	5	0%	200[1]	
	Styrene	6-8	ND – 48	N/a	6	16.7%	200[1]	
SWMU 10	Acetone	0-2	ND – 0.055	0.036	5	60%	50,000[1]	
	Acetone	0-8	0.057	N/a	1	100%	50,000[1]	

	Acetone	4-6	ND – 0.02	N/a	2	50%	50,000[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (Contd.)	Acetone	8-10	ND	N/a	1	0%	50,000[1]	
	Acetone	8-12	0.032	N/a	1	100%	50,000[1]	
	Acetone	10-12	ND	N/a	1	0%	50,000[1]	
	Acetone	12-16	ND	N/a	1	0%	50,000[1]	
	Acetone	14-16	ND	N/a	1	0%	50,000[1]	
	Acetone	All	ND – 0.057	0.033	13	46.2%	50,000[1]	
	Aluminum	4-6	3,700 – 4,000	N/a	2	100%	50,000[1]	
	Aluminum	8-10	2,300	N/a	1	100%	50,000[1]	
	Aluminum	10-12	5,600	N/a	1	100%	50,000[1]	
	Aluminum	14-16	1,700	N/a	1	100%	50,000[1]	
	Aluminum	All	1,700 – 5,600	3,460	5	100%	50,000[1]	
	Arsenic	0-2	1.7 – 5.7	3.2	5	100%	0.39[2]	
	Arsenic	0-8	2.3	N/a	1	100%	0.39[2]	
	Arsenic	4-6	1.3 – 1.4	N/a	2	100%	0.39[2]	
	Arsenic	8-10	0.99	N/a	1	100%	0.39[2]	
	Arsenic	8-12	2.2	N/a	1	100%	0.39[2]	
	Arsenic	10-12	2.1	N/a	1	100%	0.39[2]	
	Arsenic	12-16	1.5	N/a	1	100%	0.39[2]	
	Arsenic	14-16	0.76	N/a	1	100%	0.39[2]	
	Arsenic	All	0.76 – 5.7	2.21	13	100%	0.39[2]	
	Barium	0-2	57.2 - 247	127.8	5	100%	10,000[1]	
	Barium	0-8	76.8	N/a	1	100%	10,000[1]	
	Barium	4-6	32 - 34	N/a	2	100%	10,000[1]	
	Barium	8-10	16	N/a	1	100%	10,000[1]	

	Barium	8-12	70.9	N/a	1	100%	10,000[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Barium	10-12	56	N/a	1	100%	10,000[1]	
	Barium	12-16	33.4	N/a	1	100%	10,000[1]	
	Barium	14-16	20	N/a	1	100%	10,000[1]	
	Barium	All	16 – 247	75.2	13	100%	10,000[1]	
	Beryllium	4-6	0.36 – 0.39	N/a	2	100%	100[1]	
	Beryllium	8-10	0.24	N/a	1	100%	100[1]	
	Beryllium	10-12	0.51	N/a	1	100%	100[1]	
	Beryllium	14-16	0.2	N/a	1	100%	100[1]	
	Beryllium	All	0.2 – 0.51	0.34	5	100%	100[1]	
	Bis(2-ethylhexyl)phthalate	0-2	1.8 – 4.2	2.9	5	60%	35[2]	
	Bis(2-ethylhexyl)phthalate	0-8	ND	N/a	1	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	4-6	ND	N/a	2	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	8-10	ND	N/a	1	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	8-12	ND	N/a	1	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	10-12	ND	N/a	1	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	12-16	ND	N/a	1	0%	35[2]	
	Bis(2-ethylhexyl)phthalate	14-16	ND	N/a	1	0%	35[2]	

	Bis(2-ethylhexyl)phthalate	All	ND – 4.2	2.9	13	23.1%	35[2]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Cadmium	0-2	ND	N/a	5	0%	5[1]	
	Cadmium	0-8	ND	N/a	1	0%	5[1]	
	Cadmium	4-6	0.055 – 0.062	N/a	2	100%	5[1]	
	Cadmium	8-10	ND	N/a	1	0%	5[1]	
	Cadmium	8-12	ND	N/a	1	0%	5[1]	
	Cadmium	10-12	0.17	N/a	1	100%	5[1]	
	Cadmium	12-16	ND	N/a	1	0%	5[1]	
	Cadmium	14-16	0.033	N/a	1	100%	5[1]	
	Cadmium	All	ND – 0.17	0.08	13	30.8%	5[1]	
	Calcium	4-6	950 – 1,000	N/a	2	100%	NA	
	Calcium	8-10	540	Na/a	1	100%	NA	
	Calcium	10-12	3,100	N/a	1	100%	NA	
	Calcium	14-16	460	N/a	1	100%	NA	

	Calcium	All	460 – 3,100	1,210	5	100%	NA	
	Chromium	0-2	4.0 – 24.0	10.94	5	100%	280[2]	
	Chromium	0-8	8.6	N/a	1	100%	280[2]	
	Chromium	4-6	2.5 – 2.7	N/a	2	100%	280[2]	
	Chromium	8-10	1.5	N/a	1	100%	280[2]	
	Chromium	8-12	7.3	N/a	1	100%	280[2]	
	Chromium	10-12	4.4	N/a	1	100%	280[2]	
	Chromium	12-16	2.8	N/a	1	100%	280[2]	
	Chromium	14-16	1.2	N/a	1	100%	280[2]	
	Chromium	All	1.2 – 24	6.59	13	100%	280[2]	
	Cobalt	4-6	1.1 – 1.4	N/a	2	100%	20[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Cobalt	8-10	0.53	N/a	1	100%	20[1]	
	Cobalt	10-12	1.8	N/a	1	100%	20[1]	
	Cobalt	14-16	0.62	N/a	1	100%	20[1]	
	Cobalt	All	0.53 – 1.8	1.1	5	100%	20[1]	
	Copper	4-6	2.2 – 2.3	N/a	2	100%	500[1]	
	Copper	8-10	1	N/a	1	100%	500[1]	
	Copper	10-12	4.3	N/a	1	100%	500[1]	
	Copper	14-16	1.2	N/a	1	100%	500[1]	
	Copper	All	1.0 – 4.3	2.2	5	100%	500[1]	
	Iron	4-6	4,800 – 5,300	N/a	2	100%	55,000[2]	
	Iron	8-10	2,900	N/a	1	100%	55,000[2]	
	Iron	10-12	7,400	N/a	1	100%	55,000[2]	
	Iron	14-16	2,200	N/a	1	100%	55,000[2]	

	Iron	All	2,200 – 7,400	4,520	5	100%	55,000[2]	
	Lead	0-2	5.3 – 14.3	9.34	5	100%	400[3]	
	Lead	0-8	6.3	N/a	1	100%	400[3]	
	Lead	4-6	4.8 – 5.6	N/a	2	100%	400[3]	
	Lead	8-10	2.7	N/a	1	100%	400[3]	
	Lead	8-12	5.4	N/a	1	100%	400[3]	
	Lead	10-12	22	N/a	1	100%	400[3]	
	Lead	12-16	3.6	N/a	1	100%	400[3]	
	Lead	14-16	2.4	N/a	1	100%	400[3]	
	Lead	All	2.4 – 22	7.65	13	100%	400[3]	
	Magnesium	4-6	630 - 670	N/a	2	100%	NA	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Magnesium	8-10	380	N/a	1	100%	NA	
	Magnesium	10-12	1,200	N/a	1	100%	NA	
	Magnesium	14-16	300	N/a	1	100%	NA	
	Magnesium	All	300 – 1,200	636	5	100%	NA	
	Manganese	4-6	84 – 92	N/a	2	100%	3,000[1]	
	Manganese	8-10	44	N/a	1	100%	3,000[1]	
	Manganese	10-12	120	N/a	1	100%	3,000[1]	
	Manganese	14-16	120	N/a	1	100%	3,000[1]	
	Manganese	All	44 – 120	92	5	100%	3,000[1]	
	Nickel	4-6	1.9 – 2.0	N/a	2	100%	1,000[1]	
	Nickel	8-10	1.1	N/a	1	100%	1,000[1]	
	Nickel	10-12	3.5	N/a	1	100%	1,000[1]	
	Nickel	14-16	1.8	N/a	1	100%	1,000[1]	

	Nickel	All	1.1 – 3.5	2.1	5	100%	1,000[1]	
	Nitrate	4-6	0.44 – 0.45	N/a	2	100%	80,000[1]	
	Nitrate	8-10	0.42	N/a	1	100%	80,000[1]	
	Nitrate	10-12	11	N/a	1	100%	80,000[1]	
	Nitrate	14-16	2.9	N/a	1	100%	80,000[1]	
	Nitrate	All	0.42 – 11	3.04	5	100%	80,000[1]	
	Nitrate/Nitrite/Nitrogen	0-2	ND – 3.3	N/a	5	40%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	0-8	ND	N/a	1	0%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	8-12	ND	N/a	1	0%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	12-16	ND	N/a	1	0%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	All	ND – 3.3	N/a	8	25%	7,800[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Potassium	4-6	800 – 860	N/a	2	100%	NA	
	Potassium	8-10	420	N/a	1	100%	NA	
	Potassium	10-12	1,300	N/a	1	100%	NA	
	Potassium	14-16	390	N/a	1	100%	NA	
	Potassium	All	390 – 1,300	754	5	100%	NA	
	Sodium	4-6	ND	N/a	2	0%	NA	
	Sodium	8-10	ND	N/a	1	0%	NA	
	Sodium	10-12	85	N/a	1	100%	NA	
	Sodium	14-16	ND	N/a	1	0%	NA	
	Sodium	All	ND – 85	N/a	5	20%	NA	
	Thallium	4-6	0.66 – 1.0	N/a	2	100%	4.0[1]	
	Thallium	8-10	0.72	N/a	1	100%	4.0[1]	
	Thallium	10-12	1.1	N/a	1	100%	4.0[1]	

	Thallium	14-16	ND	N/a	1	0%	4.0[1]	
	Thallium	All	ND – 1.1	0.87	5	80%	4.0[1]	
	Vanadium	4-6	6.0 – 6.6	N/a	2	100%	200[1]	
	Vanadium	8-10	3.6	N/a	1	100%	200[1]	
	Vanadium	10-12	10	N/a	1	100%	200[1]	
	Vanadium	14-16	2.8	N/a	1	100%	200[1]	
	Vanadium	All	2.8 – 10	5.8	5	100%	200[1]	
	Zinc	4-6	14	N/a	2	100%	20,000[1]	
	Zinc	8-10	7.6	N/a	1	100%	20,000[1]	
	Zinc	10-12	41	N/a	1	100%	20,000[1]	
	Zinc	14-16	7.4	N/a	1	100%	20,000[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 10 (contd.)	Zinc	All	7.4 – 41	16.8	5	100%	20,000[1]	
SWMU 12	Lead	0-2	16 – 110	55.3	4	100%	400[3]	
	Lead	6-8	6.9 – 12.0	8.9	3	100%	400[3]	
	Lead	12-14	4.6 - 11	8.13	3	100%	400[3]	
	Lead	All	4.6 – 110	27.21	10	100%	400[3]	
SWMU 14	Lead	12-14	59	N/a	1	100%	400	
SWMU 18	Diesel Range Organics	0-2	ND – 6.8	N/a	4	25%	NA	
	Diesel Range Organics	2-3	4,800	N/a	1	100%	NA	
	Diesel Range Organics	4-5	ND	N/a	1	0%	NA	
	Diesel Range Organics	10-11	ND	N/a	1	0%	NA	
	Diesel Range Organics	11-12	11	N/a	1	100%	NA	
	Diesel Range Organics	14-15	ND	N/a	1	0%	NA	

	Diesel Range Organics	15-16	100	N/a	1	100%	NA	
	Diesel Range Organics	Aquifer	3,900	N/a	1	100%	NA	
	Diesel Range Organics	All	ND – 4,800	1764	11	45.4%	NA	
	Ethylbenzene	0-2	ND	N/a	4	0%	5.7[2]	
	Ethylbenzene	2-3	ND	N/a	1	0%	5.7[2]	
	Ethylbenzene	11-12	ND	N/a	1	0%	5.7[2]	
	Ethylbenzene	14-15	ND	N/a	1	0%	5.7[2]	
	Ethylbenzene	15-16	ND	N/a	1	0%	5.7[2]	
	Ethylbenzene	Aquifer	0.084	N/a	1	100%	5.7[2]	
	Ethylbenzene	All	ND – 0.084	N/a	1	11%	5.7[2]	
	Nitrate/Nitrite/Nitrogen	0-2	ND – 3.7	N/a	4	50%	7,800[1]	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 18 (contd.)	Nitrate/Nitrite/Nitrogen	2-3	18.3	N/a	1	100%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	11-12	5.2	N/a	1	100%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	14-15	15.6	N/a	1	100%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	15-16	4.5	N/a	1	100%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	Aquifer	ND	N/a	1	0%	7,800[1]	
	Nitrate/Nitrite/Nitrogen	All	ND – 18.3	8.18	9	66.7%	7,800[1]	
	Toluene	0-2	ND	N/a	4	0%	1,000[1]	
	Toluene	2-3	ND	N/a	1	0%	1,000[1]	
	Toluene	11-12	ND	N/a	1	0%	1,000[1]	
	Toluene	14-15	ND	N/a	1	0%	1,000[1]	
	Toluene	15-16	ND	N/a	1	0%	1,000[1]	
	Toluene	Aquifer	0.072	N/a	1	100%	1,000[1]	
	Toluene	All	ND – 0.072	N/a	9	11%	1,000[1]	

	Gasoline	0-2	ND	N/a	4	0%	NA	
	Gasoline	2-3	2.4	N/a	1	100%	NA	
	Gasoline	11-12	1.3	N/a	1	100%	NA	
	Gasoline	14-15	ND	N/a	1	0%	NA	
	Gasoline	15-16	ND	N/a	1	0%	NA	
	Gasoline	Aquifer	12	N/a	1	100%	NA	
	Gasoline	All	ND – 12	5.23	9	33%	NA	
	Xylenes	0-2	0.052 – 0.058	0.054	4	100%	600[2]	
	Xylenes	2-3	ND	N/a	1	0%	600[2]	
	Xylenes	11-12	0.054	N/a	1	100%	600[2]	
	Xylenes	14-15	0.059	N/a	1	100%	600[2]	

(Table 1. Continued)

Area	**Contaminant**	**Depth (in feet)**	**Concentration Range (in mg/kg)**	**Mean Concentration (in mg/kg)**	**Number of Samples**	**Percent Detected**	**Comparison Value (in mg/kg)**	**COPC**
SWMU 18 (contd.)	Xylenes	15-16	0.055	N/a	1	100%	600[2]	
	Xylenes	Aquifer	0.34	N/a	1	100%	600[2]	
	Xylenes	All	ND – 0.34	0.09	9	88.9%	600[2]	
SWMU 31E	Arsenic	0-2	4.5 – 6.5	5.82	6	100%	0.39[2]	X
	Arsenic	6-8	4.1 – 5.8	4.84	5	100%	0.39[2]	X
	Barium	0-2	121 – 205	164.3	6	100%	10,000[1]	
	Barium	6-8	141 – 204	171.8	5	100%	10,000[1]	
	Bis(2-ethylhexyl) phthalate	0-2	ND – 0.0054	N/a	6	16.7%	35[2]	
	Bis(2-ethylhexyl) phthalate	6-8	ND	N/a	5	0%	35[2]	
	Chromium	0-2	11 – 30.4	23.9	6	100%	280[2]	
	Chromium	6-8	17.4 – 26.3	21.7	5	100%	280[2]	

	Diesel Range Organics	0-2	ND – 6,100	2243	9	33.3%	NA	
	Diesel Range Organics	6-8	ND – 1,200	N/a	8	12.5%	NA	
	Diesel Range Organics	12-14	ND – 77	N/a	3	33.3%	NA	
	Lead	0-2	13.9 – 117	33.3	6	100%	400	
	Lead	6-8	10.1 – 13.7	11.5	5	100%	400	
	Mercury	0-2	ND – 0.04	N/a	6	16.7%	4.3[2]	
	Mercury	6-8	ND	N/a	5	0%	4.3[2]	
SWMU 31L	Lead	0-2	6.4 – 185	54.0	4	100%	400[3]	
	Lead	6-8	1.4 – 2,840	628.1	5	100%	400[3]	X
	Lead	12-14	ND – 6.1	N/a	3	66.7%	400[3]	
	Lead	All	ND – 2,840	306	12	91.7%	400[3]	

(Table 1. Continued)

Area	**Contaminant**	**Depth (in feet)**	**Concentration Range (in mg/kg)**	**Mean Concentration (in mg/kg)**	**Number of Samples**	**Percent Detected**	**Comparison Value (in mg/kg)**	**COPC**
SWMU 31L (contd.)	Pentaerythritol Tetranitrate (PETN)	0-2	9.2	N/a	1	100%	NA	
	Pentaerythritol Tetranitrate (PETN)	6-8	ND – 10	N/a	1	100%	NA	
SWMU 31O	Arsenic	0-2	2.3 – 6	3.53	7	100%	0.39[2]	X
	Arsenic	6-8	ND – 10.6	4.24	6	83.3%	0.39[2]	X
	Barium	0-2	91.8 – 170	123.5	7	100%	10,000[1]	
	Barium	6-8	39.4 – 156	95.7	6	100%	10,000[1]	
	Benz(a)anthracene	0-2	ND – 0.44	N/a	7	28.6%	0.15[2]	X
	Benz(a)anthracene	6-8	ND	N/a	6	0%	0.15[2]	
	Benz(a)pyrene	0-2	ND – 0.39	N/a	7	28.6%	0.015[2]	X

	Benz(a)pyrene	6-8	ND	N/a	6	0%	0.015[2]	
	Bis (2-ethylhexyl) phthalate	0-2	ND	N/a	7	0%	35[2]	
	Bis (2-ethylhexyl) phthalate	6-8	ND – 5.5	N/a	6	16.7%	35[2]	
	Chromium	0-2	10.4 – 24	16.5	7	100%	280[2]	
	Chromium	6-8	4.7 – 19.6	14.1	6	100%	280[2]	
	Chromium	All					280[2]	
	Chrysene	0-2	ND – 0.44	N/a	7	28.6%	15[2]	
	Chrysene	6-8	ND	N/a	6	0%	15[2]	
	Diesel Range Organics	0-2	ND - 110	38.9	7	57.1%	NA	
	Diesel Range Organics	6-8	ND - 78	78	6	16.7%	NA	

(Table 1. Continued)

Area	Contaminant	Depth (in feet)	Concentration Range (in mg/kg)	Mean Concentration (in mg/kg)	Number of Samples	Percent Detected	Comparison Value (in mg/kg)	COPC
SWMU 31O (contd.)	Diesel Range Organics	12-14	120	N/a	1	100%	NA	
	Diesel Range Organics	All	ND – 120	59.0	14	42.9%	NA	
	Fluoranthrene	0-2	ND – 0.96	N/a	7	28.6%	2,000[1]	
	Fluoranthrene	6-8	ND	N/a	6	0%	2,000[1]	
	Lead	0-2	9.1 – 23.8	14.88	12	100%	400[3]	
	Lead	6-8	2.5 – 22.3	10.93	10	100%	400[3]	
	Lead	12-14	5.9 – 9.4	7.9	5	100%	400[3]	
	Lead	All	2.5 – 23.8	12.13	27	100%	400[3]	
	Mercury	0-2	ND – 0.49	0.18	12	58.3%	4.3[2]	
	Mercury	6-8	ND – 0.47	0.25	10	30%	4.3[2]	
	Mercury	12-14	ND – 0.04	N/a	5	20%	4.3[2]	

	Mercury	All	ND – 0.49	0.19	27	40.7%	4.3[2]	
	Phenanthrene	0-2	ND – 1.0	N/a	7	28.6%	NA	
	Phenanthrene	6-8	ND	N/a	7	0.0%	NA	
	Pyrene	0-2	ND – 1.1	N/a	6	28.6%	1,700[1]	
	Pyrene	6-8	ND	N/a	6	0.0%	1,700[1]	
	Tetrachloroethene	0-2	ND – 0.022	N/a	7	14.3%	0.57[2]	
	Tetrachloroethene	6-8	ND	N/a	6	0.0%	0.57[2]	

[1] ATSDR Soil Comparison Values 10/27/2008
[2] EPA Region 9 Regional Screening Level Table April 2009
[3] EPA OSWER Directive #9355.4-12

Table 4. Current and Future Non-cancer Hazard Quotients of Incidental Soil Ingestion at the DuPont-Louviers site

Area of Investigation	Contaminant of Potential Concern	Current and Future Trespasser Non-cancer Hazard Quotients	Future Industrial Worker Non-cancer Hazard Quotients	Future Construction Worker Non-cancer Hazard Quotients
SWMU 8	Arsenic	1.65E-02	2.54E-02	4.03E-02
	Barium	3.17E-02	4.89E-02	N/a
SWMU 9	Arsenic	1.50E-02	2.32E-02	1.10E-01
SWMU 10	Arsenic	1.20E-02	1.86E-02	3.23E-02
SWMU 31E	Arsenic	1.37E-02	2.12E-02	6.30E-02
SWMU 31O	Arsenic	9.46E-03	1.46E-02	7.05E-02

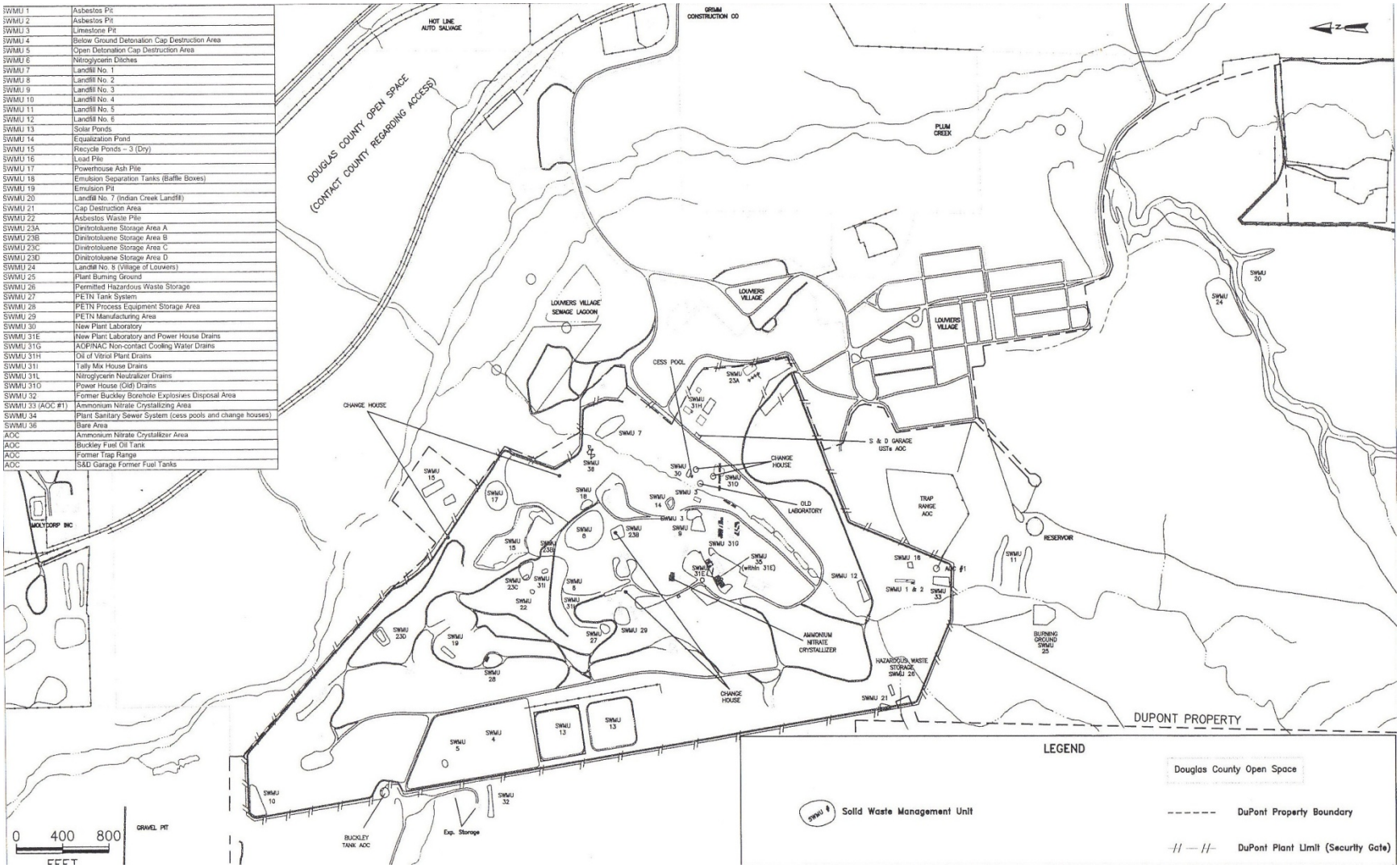
Notes: Hazard Quotients are simply the estimated exposure dose for non-cancer health effects divided by the applicable health-based guideline. Hazard Quotients greater than 1 indicates that the estimated dose exceeds the health-based guideline. Bolded values are Hazard Quotients greater than 1.
N/a: Not Applicable

Table 5. Current and Future Theoretical Cancer Risks of Incidental Soil Ingestion at the DuPont-Louviers site

Area	Contaminant of Potential Concern	Current and Future Trespasser Theoretical Cancer Risks	Future Industrial Worker Theoretical Cancer Risks	Future Construction Worker Theoretical Cancer Risks
SWMU 8	Arsenic	1.06E-06	4.09E-06	2.59E-07
SWMU 9	Arsenic	9.63E-07	3.72E-06	7.04E-07
SWMU 10	Arsenic	7.73E-07	2.99E-06	2.08E-07
SWMU 31E	Arsenic	8.82E-07	3.41E-06	4.05E-07
SWMU 31O	Arsenic	6.08E-07	2.35E-06	4.53E-07
	Benz(a)anthracene	2.91E-08	1.12E-07	1.48E-08
	Benzo(a)pyrene	2.58E-07	9.95E-07	1.28E-07
	Combined Risk	8.94E-07	3.46E-06	5.96E-07

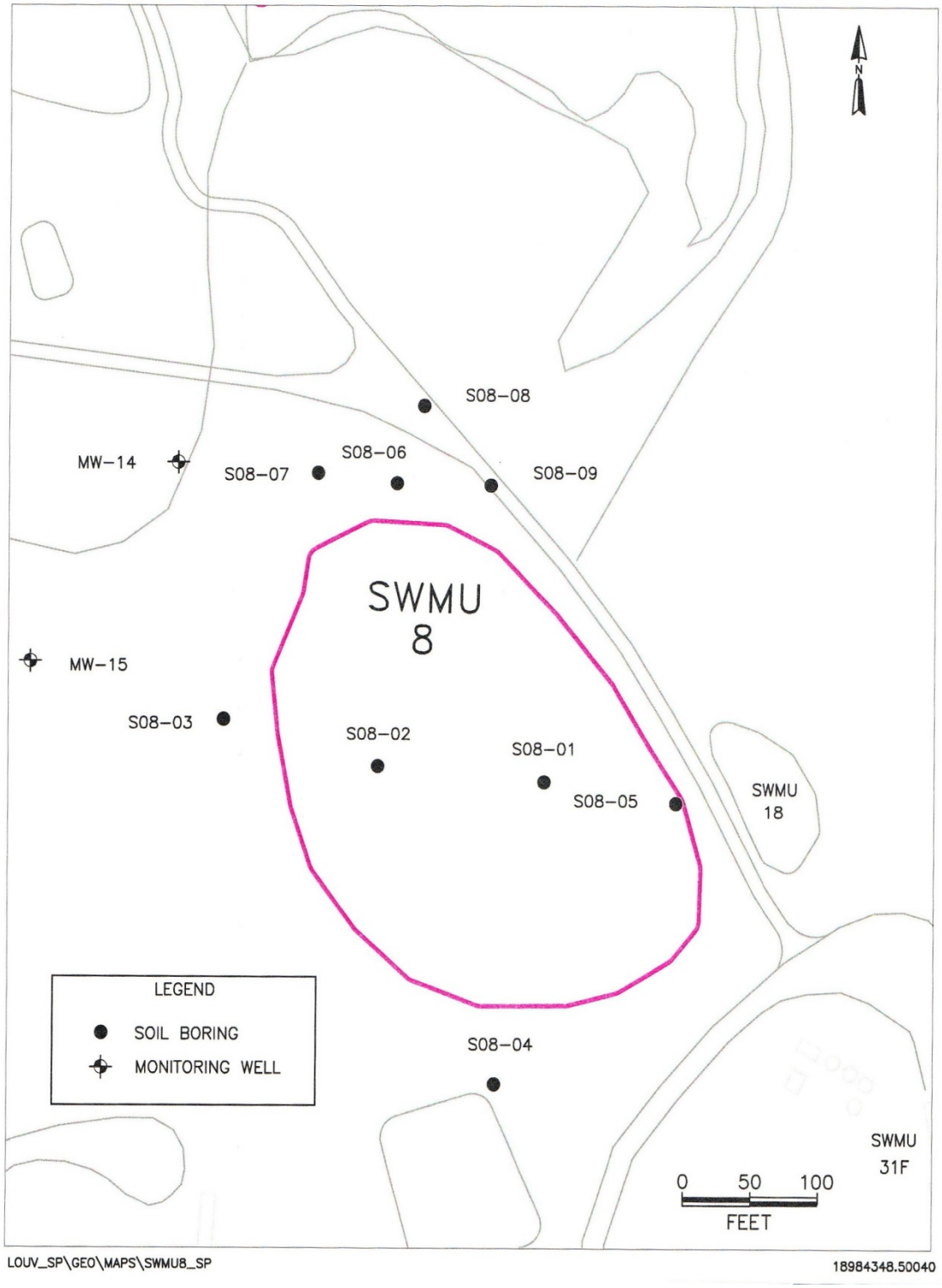
Notes: Acceptable Cancer Risk Range is 1.00E-06 (low-end) to 1.00E-04 (high-end)

Figure 1. DuPont-Louviers Site Map



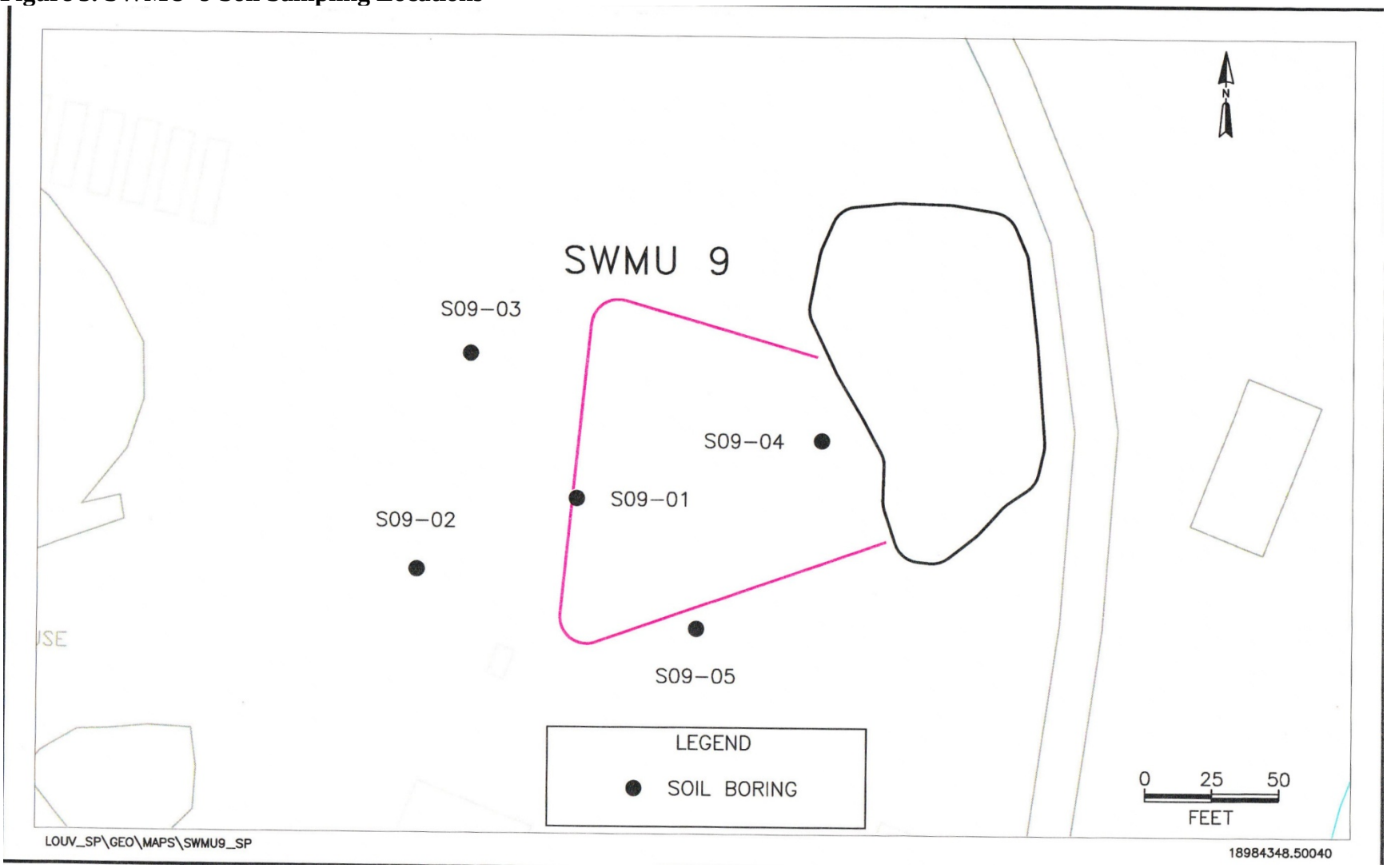
SOURCE: DuPont HHRA 2008

Figure 2. SWMU 8 Soil Sampling Locations



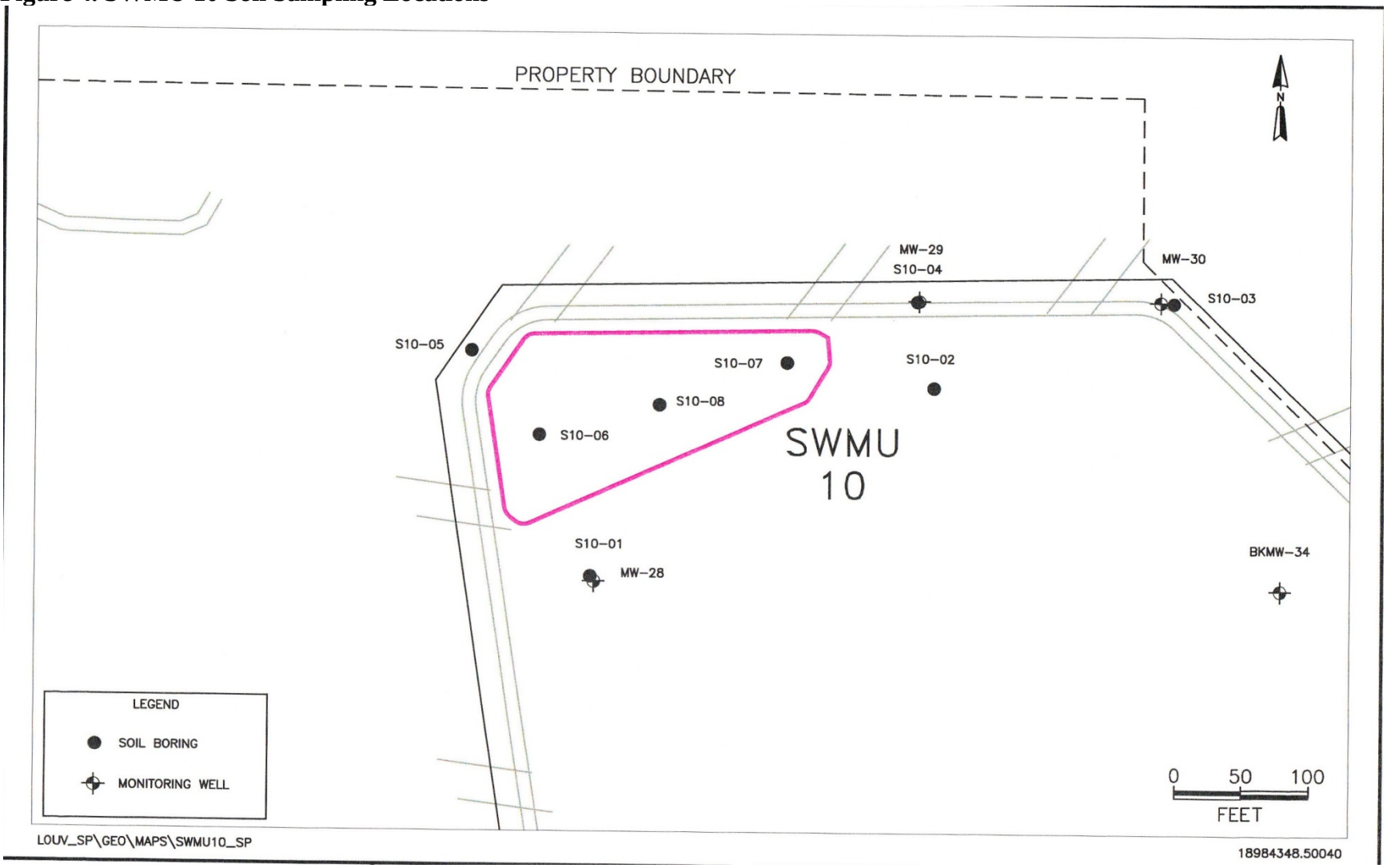
SOURCE: DuPont HHRA 2008

Figure 3. SWMU 9 Soil Sampling Locations



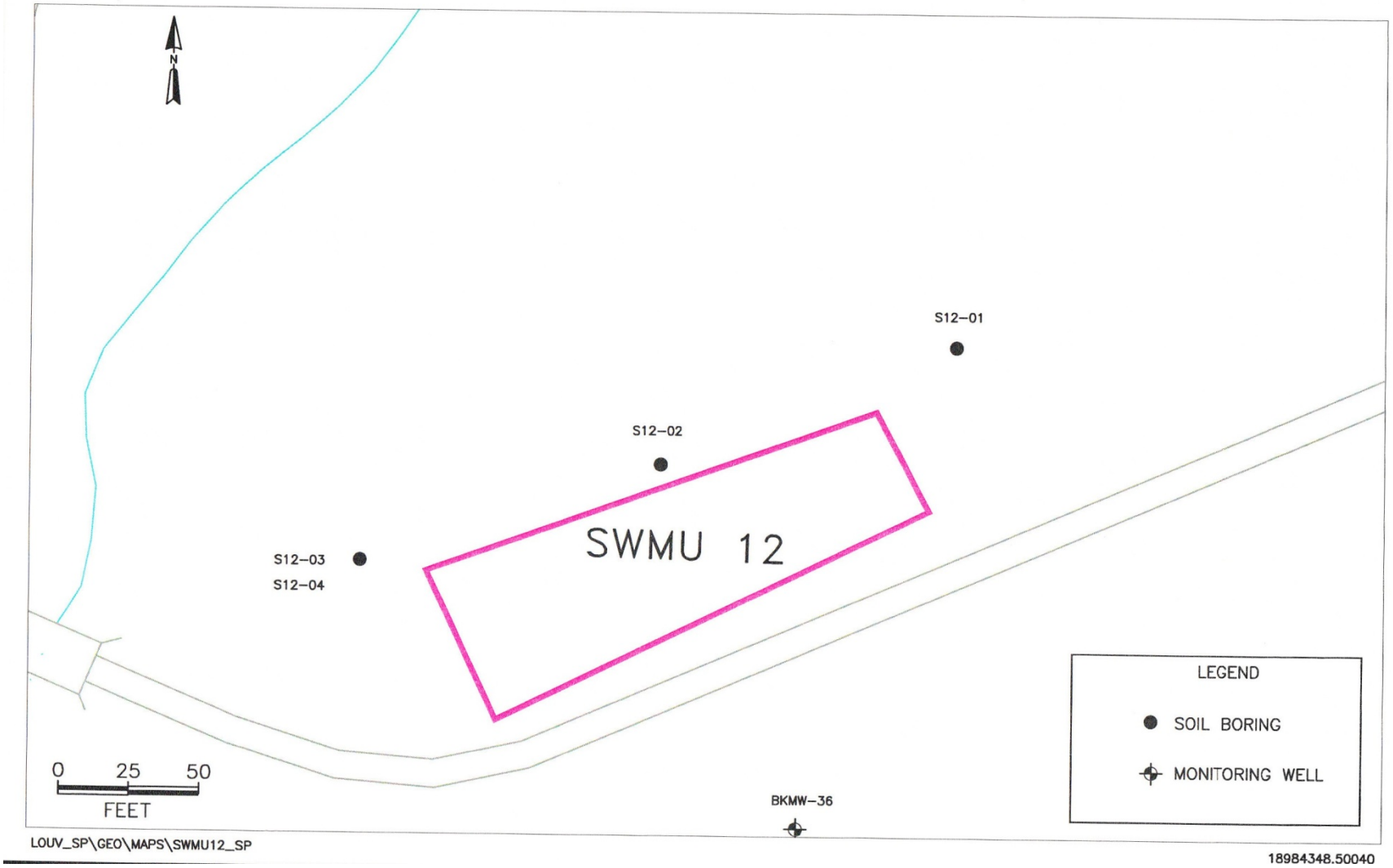
SOURCE: DuPont HHRA 2008

Figure 4. SWMU 10 Soil Sampling Locations



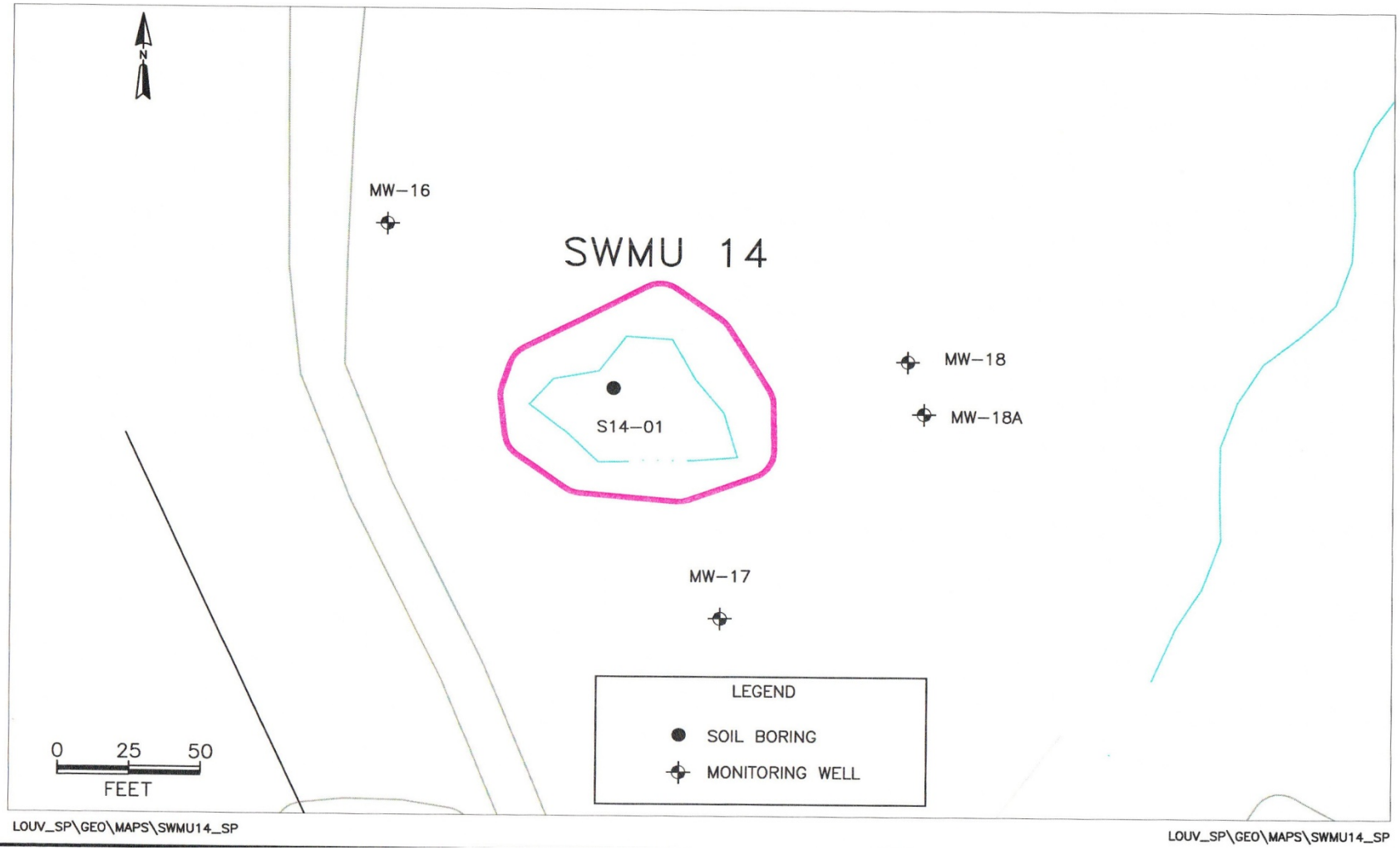
SOURCE: DuPont HHRA 2008

Figure 5. SWMU 12 Soil Sampling Locations



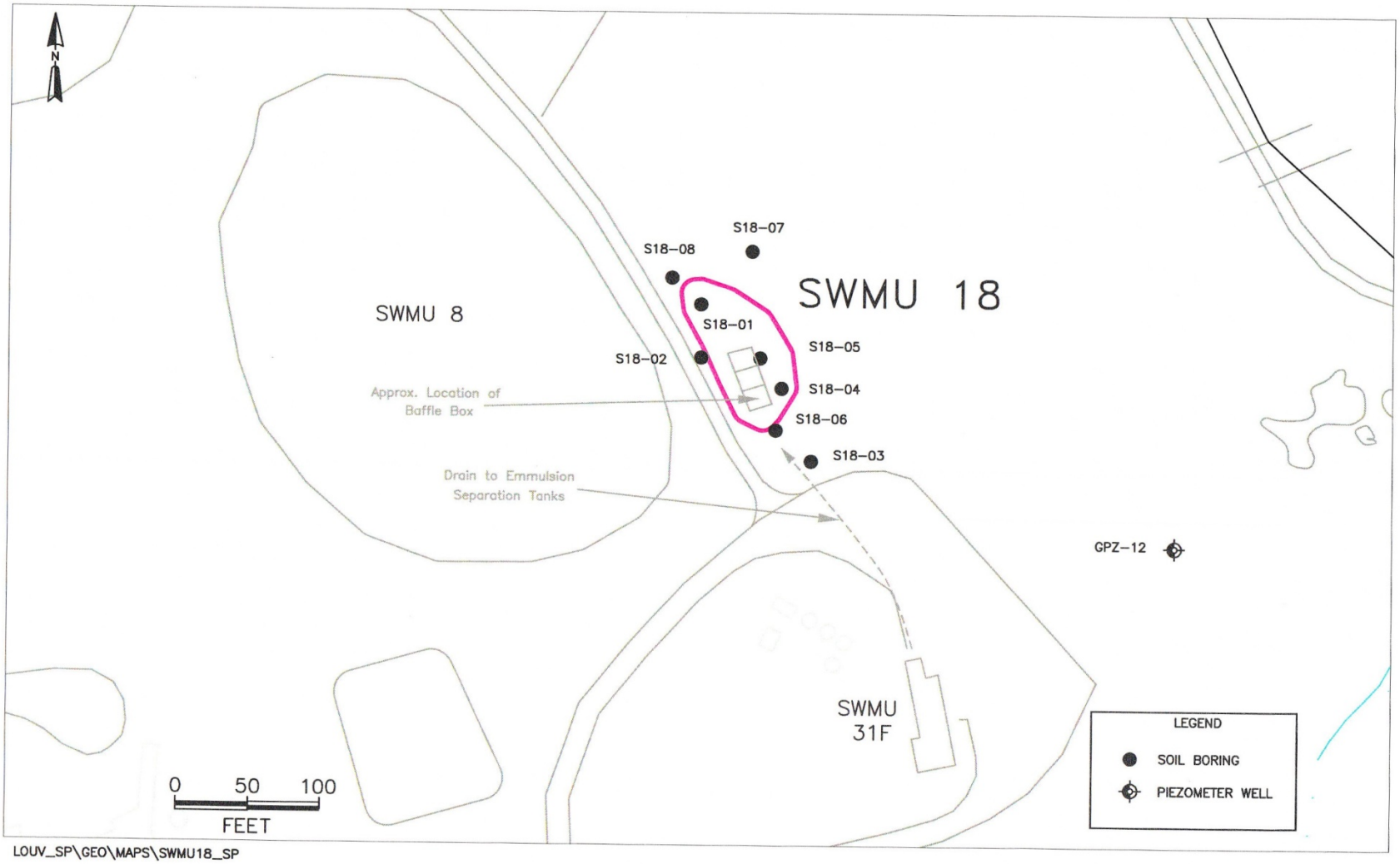
SOURCE: DuPont HHRA 2008

Figure 6. SWMU 14 Soil Sampling Locations



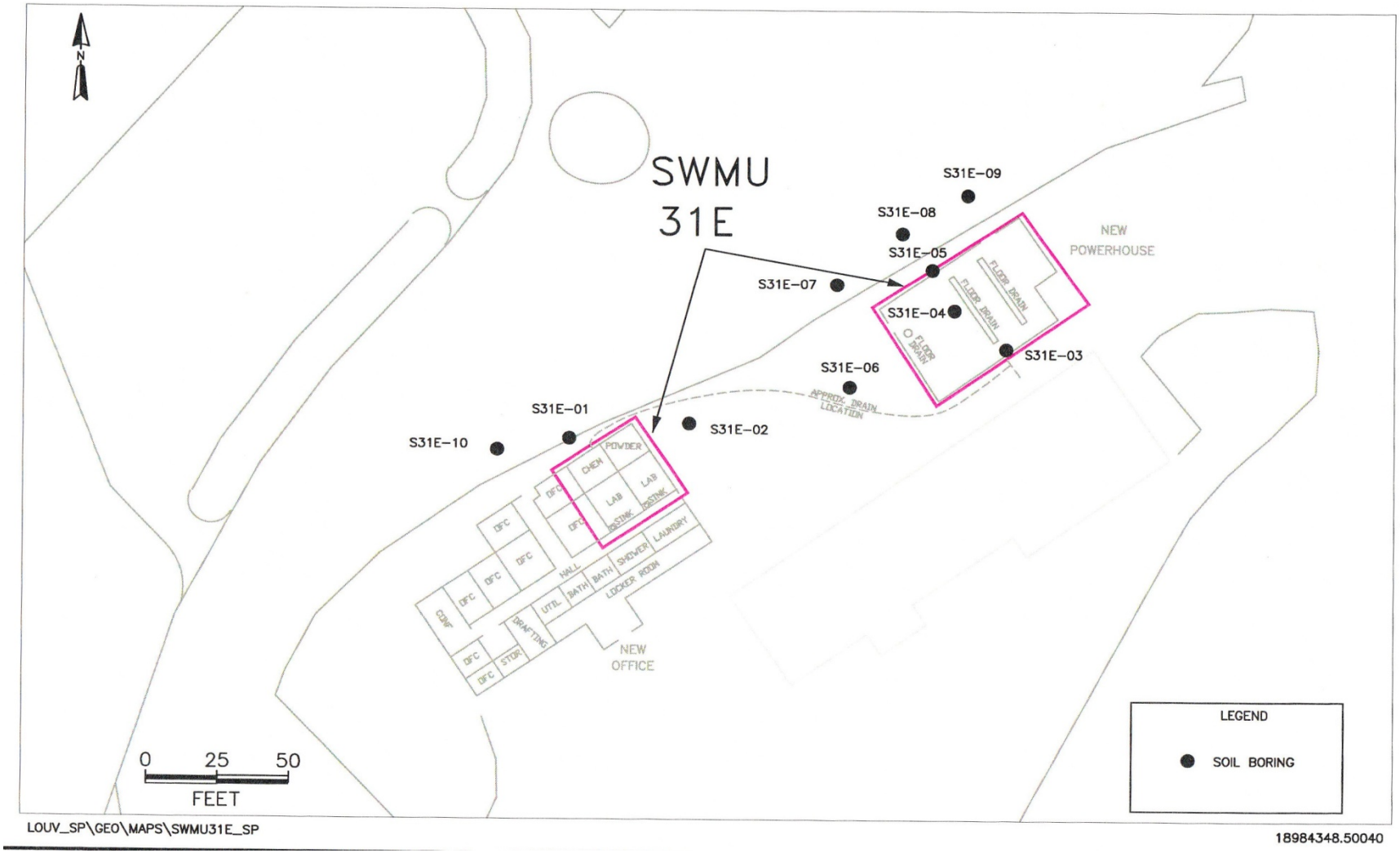
SOURCE: DuPont HHRA 2008

Figure 7. SWMU 18 Soil Sampling Locations



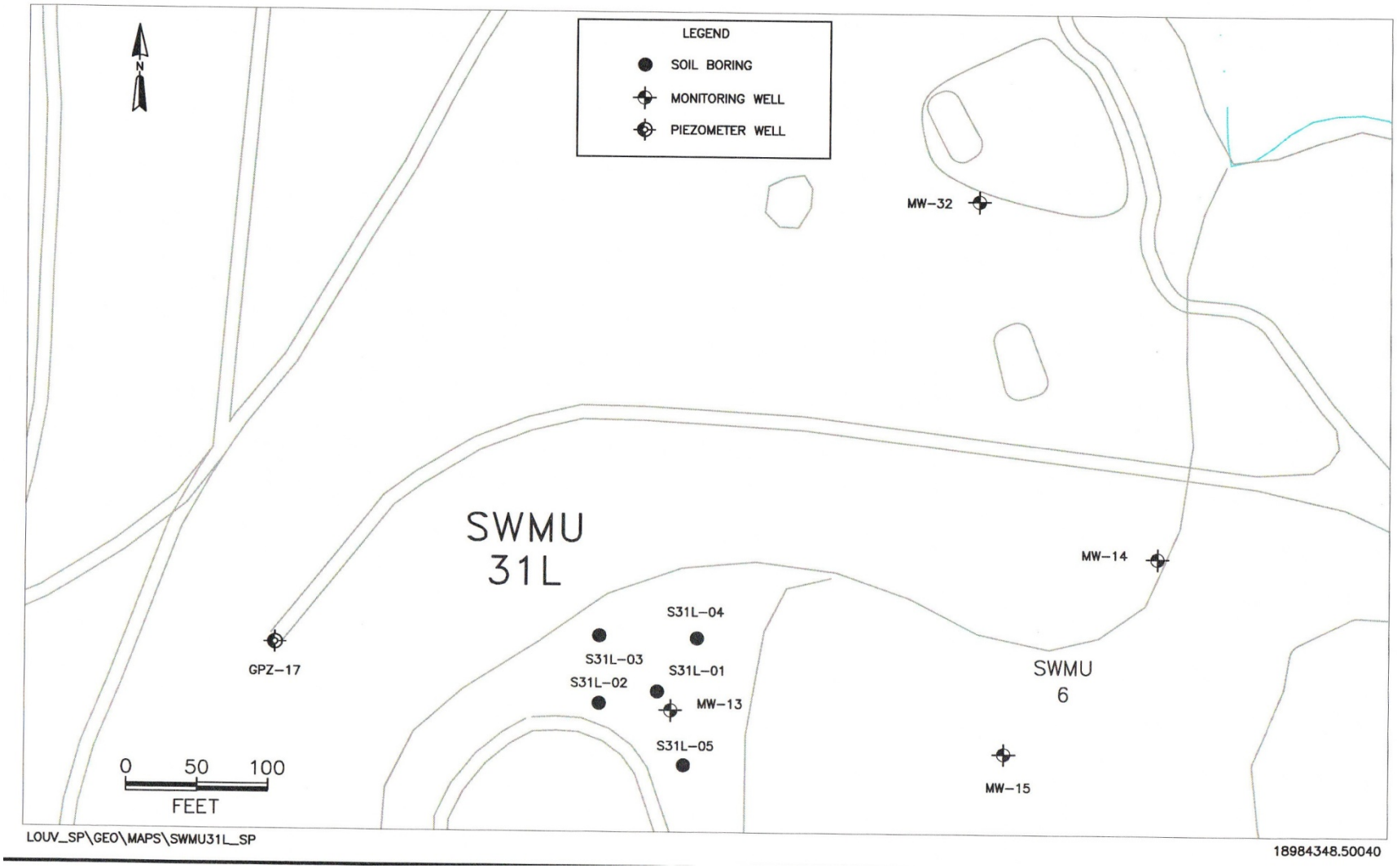
SOURCE: DuPont HHRA 2008

Figure 8. SWMU 31E Soil Sampling Locations



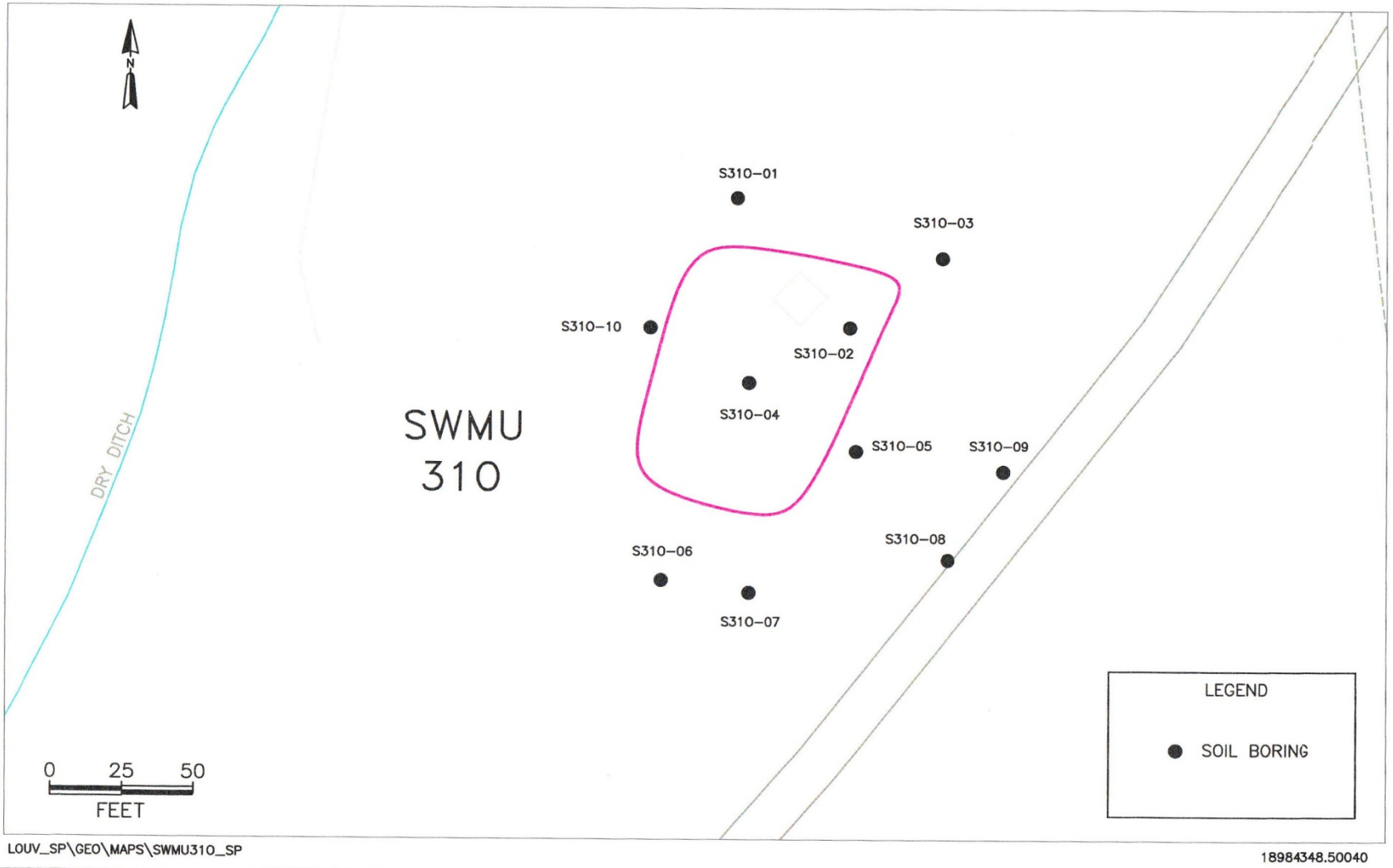
SOURCE: DuPont HHRA 2008

Figure 9. SWMU 31L Soil Sampling Locations



SOURCE: DuPont HHRA 2008

Figure 10. SWMU 31O Soil Sampling Locations



SOURCE: DuPont HHRA 2008

Appendices

Appendix A. Additional Exposure Assessment Information

The first step to determine if adverse health effects are likely to occur from exposure to contamination found at the DuPont-Louviers site is to estimate exposure doses for each group of people that are likely to come into contact with site-related contamination. The estimated exposure doses are designed to be conservative estimations of actual contaminant intake, accounting for the majority of potential exposures at the site. As mentioned previously in the document, exposure doses are only estimated for Contaminants of Potential Concern, which have exceeded the comparison values (CVs) since the contaminants with concentrations below the CV are not likely to result in adverse health effects. Estimating the exposure dose requires assumptions to made regarding various exposure parameters such as the frequency of a particular activity, duration of exposure to site-related contamination, and the amount of a particular substance that is taken in by an individual during a given activity. Site-specific exposure information is always preferable when estimating exposure doses. In lieu of site-specific information, default exposure parameters that are established by the EPA and ATSDR are used in the exposure dose estimation. At times, professional judgment is used when default values are not available or seem unreasonable for the site exposures.

Three primary receptors were identified in this evaluation that are likely to come into contact with site-related contamination now or in the future: current/future trespassers, future industrial workers, and future construction workers. The major exposure factors used for each receptor are listed below in Table A1.

Table A1. Exposure Factors

Receptor	Body Weight (BW)	Exposure Frequency (EF)	Exposure Duration (ED)	Soil Ingestion Rate (IRS)	Averaging $Time_{Cancer}$ (AT_{Cancer})
Trespassers (7-16 years)	45 kg.	52 days per year	10 years	200 mg. per day	25550 days
Construction Workers	70 kg.	250 days per year	1 year	330 mg. per day	25550 days
Industrial Worker	70 kg.	250 days per year	25 years	100 mg. per day	25550 days

Notes:
kg. = kilogram
mg. = milligram

Another critical component of the exposure dose estimation is the concentrations of chemicals that individuals are likely to be exposed to in a particular medium or the Exposure Point Concentration (EPC). The EPA has established guidelines for determining the EPC. In Region 8, if there are less than 10 samples available for a contaminant, the maximum detected concentration is used as the EPC since very little is

known about the actual concentration in a particular medium and area. In situations where there are more than 10 samples for an analyte, the available data is inserted into a statistical software package designed to calculate EPCs called ProUCL. Generally speaking, the resulting EPC is the 95% Upper Confidence Limit (UCL) on the mean (average) concentration assuming a normal distribution of the data. In this evaluation, the EPC for construction workers is different from the other receptors because it was assumed that construction workers could also be exposed to soil up to 15 feet in depth. Thus, the data from all depth intervals (up to 15 ft.) was combined for the EPC calculation for construction workers. Data from the 0-2 foot depth interval was used in the EPC calculation for current and future trespassers as well as future industrial workers. The EPCs used in this evaluation are presented in Table A2 below along with the method used to determine the value.

Table A2. Soil COPC Exposure Point Concentrations and Statistical Methods

Area	Contaminant of Potential Concern	Receptor	Exposure Point Concentration	Recommended ProUCL 4.0 Statistical Method
SWMU 8	Arsenic	Trespasser & Industrial Worker	7.80	Maximum Detected Values (*n* < 10 samples)
		Construction Worker	3.74	95% Approximate Gamma UCL
	Barium	Trespasser & Industrial Worker	10,000	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	6,910	99% KM UCL (Mean, Sd)
SWMU 9	Arsenic	Trespasser & Industrial Worker	7.10	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	10.18	95% Approximate Gamma UCL
SWMU 10	Arsenic	Trespasser & Industrial Worker	5.7	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	2.95	95% Approximate Gamma UCL
SWMU 31E	Arsenic	Trespasser & Industrial Worker	6.50	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	5.85	95% Student's-t UCL
SWMU 31L	Lead	Construction Worker	306 (99% UCL=2618)	Mean
SWMU 31O	Arsenic	Trespasser & Industrial Worker	4.48	Maximum Detected Value (*n* < 10 samples)

		Construction Worker	6.55	95% KM UCL (Chebyshev)
	Benz(a)anthracene	Trespasser & Industrial Worker	0.44	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	0.44	95% KM UCL (% bootstrap)
	Benz(a)pyrene	Trespasser & Industrial Worker	0.39	Maximum Detected Value (*n* < 10 samples)
		Construction Worker	0.38	95% KM UCL (t)

* ProUCL 4.0 recommended statistical method used to calculate EPC

Non-cancer and cancer health endpoints are evaluated differently so the estimation of exposure dose also differs slightly (non-cancer doses are averaged over the timeframe of exposure and cancer doses are averaged over a lifetime). The exposure dose equations used in this evaluation are presented below.

Non-Cancer Surface Soil Ingestion Dose

Non-cancer Dose = $\mathbf{(C_s * IRS * EF * CF) / BW}$

Where: $\mathbf{EF = (F * ED) / AT_{non\text{-}cancer}}$

Age-Adjusted Soil Ingestion Cancer Dose

Cancer Dose = $\mathbf{(C_s * IRS * CF * EF) / BW}$

Where: $\mathbf{EF = (F * ED) / AT_{cancer}}$

The estimated exposure dose results for this evaluation are shown below in Tables A3 and A4.

Table A3. Current and Future Estimated Non-cancer Exposure Doses of Incidental Soil Ingestion at the DuPont-Louviers site

Area	Contaminant of Potential Concern	Current and Future Trespasser Non-cancer Exposure Doses	Future Industrial Worker Non-cancer Exposure Doses	Future Construction Worker Non-cancer Exposure Doses	Health-based Guideline
SWMU 8	Arsenic	4.94E-06	7.63E-06	1.21E-05	3.00E-04
SWMU 9	Arsenic	4.50E-06	6.95E-06	3.29E-05	3.00E-04
SWMU 10	Arsenic	3.61E-06	5.58E-06	9.69E-06	3.00E-04
SWMU 31E	Arsenic	4.12E-06	6.36E-06	1.89E-05	3.00E-04
SWMU 31O	Arsenic	2.84E-06	4.38E-06	2.11E-05	3.00E-04

Table A4. Current and Future Estimated Cancer Exposure Doses of Incidental Soil Ingestion at the DuPont-Louviers site

Area	Contaminant of Potential Concern	Current and Future Trespasser Cancer Exposure Doses	Future Industrial Worker Cancer Exposure Doses	Future Construction Worker Cancer Exposure Doses
SWMU 8	Arsenic	7.06E-07	2.73E-06	1.73E-07
SWMU 9	Arsenic	6.42E-07	2.48E-06	4.70E-07
SWMU 10	Arsenic	5.16E-07	1.99E-06	1.38E-07
SWMU 31E	Arsenic	5.88E-07	2.27E-06	2.70E-07
SWMU 31O	Arsenic	4.05E-07	1.57E-06	3.02E-07
	Benz(a)anthracene	3.98E-08	1.54E-07	2.03E-08
	Benzo(a)pyrene	3.53E-08	1.36E-07	1.75E-08

Appendix B. Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on dose. The toxic effects of a chemical also depend on the route of exposure (oral, inhalation, dermal), the duration of exposure (acute, subchronic, chronic or lifetime), the health condition of the person, the nutritional status of the person, and the life style and family traits of the person. In this evaluation, chronic oral exposures were evaluated.

The major contaminants of concern identified in this consultation include arsenic, 2,4-DNT, and lead. It is important to note that estimates of human health risks may be based on evidence of health effects in humans and/or animals depending upon the availability of scientific data. The toxicity assessment process is usually divided into two parts: non-cancer health effects and cancer health effects of a chemical. The cancer health effects are only evaluated for known or likely human carcinogens by route of exposure. This evaluation quantitatively addresses chronic non-cancer health hazards for antimony and arsenic and qualitatively addresses chronic non-cancer health effects of lead. The only oral carcinogen that was considered a Contaminant of Potential Concern is arsenic.

Arsenic is a metal that occurs naturally in the environment. Exposure to high levels of arsenic may cause non-cancer nausea, vomiting, diarrhea, abnormal heart rhythm, blood vessel damage, or a pins and needle sensation in hands and feet. Long-term exposure to low levels of arsenic may lead to a darkening of the skin and the appearance of small corns or warts on the palms, soles, and torso. Ingesting sufficient amount of arsenic also has been reported to increase the risk of developing cancer in the liver, bladder, kidneys, and lungs (ATSDR, 2007a). Arsenic is classified as a Class 1 carcinogen by the U.S. Department of Health and Human Service's National Toxicology Program, which indicates that arsenic is a known human carcinogen. For additional health effect information on arsenic, refer to ATSDR's Toxicological Profile at: http://www.atsdr.cdc.gov/toxprofiles/tp2.html.

2,4-Dinitrotoluene is an organic compound formed by reacting toluene with nitric and sulfuric acids. 2,4-DNT is used in the manufacture of polyurethane foams, ammunition, explosives, and dyes. No solid human health effect data is currently available on 2,4-DNT. However, some evidence suggests that exposure to 2,4-DNT may result in neurological, cardiovascular, and hematological adverse health effects in humans. Animal data also supports these health effects as well as kidney and liver damage. The IARC has determined that 2,4-DNT is possibly carcinogenic to humans. For additional health effect information on 2,4-DNT, refer to the ATSDR's Toxicological Profile at: http://www.atsdr.cdc.gov/toxprofiles/tp109.html.

Lead is a naturally occurring element typically found at low levels in soil. However, lead is ubiquitous in the environment as a result of various industrial operations and activities that utilize and/or introduce lead into the environment. The main target organ of non-cancer toxicity of lead is the neurological system. In adults and children who have been exposed to high amounts of lead, non-cancer adverse health effects such as decreases in

neurologic function and mental capacity have occurred. However, young children (0-7 years) and developing fetuses appear to be the most sensitive to the toxic effects of lead. Lead is generally considered a probable human carcinogen by leading health authorities. For additional health effect information on lead, refer to ATSDR's Toxicological Profile at: http://www.atsdr.cdc.gov/toxprofiles/phs13.html.

The USEPA and the ATSDR have established oral reference doses (RfD) and minimal risk levels (MRL) for non-cancer effects. An RfD is the daily dose in humans (with uncertainty spanning perhaps an order of magnitude), including sensitive subpopulations, that is likely to be without an appreciable risk of non-cancer adverse health effects during a lifetime of exposure to a particular contaminated substance. An MRL is the dose of a compound that is an estimate of daily human exposure that is likely to be without an appreciable risk of adverse non-cancer effects of a specified duration of exposure. The acute, intermediate, and chronic MRLs address exposures of 14 days or less, 14 days to 365 days, and 1-year to lifetime, respectively. The health-based guidelines for the contaminants of potential concern for this evaluation are listed below.

Table B1. Oral Health-based Guidelines for the contaminants of potential concern

Contaminant	Health-based Guideline (mg/kg-day)	Source
2,4-DNT	0.002	EPA IRIS Chronic RfD
2,6-DNT	0.001	EPA PPRTV
Arsenic	0.0003	ATSDR Chronic MRL
Tetrachloroethene	0.01	EPA IRIS Chronic RfD

EPA IRIS: Chronic oral reference doses (RfDs) from EPA Integrated Risk Information System
ATSDR MRL: Chronic Minimal Risk Level from ATSDR Toxicological Profile

Table B2. Oral Health Effect Levels for soil contaminants of potential concern

Contaminant	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Source
2,4-DNT	0.2	1.5	EPA IRIS Chronic RfD
2,6-DNT	4.0	N/a	EPA PPRTV
Arsenic	0.0008	0.014	ATSDR Chronic MRL

NOAEL: No Observable Adverse Health Effect Level
LOAEL: Lowest Observable Adverse Health Effect Level
NA: Not available

Table B3. Oral Cancer Slope Factors

Contaminant	Oral Cancer Slope Factor ($mg/kg\text{-}day^{-1}$)	Source
Arsenic	1.5	EPA IRIS
2,4-DNT	0.31	Cal EPA

CERTIFICATION

This DuPont-Louviers Health Consultation was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Jennifer Freed
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Alan Yarbrough
Team Lead
CAT, CAPEB, DHAC, ATSDR