Health Consultation

DUPONT-LOUVIERS SITE

Evaluation of Current and Future Soil Exposures at a Former Explosives Manufacturing Facility (Unrestricted Use Area)

VILLAGE OF LOUVIERS, DOUGLAS COUNTY, COLORADO

EPA FACILITY ID: COD007060981

Prepared by the
Colorado Department of Public Health and Environment

SEPTEMBER 3, 2009

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.

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Foreword

The Colorado Department of Public Health and Environment's (CDPHE) Environmental Epidemiology Section has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances. The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) of the Environmental Epidemiology Section (EES) evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding the contents of this health consultation or the Environmental Epidemiology Section, please contact the authors of this document:

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Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CCPEHA	Colorado Cooperative Program for Environmental Health Assessment
CDPHE	Colorado Department of Public Health and Environment
COPC	Contaminant of Potential Concern
CV	Comparison Value
EPA	Environmental Protection Agency
PAH	Polycyclic aromatic hydrocarbons
SVOC	Semi-volatile organic compound
VOC	Volatile organic compounds

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. Manufacturing operations ceased at the site in 1989 and most of the facility has been dismantled. The available information suggests that individuals are currently trespassing onto the site for recreational activity. In addition, portions of the 1,520-acre site could be available for future residential development once all remedial and closure activities have been completed. However, future residential development does not appear likely at this time.

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 the area of the DuPont-Louviers site that is outside of the security fence and former explosives manufacturing area.

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. The data used in this evaluation was collected by DuPont as part of the Compliance Order on Consent (No. 98-08-28-01) with the state health department. Three primary groups of people have been identified that could come into contact with soil contaminants outside of the security fence on DuPont property: 1) current and future trespassers, 2) future construction workers, and 3) future hypothetical residents. However, the only complete exposure pathway that is currently occurring is a trespasser that comes into contact with soil contamination. Future potential exposures to construction workers and residents are also evaluated because the

area outside of the security fence on the DuPont property could possibly be developed in the future. Thus, the overall focus of this health consultation is to evaluate the potential health hazards from exposure to soil contamination by current and future trespassers, future construction workers, and future residents in the area outside of the security fence on the DuPont property.

OVERVIEW

CCPEHA and ATSDR have reached four important conclusions regarding exposure to soil contamination in the areas outside of the security fence at the DuPont-Louviers site.

CONCLUSION 1

Accidentally eating soil in the Trap Range area during residential activities could harm future hypothetical residents, particularly children.

BASIS FOR DECISION

This conclusion was reached because the currently available data suggests that the potential for cancer and noncancer health effects is high due to high levels of arsenic, antimony, and lead that are capable of producing adverse health effects through a soil ingestion pathway are present in the Trap Range area. These high levels of metals appear to be associated with shot materials present in the Trap Range area. Due to high arsenic concentrations, the potential cancer risk for future residents at the Trap Range area is above a level that is considered acceptable. Very high levels of lead were found in the Trap Range area that could harm young children and developing babies. High levels of antimony were also found in the Trap Range area that resulted in estimated exposures to be significantly above the health guidelines but below the known health effect levels in animal or human studies.

NEXT STEPS

DuPont should reduce exposure to the arsenic, antimony, and lead contamination found in the Trap Range area. Reduction in exposure can be achieved by following various strategies (e.g., eliminating exposure pathway and institutional controls).

CONCLUSION 2

Accidentally eating soil while trespassing is not expected to harm trespassers (ages 7-16 years) now or in the future.

BASIS FOR DECISION

This conclusion was reached because the currently available data suggests that the potential for non-cancer and cancer health effects at Solid Waste Management Units (SWMUs) 11, 20, and 24 is low. The levels of contamination in the SWMUs 11, 20, and 24 do not

appear to be high enough to cause significant noncancer or cancer health effects. At the Trap Range, the potential for non-cancer and cancer health effects is low because the levels of contamination do not appear to be high enough to cause significant cancer and noncancer health effects. The estimated non-cancer hazards are below the health-based guideline ("safe" dose) and the estimated theoretical cancer risks are near the mid-point of the acceptable cancer risk range.

NEXT STEPS Arsenic is a known human carcinogen. To be prudent of public health, exposure to arsenic in the Trap Range should be reduced to CDPHE's long-term cancer risk goal of one in a million or to background levels. Reduction in exposure can be achieved by following various strategies (e.g., eliminating exposure pathway and institutional controls).

CONCLUSION 3 **Accidentally eating soil during residential activities in SWMUs 11, 20, and 24 is not expected to harm future potential residents.**

BASIS FOR DECISION This conclusion was reached because the currently available data suggests that the levels of arsenic contamination in these areas outside of the security fence on the DuPont-Louviers property are within the acceptable cancer risk range.

NEXT STEPS No further actions are needed because the estimated theoretical cancer risks appear to be associated with naturally occurring arsenic and are not site-related.

CONCLUSION 4 **Accidentally eating soil during construction activities is not expected to harm future construction workers.**

BASIS FOR DECISION This conclusion was reached because the currently available data suggests that the potential for cancer and noncancer health effects is low. The levels of contamination in the SWMUs 11, 20, and 24 do not appear to be high enough to cause significant non-cancer or cancer health effects. In addition, at the Trap Range area, the potential for cancer and noncancer health effects is low. The estimated theoretical cancer risks for arsenic are at the mid-point of a range that is considered acceptable and the estimated non-cancer hazards for antimony are slightly above the acceptable level (i.e., "safe" dose), but below levels known to cause harmful effects.

NEXT STEPS Arsenic is a known human carcinogen. To be prudent of public health, DuPont should reduce exposure to arsenic in the Trap Range 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. Reduction in exposure can be achieved by following various strategies (e.g., eliminating exposure pathway and institutional controls).

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, future construction workers, and future residents in the area outside of the security fence on the DuPont property.

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 material for this health consultation. For more detailed site background information, refer to the Environmental Site Assessment (DuPont 1991), the RCRA Facility Investigation Report (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, 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.

Under voluntary cooperation with the Colorado Department of Public Health and Environment (CDPHE), DuPont developed a workplan (June 1990) to assess soil and ground water conditions at the site. 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. In 1998, DuPont entered into a Compliance Order on Consent with the CDPHE. Since this time, cleanup 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. To the west, the site is bounded by DynoNobel and Plum Valley Estates. 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 towards Plum Creek to the northeast. Plum Creek is a tributary of the South Platte River.

The site currently consists of four main areas:

- Former manufacturing facilities (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 and the former manufacturing area is secured by a seven-foot security fence. Security patrols the site to control access by trespassers.

During the years of production, various site locations have been constructed to manage operational and site wastes. These areas are referred to as Solid Waste Management Units (SWMUs). In 1990, DuPont developed a work plan in conjunction with the CDPHE to address the closure and removal of site wastes located at SWMUs. Initially, 20 SWMUs were thought to exist at the DuPont-Louviers site. Following the Environmental Site Assessment Investigation conducted in 1991, 4 additional SWMUs were added to the list of areas designated for assessment and remediation prior to closure. In addition, 3 Areas of Concern have also been designated for assessment and remediation. Figure 1 shows

the location of each SWMU and AOC at the DuPont-Louviers site. As shown, 3 SWMUs and 1 AOC are located outside of the security fence on DuPont property.

Demographics

Louviers, Colorado was initially established as a company town for the DuPont-Louviers site. 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. It is likely that 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.

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 meeting. 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. If exposure pathways to contaminants of potential concern 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

In general, 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 samples have been collected from the surface (0-2 feet) and sub-surface (6 –8 feet) in all SWMUs addressed in this evaluation (Table 1). Minor asbestiform components were randomly detected in a couple of samples at very low concentrations (e.g., 0.0028% and 0.0056%). Asbestos will be managed by the State EPA in accordance with the CDPHE regulations for asbestos in soil.

Soil sampling at the Trap Range AOC were collected from 0-2 feet below ground surface (bgs.) in increments of 6 inches. All soil samples that were collected were analyzed for a variety of constituents from metals to volatile organic compounds (VOCs). The following information provides specific information on the soil data collected from each area evaluated in this health consultation.

Solid Waste Management Unit 11

SWMU 11, also known as Landfill Number 5, consists of two erosional features at the southern edge of the property near the site reservoir. The approximate volume of waste is roughly 5,000 cubic feet. Currently, it is not known how long the landfill was used by DuPont. During preliminary site investigation activities, DuPont personnel mapped the area around SWMU 11 and items visible in the northern pit included refrigerators, DNT drums, scrap metal, concrete, and asbestos. Former employees were also interviewed and they indicated that ammonia drums, paint, and other scrap metal may also be present below the surface of the northern pit. The southern pit is thought to contain DNT drums, asbestos, concrete blocks, scrap metal, and other debris. In addition, the southern gully was also used as an overflow for the site reservoir at one point in time.

During the Phase I RCRA Facility Investigation (RFI), which was conducted in 2002, DuPont collected soil samples from 14 locations in and around SWMU 11 for characterization and delineation of potentially impacted soils (Figure 2). The soil samples were collected with a continuous corer and portions of the 0-2 ft. core and 6-8 ft. core were submitted for analysis. The samples were analyzed for semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), asbestos, and eight metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Carbon tetrachloride, chloroform, and tetrachloroethylene were the only organic compounds detected in the soil samples and all of the detected organics were below 0.1 parts per million (ppm). Arsenic, barium, chromium, lead, and mercury were also detected in surface and subsurface samples. However, mercury was only detected in one sample at a relatively low concentration (0.074 ppm).

Solid Waste Management Unit 20

Located adjacent to SWMU 24 on the southern portion of the DuPont-Louviers property is SWMU 20. SWMU 20 is located in a dry creek bed that individuals from the Village of Louviers and the surrounding area used for disposal of various wastes and other debris.

SWMU 20 stretches approximately ½- ¾ of a mile along Indian Creek, which does not convey water. Debris that were mapped during preliminary site investigations includes automobiles, washing machines, household trash, asbestos roofing shingles, and other types of domestic waste.

Six soil borings were completed in and around SWMU 20 during the Phase I RFI in 2002 (Figure 3). The samples were gathered using a Geoprobe or hand auger and aliquots from 0-2, 4-6, and 6-8 feet below ground surface (bgs.) were submitted for analysis. A total of 12 samples were analyzed for VOCs, SVOCs, metals, and asbestos. The only analytes that were detected were metals. Arsenic, barium, chromium, and lead were detected in all 12 samples submitted for analysis (surface and subsurface). Selenium was only detected one time at a relatively low concentration (1.7 ppm).

Solid Waste Management Unit 24

The Village of Louviers used SWMU 24 as a landfill from approximately 1908-1961. The landfill was used almost exclusively by the Village of Louviers. However, employee interviews indicate that some non-burnable plant waste may also be present in SWMU 24.

During the Phase I RFI, 8 soils borings were completed in and around SWMU 24 using a Geoprobe or hand auger (Figure 4). Two of the borings were completed through the unit and the remaining were completed around SWMU 24. A total of 19 samples were collected from 0-2, 6-8, 9-10, and 19-20 ft. bgs. The samples were analyzed for metals, VOC, SVOCs, and asbestos. Tetrachloroethylene (3 detects) and trichloroethylene (1 detect) were the only organic compounds detected with a maximum concentration of both compounds at 0.015 ppm. No SVOCs were detected. Arsenic, barium, chromium, and lead were detected in all 19 samples (surface and subsurface). Cadmium, mercury, selenium, and silver were also detected in some samples.

Trap Range Area of Concern

The Trap Range AOC is a former trap shooting range, which is located on the DuPont-Louviers site. The trap range was operated by the Village of Louviers and the years of operation are currently unknown. The trap range consisted of 4 trap houses spaced approximately 100 feet apart in a straight line. No physical hazards were observed.

As mentioned previously, 4 trap houses were located at the former Trap Range AOC, which was operated by the Village of Louviers. During the Phase II RFI, DuPont collected samples from 10 designated areas that are thought to contain the most likely shot fall areas at the trap range. Composite samples were collected from depths of 0-2 ft. bgs. in 6 inch increments. The composites were collected in an “X” pattern from eight 50’ x 50’ grids and two 50’ x 25’ grids shown in Figure 5. The samples were analyzed for antimony, arsenic, copper, lead, zinc and PAHs. All of the analytes were detected in some samples collected from the trap range with the exception of 2 PAHs. However, all PAHs that were detected were found at relatively low concentrations.

Table 1 is a summary of detected compounds in soil at SWMUs 11, 20, 24, and the Trap Range AOC.

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 including residential exposure to surface soil. The use of these CVs is considered conservative in that it is unlikely individuals are currently being exposed to site-related contaminants at the DuPont-Louviers site on the same scale as a residential exposure scenario. 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. Exceeding the CV does not indicate that a health hazard exists, only that additional examination is warranted.

Overall, the number of COPCs is relatively small in comparison to the number of analytes sampled in the soil samples collected from outside the security fence. Of the three SWMUs and one AOC under consideration in this evaluation, antimony, arsenic, and lead were the only contaminants that exceeded the CV (COPCs). Arsenic was retained in each SWMU and the Trap Range AOC. Lead was selected as a COPC in SWMU 24 and the Trap Range AOC. In addition, antimony was also selected as a COPC in the Trap Range AOC. This information is summarized below in Table 2.

Table 2. COPC Selection Summary

Area	Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	CV Source
SWMU 11	Arsenic	6.5	0.39	EPA RSL- cancer
SWMU 20	Arsenic	3.3	0.39	EPA RSL-cancer
SWMU 24	Arsenic	16	0.39	EPA RSL- cancer
	Lead	880	400	EPA OSWER-noncancer
Trap Range AOC	Antimony	1,100	20	ATSDR cRMEG-noncancer
	Arsenic	550	0.39	EPA RSL -cancer
	Lead	65,000	400	EPA OSWER-noncancer

Terms:
CV = Comparison Value
ATSDR cRMEG = Agency for Toxic Substances and Disease Registry's Reference Dose Media Evaluation Guide for children
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.

Current and Future Land-Use

As previously mentioned, current activity at the site is essentially limited to maintenance and environmental assessment and remediation activities performed by a small number of individuals. The nearest residential property is located within ¼ - ½ mile of the outer perimeter fence. In 2002, a 506-acre portion of the property was donated to Douglas County for open space preservation. A conservation easement of 349 acres, which is currently owned and maintained by DuPont, will also be donated. SWMUs 20 and 24 are located within the conservation easement. The open space preservation does have some public access areas. However, none of the SWMUs or the Trap Range AOC are located in areas that the public could access through the open space preservation. The conservation easement is not currently being used.

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. Outside of the security fence, future land-use is mixed. Douglas County plans to develop trails restricted to hiking and horseback riding in the open space preservation area. Once all remedial activity is complete outside of the security fence, the area may be developed into residential 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.

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 the property by climbing over the perimeter fence and gaining access to the area located outside of the former manufacturing area (security fenced portion). These individuals could come into contact with site-related contamination in surface soil located outside of the security fence. The probable route of exposure is incidental ingestion of surface soil during play and hand-mouth activity. In addition, no physical hazards have been observed outside the security fence.

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 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 (outside security fence): trespassing, residential, and construction work. 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 area outside of the security fence is also available for residential/commercial development once all of the remedial activity has been completed. As mentioned, one purpose of this evaluation is to evaluate if corrective action is necessary to protect current and future public health. If the portion of the DuPont-Louviers facility is developed 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. 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 for Exposure to Contaminants in SWMUs and AOCs Located Outside the Security Fence on the Dupont Property

Source	Point of Exposure	Affected Environmental Medium	Potentially Exposed Populations	Timeframe of Exposure	Route of Exposure
Landfill and Trap Range associated wastes	SWMU 11	Surface and Subsurface soils	Trespassers	Current (Complete), Future (Potential)	Incidental Ingestion of Surface Soil
	SWMU 15				
	SWMU 20		Construction Workers	Future (Potential)	Incidental Ingestion of Surface and Subsurface
	SWMU 24		Residents	Future (Potential)	Soil Incidental Ingestion of Surface Soil
	Trap Range AOC				

Public Health Implications

Evaluating the public health implications of current and future exposure to soil contaminants located outside of the security fence on 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 outside of the security fence. If the estimated exposure dose is higher than the health-based reference points, further evaluation is conducted. Because the areas of contamination outside the security fence are separate and vary in COPCs and levels of COPCs, exposure doses were estimated for each receptor in each SWMU and the Trap Range AOC.

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 11

Arsenic was the only COPC identified in soil at SWMU 11. Arsenic can produce both non-cancer and cancer health effects in human beings so both health endpoints need to be evaluated. The estimated non-cancer exposure doses for arsenic in the area of SWMU 11 were below the health-based guideline for the current trespasser scenario and the future construction worker and resident scenarios (Table A3). This indicates that it is unlikely that non-cancer adverse health effects are occurring for current trespassers or would occur for future construction workers and residents based on the exposure factors used in this evaluation.

Theoretical cancer risks were also estimated for current and future receptors exposed to arsenic in soil at SWMU 11 and compared to the cancer risk range that is generally considered acceptable. The acceptable risk range for cancer is 1 excess cancer case per million exposed individuals (low-end of range) to 1 excess cancer case per 10,000 exposed individuals (high-end of range), which can be expressed $1 * 10^{-6} – 1 * 10^{-4}$ cancer risk. The estimated theoretical cancer risk levels for the trespassing scenario (6.4 *

10^{-7}) and the future construction worker ($2.6 * 10^{-7}$) are lower than the acceptable cancer risk range and excessive cancer risks are not likely for these receptors (Table 6). The estimated cancer risk level for future residents, which accounts for exposure during childhood and adulthood, is just above the mid-point of the acceptable cancer risk range at $1.1 * 10^{-5}$. These estimated cancer risks are considered low because these are below or within the acceptable cancer risk range. However, it appears that the arsenic levels (Exposure Point Concentration = 4.7 ppm) could be attributable to naturally occurring background levels of arsenic and not site-related. Therefore, no further remediation of arsenic in soil at SWMU 11 is recommended.

SWMU 20

The only COPC selected for further evaluation in soil at SWMU 20 was arsenic. The estimated non-cancer exposure doses for all receptors in this area are below the health-based guidelines for chronic exposure to arsenic (Table A3). The estimated cancer risks for trespassers ($4.5 * 10^{-7}$) and future construction workers ($1.9 * 10^{-7}$) are also lower than the acceptable cancer risk in SWMU 20 (Table 6). However, the estimated theoretical cancer risks for future residents are just below the mid-point of the acceptable cancer risk range ($7.8 * 10^{-6}$). These estimated cancer risks and noncancer hazards are considered low because these are below or within the acceptable cancer risk range. Again, it appears that the arsenic levels (Exposure Point Concentration = 3.3 ppm) could be attributable to naturally occurring background levels of arsenic in soils of Colorado and not site-related. Therefore, no further remediation of arsenic in soil at SWMU 20 is recommended.

SWMU 24

In SWMU 24, arsenic and lead exceeded the CVs in soil and were selected as COPCs. All of the estimated non-cancer exposure doses were below the respective health-based guidelines for chronic exposure to arsenic in soil at SWMU 24 (Table A3).

Lead was detected above the CV 3 times in SWMU 24, 2 times at boring 7 (800 ppm, 880 ppm) and 1 time at boring 8 (430 ppm). The evaluation of non-cancer exposure to lead is different than other contaminants because lead is found in a number of sources and much of what is known about the adverse health effects of lead has been described in terms of blood lead levels. To evaluate non-cancer exposure to lead, an IEUBK model is used to determine what the probable blood lead level would be following exposure. However, the IEUBK model was not performed in this evaluation because lead appears to be localized to the 2 boring locations mentioned above. Elsewhere in SWMU 24, the concentration of lead ranges from 3.6 ppm to 51 ppm (below the screening value). In addition, the mean lead concentration in SWMU 24 surface soil (0-2 ft. bgs.) is 169 ppm and 105 ppm from 6-8 ft. bgs. The mean concentration of lead is typically used for the input value in the IEUBK model and both values are below the screening value of 400 ppm. Thus, it does not appear that lead would pose a significant non-cancer hazard for all current and future receptors analyzed in this evaluation.

As shown in Table 6, the theoretical cancer risk estimate for future construction workers ($6.4 * 10^{-7}$) from exposure to arsenic in soil at SWMU 24 is below the acceptable cancer risk range. For current and future trespassers, the calculated cancer risk is $2.2 * 10^{-6}$ and at the low end of the acceptable range. The estimated theoretical cancer risk for future residents ($3.8 * 10^{-5}$) is above the mid-point of the acceptable cancer risk range. These risks are primarily driven by arsenic levels in borings 7 and 8 where the concentration of arsenic is the highest (max = 16 ppm). The theoretical cancer risks in SWMU 24 are not likely to be significant. These estimated cancer risks and noncancer hazards are considered low because these are below or within the acceptable cancer risk range.

Trap Range AOC

At the Trap Range AOC, arsenic, antimony, and lead were selected as COPCs in soil. Arsenic is a known human carcinogen. Ingesting large doses of antimony can cause vomiting. It is not known what other effects may be caused by ingesting it. Long-term animal studies have reported liver damage and blood changes when animals ingested antimony. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system.

The non-cancer exposure doses for current and future trespassers are below the health-based guidelines for chronic exposure to antimony and arsenic (Table A3). For future residential children, the estimated exposure doses exceeded the non-cancer health-based guideline for antimony by a factor of 13 and for arsenic by a factor of 4 (Table 5). The estimated exposure doses for future construction workers exceed the health-based guideline for antimony by a factor of 3 and for arsenic by a factor of 1. For future adult residents, the estimated exposure dose for antimony exceeds the health-based guideline, but the estimated dose for arsenic is below the health-based guideline. These findings indicate that the estimated exposure doses for antimony enter a range of potential concern for non-cancer adverse health effects for the future residents and construction workers.

As mentioned previously, non-cancer health-based guidelines are considered “safe” doses and exceeding the health-based guidelines does not necessarily indicate that there is a major health concern. To further evaluate the potential for adverse health effects from exposure to antimony and arsenic in the Trap Range AOC by future construction workers and residents, the estimated doses were compared to documented human health effect levels in ATSDR and EPA publications. Both ATSDR and EPA have established a chronic duration No Observable Adverse Effect Level (NOAEL) for arsenic of $8 * 10^{-4}$ mg/kg-day and a Lowest Observable Adverse Effect Level (LOAEL) of $1.4 * 10^{-3}$ mg/kg-day. An EPA LOAEL value of $3.5 * 10^{-1}$ mg/kg-day is the only established health effect level for antimony.

In comparison with the known health effect levels, the estimated exposure dose for all receptors are below the LOAEL and/or NOAEL values for arsenic and antimony (Table

4) except for arsenic in residential children. This indicates that arsenic levels at the Trap Range AOC would present a health concern for future residential children. As already mentioned above, antimony enters a range of potential concern for non-cancer adverse health effects for future residents and construction workers based on the exceedance of health-based guidelines.

Table 4. Health Evaluation of Estimated Exposure Doses in the Trap Range AOC

COPC	Estimated Exposure Doses for Construction Worker (in mg/kg-day)	Estimated Exposure Doses for Future Child Residents (in mg/kg-day)	Estimated Exposure Doses for Future Adult Residents (in mg/kg-day)		NOAEL (in mg/kg-day)	LOAEL (in mg/kg-day)
Antimony	1.31E-03	5.19E-03	5.56E-04	4.00E-04	NA	3.5E-01
Arsenic	3.12E-04	**1.23E-03**	1.32E-04	3.00E-04	**8.00E-04**	1.4E-03

The theoretical cancer risks from exposure to arsenic at the Trap Range AOC range from $6.7 * 10^{-6} – 2.3 * 10^{-4}$ (Table 6). The highest theoretical cancer risk of $2.3 * 10^{-4}$, or 230 excess cancer cases per million, is estimated for future residents and is above the acceptable cancer risk range of $1 * 10^{-6}$ - $1 * 10^{-4}$. The estimated theoretical cancer risks for current/future trespassers and future construction workers are near the mid-point of the acceptable cancer risk range. Reduction in exposure to arsenic and antimony in the Trap Range AOC is recommended to reduce potential for health hazards to all receptors, particularly if this area is developed into residential property in the future.

Lead was also selected as a COPC in the Trap Range AOC with a maximum detected concentration of 65,000 ppm. The mean value of lead (2,059 ppm) that is used in the IEUBK model for estimating lead uptake is also above the CV of 400 ppm. However, similar to SWMU 24, the high levels of lead appear to be localized to the TRAP-03 composite. In fact, the lead concentrations in all other samples collected from the TRAP-03 composite and from all the other composites collected from the Trap Range AOC are below the CV (range: 13-53 ppm). This indicates that a high concentration of lead is localized at TRAP-03, specifically in the depth interval of 0-6 inches. Moreover, the highest concentrations of antimony and arsenic in the Trap Range AOC are also located in the TRAP-03 composite. This data further support the observation that high concentrations of lead, arsenic, and antimony at this location are likely to be associated with shot material. Therefore, it appears that by reducing exposure at the TRAP-03 composite, potential for both non-cancer health effects due to antimony and cancer health effects due to arsenic could be drastically reduced for all current and future receptors at the Trap Range AOC.

Considering the former land-use and other soil data collected from the Trap Range AOC, it is possible that the composite collected from TRAP-03 contained actual shot material that was not filtered out prior to analysis. Since exposure to shot and soil is different,

especially in terms of the bioavailability of metals, the estimated exposures to antimony, arsenic, and lead in this area are associated with uncertainty. However, whether the contamination is attributable to shot material or actual soil contamination (from leaching of shot material), it is recommended that exposure to antimony, arsenic, and lead in the Trap Range AOC be reduced through an appropriate strategy.

Limitations

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. Overall, one of the major uncertainties is the assumption of 100% metal bioavailability from shot-contaminated soils. This is a conservative assumption based on the reduced availability of metals from soils. However, the bioavailability of metals from shot materials is not known. Overall, health hazards for shot-contaminated soil ingestion are likely to be overestimated. There is uncertainty associated with the source of lead, antimony, and arsenic contamination in soils at the Trap Range AOC. The available data suggests that the high concentration of metals is associated with shot materials in the soil. However, the levels of these contaminants in soil at TRAP-03 and the potential exposure to shot material are uncertain. It should also be noted that 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 health risks.

In addition, 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.

Future child residents were considered in this evaluation as a potential exposure pathway since no current residents are located on the DuPont-Louviers property. The potential health risks estimated in this evaluation are the greatest for future residential children due to the increased dose per unit body weight versus adults. Of particular concern for children's health is lead, which has been identified in some localized areas (hot spots) in this evaluation.

Conclusions

CCPEHA and ATSDR have reached the following four conclusions regarding current and future exposure to soil contaminants in the area outside of the security fence (SWMUs 11, 20, 24, and Trap Range AOC 24) on the DuPont-Louviers property:

Accidentally eating soil in the Trap Range AOC area during residential activities could harm future residents, particularly children. This conclusion was reached because because the currently available suggests that the potential for cancer and and noncancer health effects is high due to high levels of arsenic, antimony, and lead that are capable of producing non-cancer and/or cancer health effects are present in the Trap Range AOC area. These high levels of metals appear to be associated with shot materials present at the Trap Range AOC. Due to high arsenic concentrations, the potential cancer risk for future residents at the Trap Range AOC is above a level that is considered acceptable. Very high levels of lead were found in the Trap Range AOC area that could harm young children and developing babies. High levels of antimony were also found in the Trap Range AOC that resulted in estimated exposures to be significantly above the health guidelines but below the known health effect levels in animal or human studies.

Accidentally eating soil while trespassing is not expected to harm trespassers (ages 7-16 years) now or in the future. This conclusion was reached because the currently available data suggests that the estimated theoretical cancer risks as well as non-cancer health hazards at the SWMUs 11, 20, and 24 are low.. The levels of contamination in the SWMUs 11, 20, and 24 do not appear to be high enough to cause significant non-cancer or cancer health effects. At the Trap Range AOC, the potential for non-cancer and cancer health effects is low because the levels of contamination do not appear to be high enough to cause significant cancer and noncancer health effects. The estimated non-cancer hazards are below the health-based guideline ("safe" dose) and the estimated theoretical cancer risks are near the mid-point of the acceptable cancer risk range.

Accidentally eating soil during residential activities in the SWMUs 11, 20, and 24 is not expected to harm future potential residents. This conclusion was reached because the currently available data suggests that the levels of arsenic contamination in these areas are within the acceptable cancer risk range.

Accidentally eating soil during construction activities is not expected to harm future potential construction workers. This conclusion was reached because the currently available data suggests that the potential for cancer and noncancer health effects is low. The levels of contamination in the SWMUs 11, 20, and 24 do not appear to be high enough to cause significant non-cancer or cancer health effects. In addition, at the Trap Range AOC, the potential for cancer and noncancer health effects is low. The estimated theoretical cancer risks for arsenic are at the mid-point of a range that is considered acceptable and the estimated non-cancer hazards for antimony are slightly above the acceptable level (i.e., "safe" dose) but below levels known to cause harmful effects.

Recommendations

Based upon CCPEHA's review of the environmental data, exposure pathways, and potential public health implications of exposure to soil contaminants located outside 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:

- Address the antimony, arsenic, and lead contamination associated with shot materials in the Trap Range AOC (TRAP-03) to ensure a reduction in exposure by adopting various strategies such as remediation and/or institutional controls.

- Address arsenic and lead contamination in SWMU 24 to ensure reduction in exposure adopting various strategies such as remediation and/or institutional controls.

- To the extent possible, reduce exposure to arsenic in the Trap Range AOC area to achieve background levels of arsenic or CDPHE's target cancer risk level of $1 * 10^{-6}$.

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.

- CCPEHA will conduct additional health consultation activities at the DuPont-Louviers site on the remaining areas of the property (i.e., Restricted-use area inside the fence) that were not addressed in this evaluation.

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Tables and Figures

Table 1. Soil Data Summary and COPC Selection outside of the security fence at the Du Pont-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 11	Arsenic	0-2	1.9 – 6.5	4.0	14	100%	0.39[2]	X
	Arsenic	6-8	1.3 – 5.0	2.8	16	100%	0.39[2]	X
	Barium	0-2	40 – 280	108.4	14	100%	10,000[1]	
	Barium	6-8	14 – 250	85.4	16	100%	10,000[1]	
	Chromium	0-2	5.4 – 25	15.2	14	100%	230[2]	
	Chromium	6-8	3.6 – 26	12.8	16	100%	230[2]	
	Lead	0-2	6.0 – 31	14.7	14	100%	400[3]	
	Lead	6-8	2.9 – 81	16.3	16	100%	400[3]	
SWMU 20	Arsenic	0-2	1.5 – 3.3	2.3	6	100%	0.39[2]	X
	Arsenic	4-6	2.2	N/a	1	100%	0.39[2]	X
	Arsenic	6-8	1.3 – 3.3	2.6	6	100%	0.39[2]	X
	Barium	0-2	34 – 140	74	6	100%	10,000[1]	
	Barium	4-6	58	N/a	1	100%	10,000[1]	
	Barium	6-8	24 – 130	63.5	6	100%	10,000[1]	
	Chromium	0-2	2.4 – 12	7.5	6	100%	230[2]	
	Chromium	4-6	16	N/a	1	100%	230[2]	
	Chromium	6-8	4.5 – 16	8.9	6	100%	230[2]	
	Lead	0-2	4.1 – 63	20.9	6	100%	400[3]	
	Lead	4-6	14	N/a	1	100%	400[3]	
	Lead	6-8	5.3 – 13	8.1	6	100%	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 24	Arsenic	0-2	2.6 – 16	6.3	8	100%	0.39[2]	X
	Arsenic	6-8	1.9 – 13	4.0	9	100%	0.39[2]	X
	Arsenic	All[a]	1.9 – 16	4.9	19	100%	0.39[2]	X
	Barium	0-2	68 – 1700	360.6	8	100%	10,000[1]	
	Barium	6-8	38 – 1200	212.2	9	100%	10,000[1]	
	Barium	All[a]	38 – 1700	265	19	100%	10,000[1]	
	Chromium	0-2	8.2 – 36	18.9	8	100%	230[2]	
	Chromium	6-8	2.7 – 30	11.7	9	100%	230[2]	
	Chromium	All[a]	2.7 – 36	15.1	19	100%	230[2]	
	Lead	0-2	8.3 – 800	169.2	8	100%	400[3]	X
	Lead	6-8	3.6 – 880	104.6	9	100%	400[3]	X
	Lead	All[a]	3.6 – 880	122.1	19	100%	400[3]	X
Trap Range AOC	Antimony	0-2	0.41 – 1100	58.5	32	59.4%	20[1]	X
	Arsenic	0-2	4.1 – 550	22.3	32	100%	0.39[2]	X
	Copper	0-2	10 – 17	13.8	32	100%	500[1]	
	Lead	0-2	13 – 65,000	2,059	32	100%	400[3]	X
	Zinc	0-2	43 – 72	56.0	32	100%	20,000[1]	
	Anthracene	0-2	0.00014 – 0.00023	0.00019	32	21.9%	170,000[2]	
	Benzo[a]anthracene	0-2	0.00016 – 0.0017	0.00068	32	100%	0.15[2]	
	Benzo[b]fluoranthene	0-2	0.00036 – 0.0054	0.0020	32	100%	0.15[2]	
	Benzo[k]fluoranthene	0-2	0.00021	N/a	32	3.2%	1.5[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
Trap Range AOC cont.	Benzo[g,h,i]perylene	0-2	0.00022 – 0.0026	0.00098	32	100%	NA	
	Benzo[a]pyrene	0-2	0.00018 – 0.0029	0.00110	32	100%	0.015[2]	
	Chrysene	0-2	0.00026 – 0.0033	0.0012	32	100%	15.0[2]	
	Dibenz[a,h]anthracene	0-2	0.00027 – 0.00093	0.00048	32	40.6%	0.015[2]	
	Fluoranthene	0-2	0.00052 – 0.0059	0.0022	32	100%	23,000[2]	
	Indeno[1,2,3-c,d]pyrene	0-2	0.00034 – 0.0023	0.0010	32	84.4%	0.15[2]	
	Naphthalene	0-2	0.00037 – 0.00074	0.00047	32	65.6%	3.9[2]	
	Pyrene	0-2	0.00033 – 0.0055	0.0017	32	100%	17,000[2]	

Notes:
NA = Not Available
[a] = Includes 2 additional samples from 9-10 ft. bgs and 19-20 ft. bgs.
[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 5. Current and Future Non-cancer Hazard Quotients of Incidental Soil Ingestion at the DuPont-Louviers site (outside the security fence)

Area	Contaminant of Potential Concern	Current and Future Trespasser Non-cancer Hazard Quotients	Future Child Resident Non-cancer Hazard Quotients	Future Adult Resident Non-cancer Hazard Quotients	Future Construction Worker Non-cancer Hazard Quotients
SWMU 11	Arsenic	9.92E-03	2.00E-01	2.15E-02	4.10E-02
SWMU 20	Arsenic	6.96E-03	1.41E-01	1.51E-02	2.95E-02
SWMU 24	Arsenic	3.38E-02	6.82E-01	7.31E-02	9.90E-02
Trap Range AOC	Antimony	6.02E-01	**1.22E+01**	**1.30E+00**	**3.07E+00**
	Arsenic	2.04E-01	**4.11E+00**	4.41E-01	**1.04E+00**

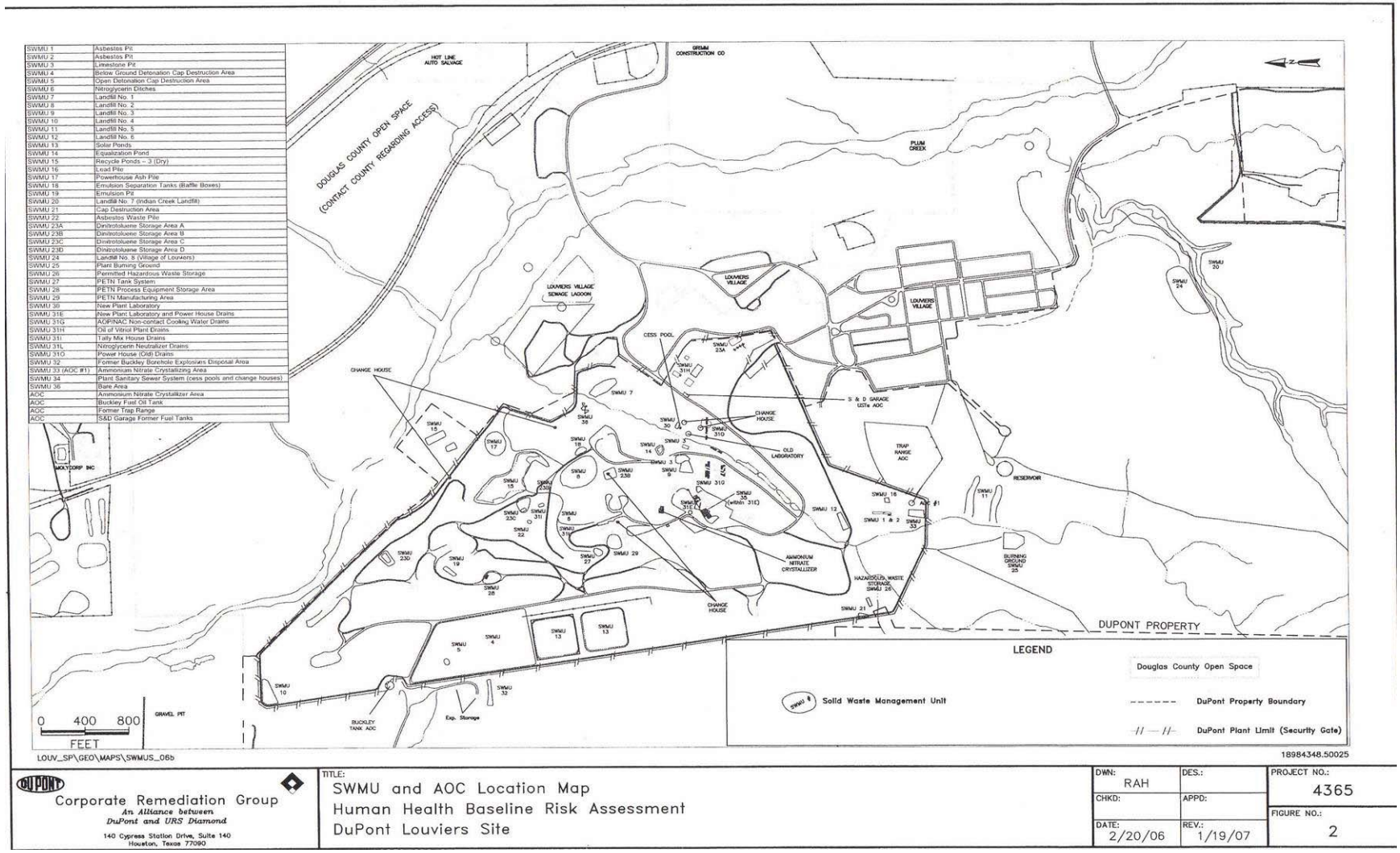
Notes: Hazard Quotients are simply the estimated exposure dose for non-cancer health effects divided by the applicable health-based guideline. Hazard Quotients greater than 1 indicates that the estimated dose exceeds the health-based guideline.
Bolded values are Hazard Quotients greater than 1.

Table 6. Current and Future Theoretical Cancer Risks of Incidental Soil Ingestion at the DuPont-Louviers site (outside the security fence)

Area	Contaminant of Potential Concern	Current and Future Trespasser Theoretical Cancer Risks	Future Resident Theoretical Cancer Risks (Age-Adjusted)	Future Construction Worker Theoretical Cancer Risks
SWMU 11	Arsenic	6.38E-07	1.10E-05	2.64E-07
SWMU 20	Arsenic	4.48E-07	7.75E-06	1.90E-07
SWMU 24	Arsenic	2.17E-06	3.76E-05	6.37E-07
Trap Range AOC	Arsenic	1.31E-05	**2.27E-04**	6.68E-06

Notes : Bolded value exceeds the accpetable cancer risk range

Figure 1. SWMU and AOC Locations on the DuPont-Louviers Site (Source : DuPont 2008)

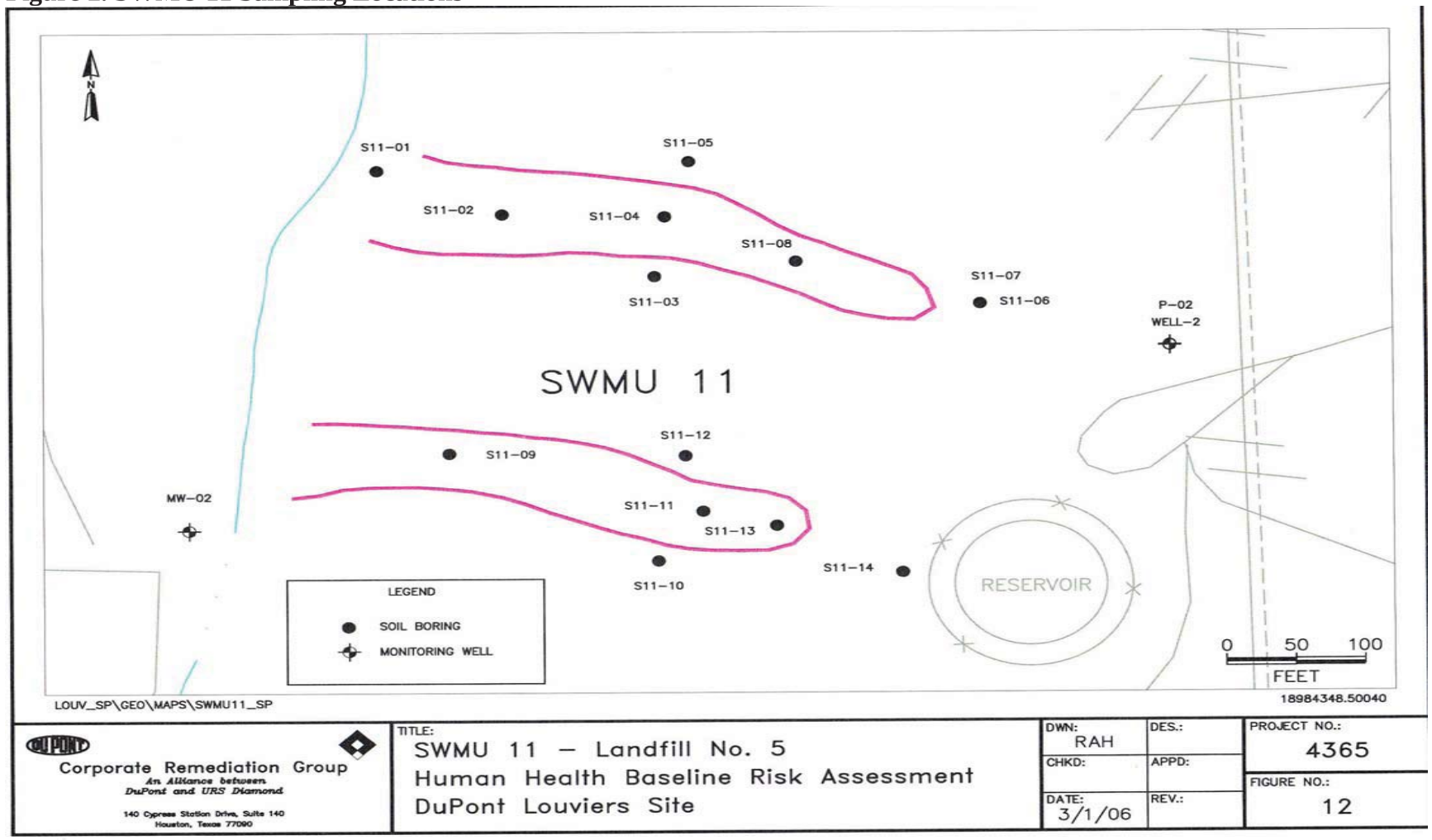


DUPONT
Corporate Remediation Group
An Alliance between DuPont and URS Diamond
140 Cypress Station Drive, Suite 140
Houston, Texas 77090

TITLE:
SWMU and AOC Location Map
Human Health Baseline Risk Assessment
DuPont Louviers Site

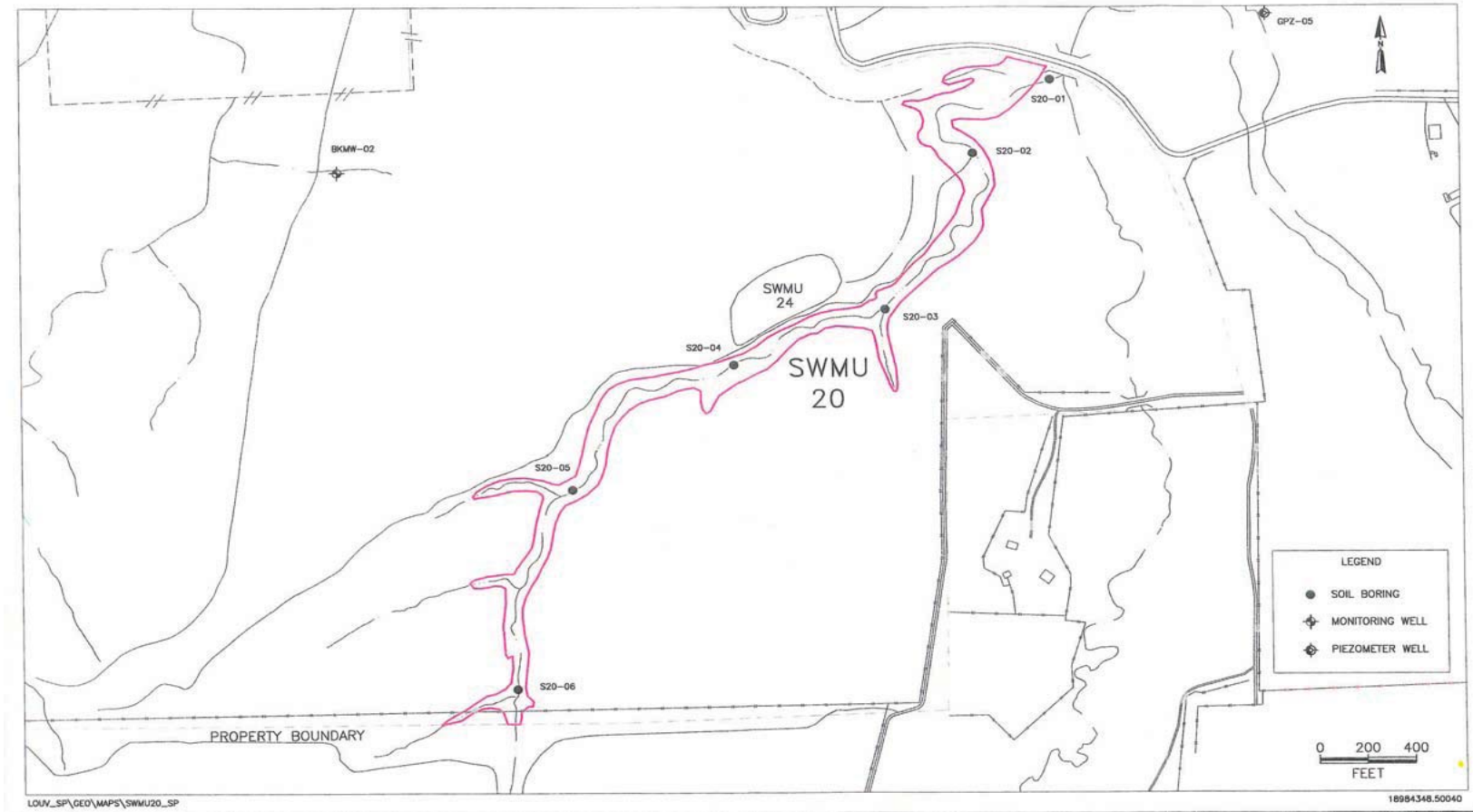
DWN: RAH	DES.:	PROJECT NO.: 4365
CHKD:	APPD:	FIGURE NO.: 2
DATE: 2/20/06	REV.: 1/19/07	

Figure 2. SWMU 11 Sampling Locations



Source : DuPont 2008

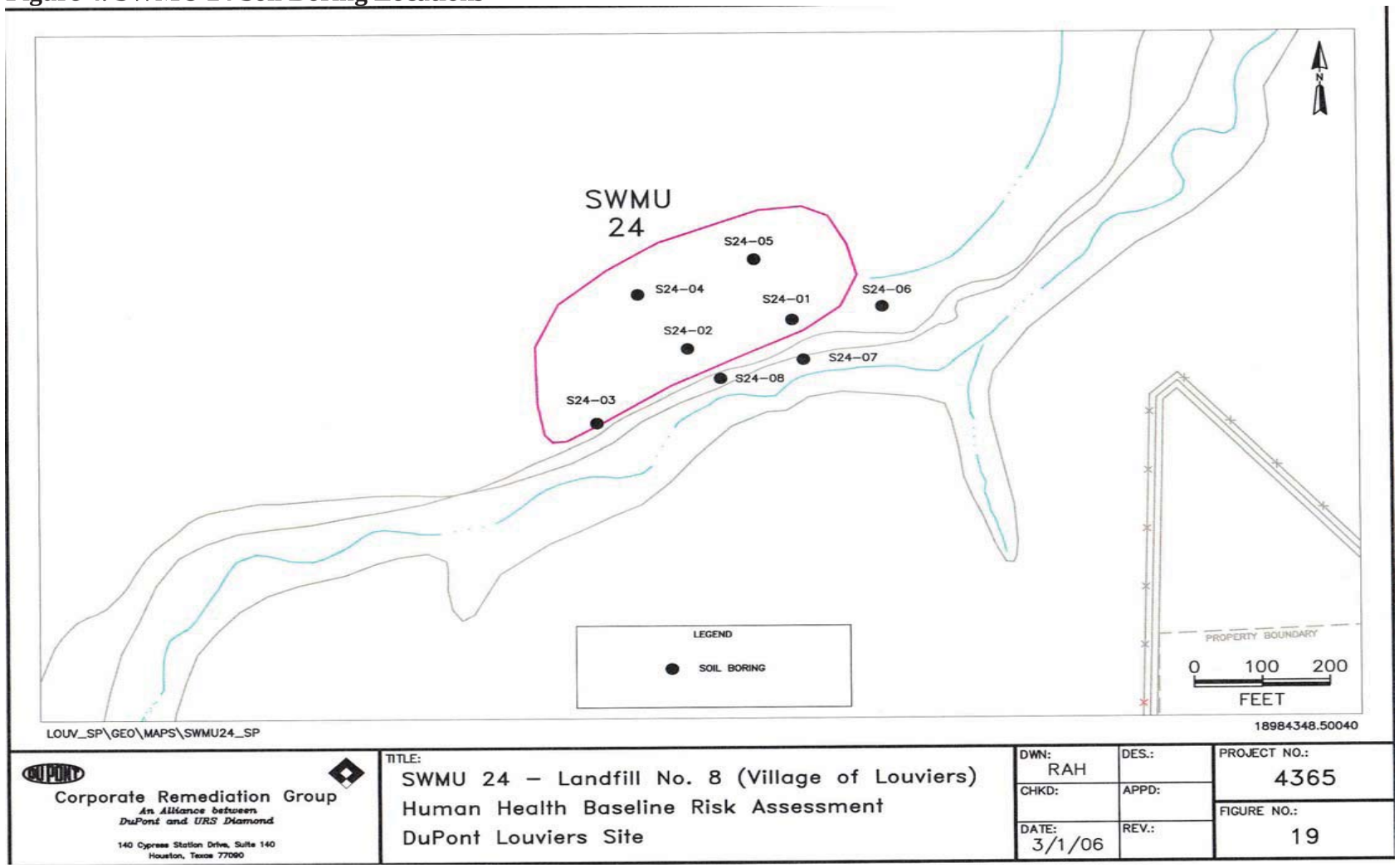
Figure 3. SWMU 20 Soil Boring Locations



DUPONT Corporate Remediation Group, An Alliance between DuPont and URS Diamond, 140 Cypress Station Drive, Suite 140, Houston, Texas 77090	TITLE: SWMU 20 – Landfill No. 7 (Indian Creek Landfill) Human Health Baseline Risk Assessment DuPont Louviers Site	DWN: RAH	DES.:	PROJECT NO.: 4365
		CHKD:	APPD:	FIGURE NO.: 17
		DATE: 3/1/06	REV.:	

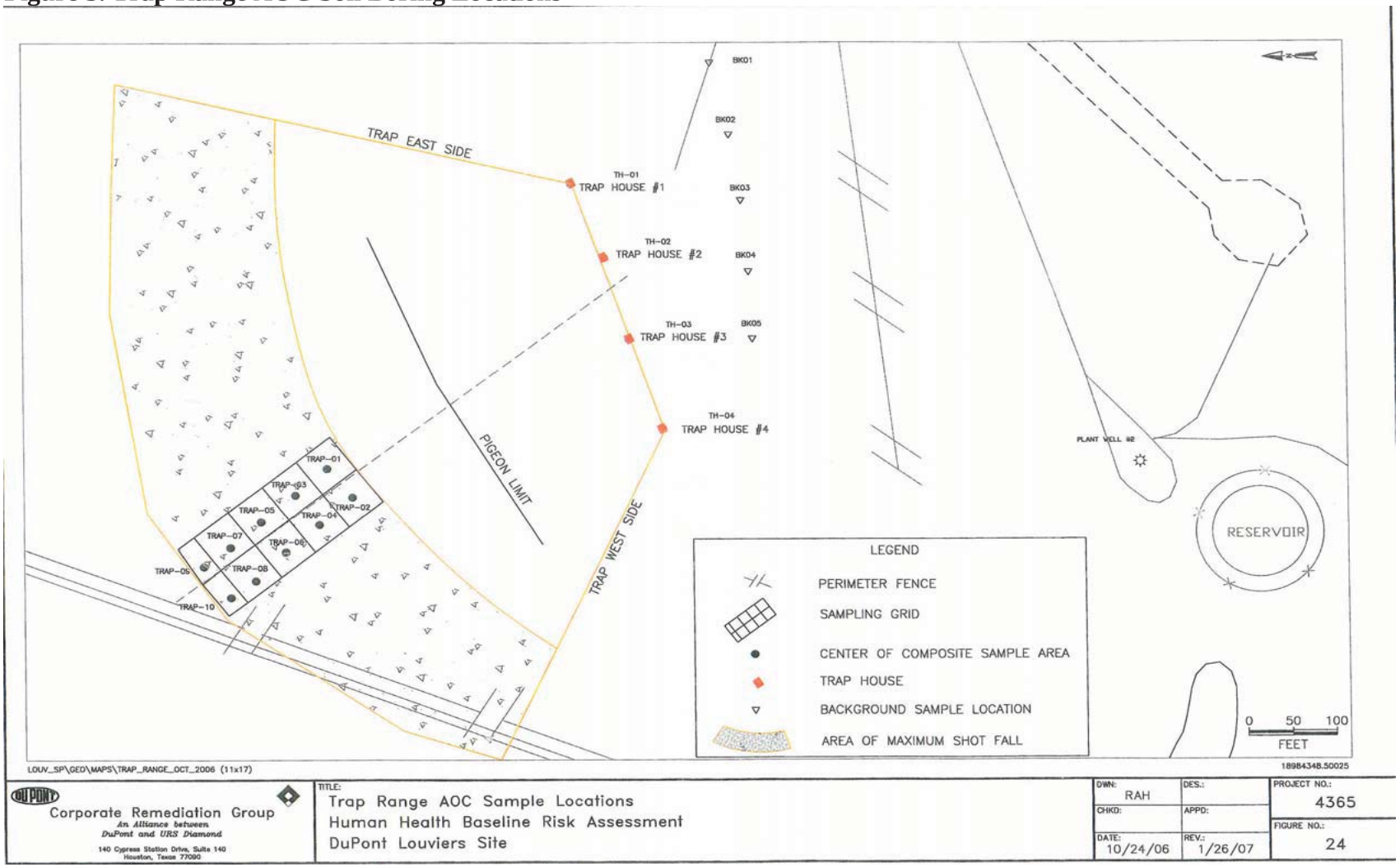
Source : DuPont 2008

Figure 4. SWMU 24 Soil Boring Locations



Source : DuPont 2008

Figure 5. Trap Range AOC Soil Boring Locations



Source : DuPont 2008

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 Comparison Value 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 hypothetical residents, 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
Child Resident[1]	15 kg.	350 days per year	6 years	200 mg. per day	25550 days
Adult Resident[1]	70 kg.	350 days per year	30 years	100 mg. per day	25550 days

Notes:
kg. = kilogram
mg. = milligram
[1] An age-adjusted equation assuming 6 years of exposure as a child and 24 years of exposure as an adult was used to calculate theoretical cancer risks for future residents.

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. 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 collected from the 6-8 foot depth interval in addition to the 0-2 ft. depth interval. Thus, the data from both depth intervals was combined for the EPC calculation. Data from the 0-2 foot depth interval was used in the EPC calculation for current and future trespassers as well as future hypothetical residents. The same soil data was used for all receptors in the Trap Range AOC because no samples were collected from the 6-8 foot depth interval in this area. 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 of Investigation	Contaminant of Potential Concern	Receptor	Exposure Point Concentration	EPC Estimation Method
SWMU 11	Arsenic	Trespassers and Future Residents	4.70	95% Student's-t UCL*
SWMU 11	Arsenic	Future Construction Workers	3.81	95% Student's-t UCL*
SWMU 20	Arsenic	Trespassers and Future Residents	3.30	Maximum detected value (<10 samples)
SWMU 20	Arsenic	Future Construction Workers	2.74	95% Student's-t UCL*
SWMU 24	Arsenic	Trespassers and Future Residents	16.0	Maximum detected value (<10 samples)
SWMU 24	Arsenic	Future Construction Workers	9.20	95% Chebyshev (Mean, Sd) UCL*
Trap Range AOC	Antimony	All	380.6	99% KM (Chebyshev) UCL*

Trap Range AOC	Arsenic	All	96.5	95% Chebyshev (Mean, Sd) UCL*

* 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). For future residents, theoretical cancer risks were calculated using an age-adjusted equation that combines child and adult cancer risk into one equation. 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: $\mathbf{EF = (F * ED) / AT_{noncancer}}$

Age-Adjusted Soil Ingestion Cancer Dose

Age-Adjusted Cancer Dose = $\mathbf{(C_s * IRS_{adj} * CF * EF) / 25{,}550\ Days}$

Where: $\mathbf{IRS_{adj} = [(ED_{child} * IRS_c) / BW_c] + [(ED_{adult} * IRS_a) / BW_a]}$

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 (outside the security fence)

Area	Contaminant of Potential Concern	Current and Future Trespasser Non-cancer Exposure Doses	Future Child Resident Non-cancer Exposure Doses	Future Adult Resident Non-cancer Exposure Doses	Future Construction Worker Non-cancer Exposure Doses	Health-based Guideline
SWMU 11	Arsenic	2.98E-06	6.01E-05	6.44E-06	1.23E-05	3.00E-04
SWMU 20	Arsenic	2.09E-06	4.22E-05	4.52E-06	8.85E-06	3.00E-04
SWMU 24	Arsenic	1.01E-05	2.05E-04	2.19E-05	2.97E-05	3.00E-04
Trap Range AOC	Antimony	2.41E-04	**4.87E-03**	**5.21E-04**	**1.23E-03**	4.00E-04
	Arsenic	6.11E-05	**1.23E-03**	1.32E-04	**3.12E-04**	3.00E-04

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

Area	Contaminant of Potential Concern	Current and Future Trespasser Theoretical Cancer Risks	Future Resident Theoretical Cancer Risks (Age-Adjusted)	Future Construction Worker Theoretical Cancer Risks
SWMU 11	Arsenic	4.25E-07	7.36E-06	1.76E-07
SWMU 20	Arsenic	2.98E-07	5.17E-06	1.26E-07
SWMU 24	Arsenic	1.45E-06	2.51E-05	4.24E-07
Trap Range AOC	Arsenic	8.73E-06	**1.51E-04**	4.45E-06

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 antimony, arsenic, 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.

Antimony is a naturally occurring element that typically is found in very low levels in the environment. Only a limited amount of data exists on human health effects from oral route of exposure. However in the past, antimony has been used for medicinal purposes for the treatment of parasite infections. Some people who had too much or were particularly sensitive to the antimony-containing medication experienced non-cancer health effects such as diarrhea, joint and/or muscle pain, vomiting, problems with the blood (anemia) and heart problems (altered electrocardiograms). Oral exposure to antimony has been shown to cause cancer. For additional health effect information on antimony, refer to ATSDR's Toxicological Profile at: http://www.atsdr.cdc.gov/toxprofiles/tp23.html.

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.

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
Antimony	0.0004	EPA IRIS chronic RfD
Arsenic	0.0003	ATSDR Chronic MRL

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
Antimony	NA	0.35	EPA IRIS chronic RfD
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

CERTIFICATION

This 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.

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

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