Health Consultation

E.C. ELECTROPLATING
(a/k/a GARFIELD CHROMIUM GROUNDWATER CONTAMINATION SITE)
GARFIELD, BERGEN COUNTY, NEW JERSEY

EPA FACILITY ID: NJD002006773

Prepared by the
New Jersey Department of Health and Senior Services

April 26, 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.

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Environmental and Occupational Health Surveillance Program
Under Cooperative Agreement with the
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Summary

Introduction

The New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) have evaluated the public health implications of hexavalent chromium contamination in the interiors of residences and other buildings potentially affected by an area of contaminated groundwater in Garfield, Bergen County, New Jersey. The contaminated groundwater is associated with the E.C. Electroplating site and perhaps other sources.

ATSDR and NJDHSS's top priority is to ensure that the residents living near the site are protected from any further exposures to hexavalent chromium.

NJDHSS and ATSDR have reached the following conclusions in this Health Consultation.

Conclusion 1

This conclusion is for houses whose basements have levels of hexavalent chromium that present a health concern. The conclusion assumes that there will be no changes in how the basement is used and the condition of the basement in the future.

NJDHSS and ATSDR conclude that children and adults were, are, and will continue to be exposed to hexavalent chromium at levels that can harm their health. People can be exposed to the harmful levels of hexavalent chromium by accidentally swallowing contaminated dust. This is a public health hazard. Hexavalent chromium was also found in indoor air and sump water, but we believe that breathing indoor air and infrequent skin contact with sump water is not likely to harm health.

Basis for Conclusion

Tests of dusts and sump water indicate that groundwater contaminated with high levels of hexavalent chromium has entered the basements of some of the residences located above the contaminated groundwater. Based on concentrations of hexavalent chromium in dusts and assumptions about basement usage, non-cancer health effects could occur among children and adults, and the lifetime risk of cancer may be increased. The amount of exposure to chromium and consequent health risk depends in part on the degree to which residents access contaminated areas.

As long as groundwater remains contaminated with high levels of hexavalent chromium and groundwater continues to infiltrate into the basements of residences, children and adults can continue to be exposed to hexavalent chromium in the residences.

Next Steps	The U.S. Environmental Protection Agency (US EPA) should clean the basements of residences where chromium was found at levels that present a health concern. Residences that are cleaned should be monitored regularly to determine if recontamination occurs as a result of infiltration of chromium contaminated groundwater. Additional long-term cleanup activities may be necessary to address recontamination. Residents of homes with hexavalent chromium concentrations above levels that present a health concern have already been advised by the US EPA to take the following precautions: o Limit use of the basement as much as possible. o If the basement is used: o remove shoes before re-entering the rest of the house and clean the bottom of shoes with a wet wipe or paper towel. o wash hands. o if cleaning, use wet cleaning techniques, such as mopping, as opposed to sweeping and dusting. o Frequently wash items that come in contact with a child's mouth, such as toys. It should be US EPA's priority to take the steps necessary to expedite groundwater remedial actions to prevent groundwater contaminated with hexavalent chromium from entering residences.
Conclusion 2	**This conclusion is for: 1) houses that that have levels of hexavalent chromium presenting a health concern where basement use changes in the future; 2) houses over the contaminated groundwater where new contamination or recontamination occurs in the future; and 3) houses that have not been tested, but which may presently be contaminated at levels that may cause people to have higher exposures to hexavalent chromium unless actions are taken to prevent exposures.** *NJDHSS and ATSDR conclude that the accidental swallowing of surface dusts contaminated with hexavalent chromium could be very harmful to people's health. This could pose an urgent public health hazard.*
Basis for Conclusion	The highest amounts of hexavalent chromium in surface dust were found in basements that were not frequently used by residents. However, if people begin to use those basements more often, both children and adults may be exposed to hexavalent chromium at levels that could significantly increase their risk of adverse health effects.

	For tested homes, if no actions are taken to prevent the infiltration of contaminated groundwater, basements may become more contaminated or re-contaminated if cleaned. Additionally, because some of the tested houses (whose basements are not used much) have very high amounts of hexavalent chromium in dust, it is possible that there are untested houses where basements are used frequently and have high concentrations of hexavalent chromium. This scenario could result in exposures at levels of very high concern.
Next Steps	Residents whose houses have water infiltration problems that have not yet been tested should follow the recommendations listed in Conclusion 1. The US EPA should offer to test additional houses with water infiltration problems in the affected area that have not currently been tested. Because of the potential for a high degree of public health risk, the US EPA should take the steps necessary to expedite groundwater remedial actions within residences to dissociate residents from exposures to hexavalent chromium.
Conclusion 3	**This conclusion is for the Roosevelt Elementary School #7.** *NJDHSS and ATSDR conclude that accidentally swallowing surface dusts contaminated with hexavalent chromium for past, present and future exposures at the Roosevelt Elementary School #7 are not expected to harm people's health.*
Basis for Conclusion	Hexavalent chromium was detected in surface dust from one of five samples collected from a floor surface within the school. At this time it is not known if hexavalent chromium contaminated groundwater is present below the school area. Based on available data, the level of hexavalent chromium children (K through 6th grade) and adult employees may be exposed to in surface dust did not indicate there is an increased concern for health effects, including cancer, dermatitis, and other illnesses.
Next Steps	The US EPA should determine if hexavalent chromium contaminated groundwater is present below the Roosevelt Elementary School #7, to prevent potential impacts to the school interior in the future.

For More Information	Copies of this public health assessment will be provided to concerned residents via the township libraries and the Internet. NJDHSS will notify area residents that this report is available for their review and provide a copy upon request. Questions about this Health Consultation should be directed to the NJDHSS at (609) 826-4984.

Statement of Issues

In September 2007, in response to a request by the United States Environmental Protection Agency (US EPA), Region 2, the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) completed a letter health consultation for the E.C. Electroplating site located at 125 Clark Street in Garfield, Bergen County. The September 2007 letter health consultation was based on limited environmental data and recommended additional sampling to better assess potential threats to public health for the residents within the community in the vicinity of the site. This health consultation assesses potential hexavalent chromium exposures to area residents based on recent investigations conducted by the US EPA, Region 2 in 2009. In addition to E.C. Electroplating, the US EPA is conducting investigations of other potential sources of chromium which may have contaminated groundwater. Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), the NJDHSS reviewed environmental data and prepared this health consultation to determine the public health implications with hexavalent chromium groundwater contamination associated with this site.

Background and Site History

The E.C. Electroplating site is located on a ¾ acre (approximate) parcel in a mixed residential and commercial area of Garfield (see Figure 1). In December 1983, approximately 3,640 gallons of chromium plating solution (chromic acid) containing 5,441 pounds of chromium was discharged from a partially below ground storage tank. In response, five monitoring wells (MW-01 through MW-05) and one recovery well (MW-06) were installed to monitor groundwater and recover discharged product. Background reports indicate that by May 1984, 1,044 gallons of product and 1,600 pounds of chromium were recovered. An initial report, dated December 1984, indicates the site is underlain by glacial ground moraine deposits (overburden aquifer) and Brunswick Formation shale (bedrock aquifer) (PAS, 1984). The tank leak and subsequent spill of chromic acid solution likely impacted the overburden and bedrock aquifers. In May 1985, the New Jersey Department of Environmental Protection (NJDEP) allowed E.C. Electroplating to cease contaminant recovery efforts, sealing four of the groundwater wells and continue groundwater monitoring from two on-site wells. E.C. Electroplating failed to comply with this monitoring directive from NJDEP. In June 1993, chromium contaminated groundwater and crystals were discovered in the nearby Garfield Fire House #3, which was subsequently taken out of service. As a result, in November 1993, E.C.

Figure 1: Location of E.C. Electroplating Site

Electroplating entered into a Memorandum of Agreement with the NJDEP to comply with regulatory investigation requirements including full delineation of the chromium-contaminated groundwater plume. Between November 1994 through April 2000 four groundwater monitoring wells were installed to comply with delineation requirements. As of April 2000, groundwater samples indicated maximum concentrations of total chromium and hexavalent chromium at 1,500,000 and 1,490,000 micrograms per liter (µg/L), respectively, at one on-site monitoring well (NJDEP 2002).

The groundwater sampling results prompted additional investigation in October 2000 revealing chromium-contaminated groundwater within the basement sumps of several residences and commercial properties in the immediate vicinity. In September 2002, the NJDEP issued a Notice of Violation to E.C. Electroplating for failing to comply with continued investigation and to initiate remedial actions. The company cited financial difficulty regarding continued cooperation to further conduct remedial investigations and actions. In October 2002, the NJDEP requested that the US EPA evaluate the site. Responding to a US EPA request, a letter health consultation was completed in September 2007 by the ATSDR and NJDHSS to evaluate the potential exposure pathways to groundwater contaminated with hexavalent chromium for the surrounding community and provide recommendations for future actions.

In addition to E.C. Electroplating, the US EPA is conducting investigations of other potential sources of chromium, which may have contaminated groundwater. These potential sources include a nearby tannery, a chemical plant, and another electroplating facility within the Garfield area (US EPA 2008).

Prior Site and Residential Property Investigations

Previous investigations of several residential properties were conducted by the NJDEP in 2000 and 2001 for the presence of chromium contamination. Analytical results for basement sump water samples from seven residences indicate total chromium was detected in six residences and hexavalent chromium was detected in three residences. Analytical results for residue solids collected from within the basement sumps of four residences indicate total chromium was detected in all residences while hexavalent chromium was not detected.

These investigations also indicated flooding events had occurred in the Golden Towers apartments located in close proximity to the EC Electroplating site. The flooding incident, which occurred at an unspecified time prior to the January 2003 sampling event, left a yellow powder-type residue on the basement floor. Two samples of the residue indicated the presence of total chromium and hexavalent chromium (ATSDR 2007). Based on the presence of hexavalent chromium contamination, the basement was remediated in February 2003 through services retained by consultants under contract with the Garfield Housing Authority.

Groundwater

Analytical results for groundwater samples collected below the E.C. Electroplating site indicate that total chromium and hexavalent chromium are approximately 15,000 times higher than the federal drinking water MCL of 100 µg/L for total chromium (including hexavalent chromium). Concentrations of total chromium were detected approximately 1,000 to 100,000

µg/L lower in groundwater from monitoring wells located approximately 2,000 feet hydraulically downgradient of the site. Groundwater flow is to the west towards the Passaic River, which is located approximately 2,500 feet from the EC Electroplating facility.

US EPA Investigations

Roosevelt Elementary School #7

On August 20, 2008, the US EPA collected five dust wipe samples from the floor and wall surfaces within the Roosevelt Elementary Public School #7, located approximately 350 feet to the northwest of the E.C. Electroplating facility. The US EPA identified this property for evaluation based on the sensitive population (children) attending the school and its close proximity to the E.C. Electroplating facility. The purpose of this investigation was to determine if hexavalent chromium in groundwater was impacting the interior of the school causing an increased exposure potential to students.

Residential Property Investigations

From February 2009 through March 2009, the US EPA collected dust wipe samples (331), sump water samples (55), and sump/floor sediment samples (73) from a total of 163 residential properties. The US EPA identified these properties for evaluation based on resident survey response and property location in relation to what is believed to be the contaminated groundwater plume (see Figure 2). The purpose of the investigations was to determine if hexavalent chromium in groundwater was impacting the interior of residential basements, causing an increased exposure potential to residents.

Demographics

Using United States Census data for the year 2000, the ATSDR estimates that there are about 11,326 individuals residing within a one-mile radius of the E.C. Electroplating site representing the center of the Garfield Chromium Groundwater Contamination Site area (see Figure 3). The number of residences near or within the hexavalent groundwater contamination plume is estimated to be approximately 691 properties (see Figure 2; US EPA 2008). The area of potential impact lies from Sherman Place extending west towards the Passaic River.

Community Health Concerns

The NJDHSS attended a public meeting in October 2008 where the US EPA informed residents of the additional investigations planned in 2009 to address whether site-related hexavalent chromium has impacted the interior of homes causing an increased potential for exposure. NJDHSS provided information during the meeting to address health concerns regarding exposure to hexavalent chromium. The basis for recent US EPA investigations originates from previous recommendations made by the ATSDR and NJDHSS in a "letter health consultation" completed for the site in September 2007. US EPA investigations began in February 2009 and are continuing at the time of preparation of this health consultation. The available data from the investigations have been included in this report to address potential public health implications from past, current and future exposure scenarios. To date, the US

EPA has distributed questionnaire/property surveys to 673 residences of which they have received 535 responses. Based on survey response, the US EPA identified 288 residences with possible groundwater infiltration issues. Further evaluation narrowed this search to 186 residences identified as potential sampling candidates of which 163 residences have been sampled and evaluated within this health consultation.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two-tiered approach: 1) a screening analysis; and 2) a more in-depth analysis to determine public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media-specific environmental guideline comparison values (CVs). If concentrations exceed the environmental guideline CV, these substances, referred to as Contaminants of Concern (COC), are selected for further evaluation. Contaminant levels above environmental guideline CVs do not mean that adverse health effects are likely, but that further evaluation is necessary. Once exposure doses are estimated, they are compared with health guideline CVs to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

There are a number of CVs available for the screening of environmental contaminants to identify COCs. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) were also considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million persons exposed during their lifetime (70 years). In the absence of an ATSDR CV, other comparison values may be used to evaluate contaminant levels in environmental media. These include the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC); the New Jersey Maximum Contaminant Levels (NJMCLs) for drinking water; US EPA Region 6 Human Health Media-Specific Screening Levels (SLs) and NJDEP Indoor Air Screening Levels (IASLs) for air. SLs are contaminant concentrations corresponding to a fixed level of risk (i.e., a Hazard Quotient of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower contaminant concentration) in water, air, biota, and soil. These health-based benchmarks are derived from the evaluation of cancer and non-cancer effects using current toxicity criteria.

The US EPA has set a health-based screening value identified for total chromium in settled surface dust at 4,704 $\mu g/m^2$ per the World Trade Center Indoor Environment Assessment study (US EPA 2003). This screening value is based on the toxicity criteria of the US EPA Reference Dose (RfD) for hexavalent chromium (0.003 milligrams per kilogram-day).

Substances exceeding applicable environmental guideline CVs were identified as COCs and evaluated further to determine whether these contaminants pose a health threat to exposed or

potentially exposed receptor populations. If environmental guideline CVs are unavailable, these contaminants are selected for further evaluation.

Roosevelt Elementary School #7

Hexavalent Chromium Residue in Surface Dust

On August 20, 2008, five dust wipe samples were collected from the Roosevelt Elementary School #7. This facility is considered a frequently used area used by a sensitive population based on the age and duration of children attending the school. Two samples were collected from floor and wall surfaces from a school lunch room and three samples were collected from floor and wall surfaces of the facility's boiler room (including one duplicate sample). Sample collection involved wiping a 100 square centimeter area.

Concentrations of hexavalent chromium from samples collected from the Roosevelt Elementary School #7 ranged from non-detect to 178 $\mu g/m^2$, below the US EPA screening value of 4,704 $\mu g/m^2$ for total chromium (which includes hexavalent chromium). However, since a screening value for hexavalent chromium in surface dust is not available, the results have been retained for further evaluation. It is further noted that there was only one detection of hexavalent chromium in surface dust for the five dust samples collected.

Based on surface dust wipe data and the absence of a screening value for hexavalent chromium, hexavalent chromium is a COC in surface dust for the Roosevelt Elementary School #7 (see Table 1a).

Residential Property Investigations

Basement usage at sampled residences has been identified as either "high usage" or "low usage" areas. ATSDR and NJDHSS have developed exposure assumptions to define these terms that are described later in this document. The general assumption is that the high use category is applied to basements that serve as an extra living space and where usage of this area would be intensive (e.g., for playing, sleeping, working, etc.) and on a daily basis. The general assumption is that the low use category applies to basements that are used intermittently (e.g., for laundry or storage). The low use scenario applies to most of the homes that have been sampled in Garfield. Due to the individual nature of how people use their basements, however, these two usage categories may not be universally applicable to all situations. To be protective, ATSDR and NJDHSS have assumed that basements where activities take place that may fall in between these two categories (e.g., a home gym or workshop) are in the high use category.

Hexavalent Chromium Residue in Surface Dust

From February 23, 2009 through March 29, 2009, 331 dust wipe samples were collected from the basement areas of 163 residential properties and analyzed for hexavalent chromium. The US EPA identified these properties for evaluation based on resident survey response and property location (see Figure 3). Wipe samples were collected from basement floors and/or basement walls. One residential location did not have a basement, so a wipe sample was collected from the exposed sub-floor in the kitchen area. Sample collection involved wiping a

100 square centimeter area. Of the locations sampled, 16 residences were identified as having detected concentrations of hexavalent chromium residue present in surface dust.

Concentrations of hexavalent chromium were detected in six high usage basements ranging from 400 to 29,100 micrograms per square meter ($\mu g/m^2$).

Concentrations of hexavalent chromium were detected in ten low usage basements ranging from 250 to 136,000 $\mu g/m^2$.

While some of the results have exceeded the US EPA screening value of 4,704 $\mu g/m^2$ for total chromium, since a screening value for hexavalent chromium in surface dust is not available, all detections have been retained for further evaluation. Based on surface dust wipe data, hexavalent chromium is a COC in surface dust, where detected, for the residences with high and low usage basements (see Table 1b).

Hexavalent Chromium in Basement Sediment

From February 23, 2009 through March 29, 2009, 73 sediment samples were collected from basement floors (42) and sump interiors (31) from 54 residential properties and analyzed for hexavalent chromium. The US EPA identified residential locations where sediment was observed on the basement floor and selected for sampling.

Concentrations of hexavalent chromium were detected in floor or sump sediment at one high use, four low use and eight undefined use basements. Hexavalent chromium concentrations only in low use basements (ranging from 1.3 to 74 milligrams per kilogram (mg/Kg)) exceeded the EMEG of 50 mg/Kg for children but below the EMEG of 700 mg/Kg for adults.

In January 2003, hexavalent chromium was detected in the basement of the Golden Towers apartment complex at 95,800 mg/Kg, exceeding the aforementioned EMEGs for children and adults. The basement area of this complex is considered a low use area. Hexavalent chromium contamination was remediated for this complex in February 2003. However, recent surface wipe investigation of this basement by the US EPA shows hexavalent chromium was detected at concentrations exceeding the environmental CVs indicating this basement remains an area of concern.

Based on basement sediment data, hexavalent chromium is a COC in sediment for residences with low usage basements (see Table 2).

Hexavalent Chromium in Basement Sump Water

From February 23, 2009 through March 29, 2009, 55 water samples were collected from basement sumps from 35 residential properties and analyzed for hexavalent chromium.

Concentrations of hexavalent chromium in sump water for low usage areas ranged from 2,200 to 9,300 µg/L at three residences. A concentration of hexavalent chromium in sump water for an undefined usage area was 140 µg/L.

Historical sump water data collected in 2000 through 2003 (reported in the September 2007 letter health consultation) indicate detected concentrations of hexavalent chromium were present at three residential properties (one re-sampled during 2009 investigations) ranging from 54 to 11,300 µg/L.

There is no known environmental comparison value regarding dermal exposures to hexavalent chromium in sump water. This data, however, is important to US EPA investigations as it identifies residences where hexavalent chromium contaminated groundwater from the plume source is known to enter basement sumps. This establishes a mechanism where, under conditions of water intrusion, hexavalent chromium can impact interior basement surfaces to create a completed exposure pathway to residents through contamination of dusts and/or sediments. Therefore, hexavalent chromium in sump water is considered a COC of concern in sump water based on the potential for this media to impact basement interiors causing contamination of surface dusts and/or sediment to establish a completed exposure pathway with known public health implications (see Table 3).

Hexavalent Chromium in Indoor Air

On August 27 and 31, 2009 and September 3, 2009, 28 air samples (plus three duplicate samples) were collected primarily from basement areas of 19 residential properties and two control residences. [Most of the data from the sampling event that included the control homes (August 2009) is not incorporated into this report and the control homes are not mentioned anywhere else. EPA recommends the discussion of the control homes here be removed and also from Table 4.] Samples were analyzed for hexavalent chromium.

Concentrations of hexavalent chromium for high usage areas ranged from non-detect to 0.0000428 micrograms per cubic meter (µg/m^3) which did not exceed the CREG of 0.00008 µg/m^3.

Concentrations of hexavalent chromium for low usage areas ranged from non-detect to 0.0001580 µg/m^3 exceeding the CREG of 0.00008 µg/m^3.

Based on the above results, hexavalent chromium is a COC in indoor air for low usage areas (see Table 4).

Groundwater

Historical groundwater results collected in April 2000 from groundwater monitoring wells located on the EC Electroplating site indicate hexavalent chromium was detected at 1,490,000 µg/L, exceeding both the RMEG of 30 µg/L and the federal drinking water MCL of 100 µg/L for total chromium (including hexavalent chromium).

Summary of Contaminants of Concern for Evaluated Locations

Based on the review of data described above, hexavalent chromium is considered a COC in basement dust, sump water and indoor air for US EPA investigated residences and in groundwater based on historical data.

Groundwater	
Shallow Groundwater Aquifer	Hexavalent Chromium
Roosevelt Elementary School #7	
Surface Dust	Hexavalent Chromium
Residential Locations	
Surface Dust – High & Low Use Basements	Hexavalent Chromium
Sediment – Low Use Basements	
Sump Water – Low Use and Undefined Use Basements [(a)]	
Indoor Air – Low Use Basements	

(a) Considered a contaminant of concern in sump water based on the potential of this media to impact basement interiors causing contamination of surface dusts and/or sediment establishing a completed exposure pathway.

The toxicological summary for hexavalent chromium is provided in Appendix A.

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to a receptor population and whether exposures to contamination are high enough to be of health concern. Site-specific exposure doses can be calculated and compared with health guideline CVs.

Assessment Methodology

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. Source of contamination
2. Environmental media and transport mechanisms
3. Point of exposure
4. Route of exposure
5. Receptor population

Generally, the ATSDR considers three exposure categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

When assessing an exposure risk to a COC, the US EPA recommends the 95 percent upper confidence limit (95% UCL) of the arithmetic mean should be used to determine the exposure point concentrations (EPC) for site-related contaminants (US EPA 1992). An EPC is

considered to be the concentration of a contaminant at the point of human exposure. The 95% UCL is considered a 'conservative estimate' of average contaminant concentrations in an environmental medium to represent the EPC. To determine EPCs, site data was analyzed using ProUCL® 4.0 (US EPA 2007) developed by the US EPA to calculate the 95% UCL.

The exposure pathways for the identified areas of concern in this update include child and adult residents and employees associated with the residence locations sampled by the US EPA. The evaluated exposure pathways for site-related contaminants are presented in Table 5.

Completed Exposure Pathways to Hexavalent Chromium

Ingestion of contaminated surface dust (past, present, future). For the past, present and future, there is a completed exposure pathway regarding ingestion of and dermal contact with surface dust containing hexavalent chromium within the Roosevelt Elementary School #7 and the basement/living space areas of sampled residences. Exposed individuals include children (students and residents) and adults (including employees associated with residential multi-tenant housing) occupying or working in structures identified to have been contaminated via the hexavalent chromium groundwater plume. The exposure pathway involves incidental ingestion of surface dust contaminated with hexavalent chromium present within the basements of evaluated residences. The presence of hexavalent chromium in dusts within the basements is believed to originate from contaminated groundwater entering the basement through walls and/or floors where the contaminant becomes deposited on surfaces. Groundwater intrusion into basement areas either by seepage or flooding events is evidenced through information provided in resident surveys and past site documentation. The assumption that hexavalent chromium in surface dusts originates from contaminated groundwater is supported due to its detected presence at elevated concentrations within basement sump water.

It is noted that hexavalent chromium was detected in surface dust from one of five samples collected within the Roosevelt Elementary School #7. The sample was collected from the tile floor surface beneath a bookcase within the Brown Bag Lunch Room. This floor area is not routinely cleaned as it is covered by the bookcase. Therefore, hexavalent chromium may not be present, or present at lower concentrations in surface dust of exposed floor surfaces as these surfaces are routinely cleaned as part of custodial duties.

In January 2003, hexavalent chromium was detected in sediment in the basement of the Golden Towers apartment complex at 95,800 mg/Kg which was remediated in February 2003. However, recent surface wipe and sump water sampling results collected within this basement by the US EPA indicates hexavalent chromium was detected at concentrations exceeding the environmental CVs. Therefore, although remedial actions were completed in the past, this basement remains an area of concern as it is evident it has become re-contaminated with hexavalent chromium likely due to its continued presence at high concentrations in groundwater.

There is an additional concern that individuals accessing the basement area may have transported contaminated residue (i.e. via shoes, clothing) into other areas of the apartment complex, including living spaces; however, there is no evidence to support if individuals accessed the contaminated area(s) of the basement to establish a transport mechanism (i.e.

tracking) to create this pathway. As additional data becomes available, an evaluation of this pathway may be feasible.

In this health consultation, hexavalent chromium in sediment is considered to occur by the same mechanism responsible for the contaminant's presence in basement surface dust. Therefore, the discussion of the health implications of exposure to contaminated surface dust (below) is considered to encompass exposures to contaminated sediment, when present.

Inhalation of airborne hexavalent chromium particulate in indoor air (past, present, future). For the past, present and future, there is an exposure pathway regarding the inhalation of airborne particulates within the basements of evaluated residences. The exposure pathway involves hexavalent chromium in surface dusts being disturbed and becoming airborne where the contaminated particulates are inhaled.

Eliminated Exposure Pathways to Hexavalent Chromium

Ingestion of groundwater (past, present, future). Ingestion of hexavalent chromium via drinking water is eliminated as a pathway as background information does not indicate there are potable groundwater wells within the area, specifically including the groundwater plume area.

Direct ingestion of contaminated sump water is not considered a likely exposure pathway. Dermal exposure to sump water may occur, but health risks via this pathway are uncertain and are not evaluated quantitatively in this health consultation.

Based on available data, there are no other known completed or potential pathways to hexavalent chromium associated with the E.C. Electroplating site.

Public Health Implications of Completed Exposure Pathways

Once it has been determined that individuals have or are likely to come in contact with site-related contaminants (i.e., a completed exposure pathway), the next step in the public health assessment process is the calculation of site-specific exposure doses. This is called a health guideline comparison which involves looking more closely at site-specific exposure conditions, the estimation of exposure doses, and comparison to health guideline CVs. Health guideline CVs are based on data drawn from the epidemiologic and toxicologic literature and often include uncertainty or safety factors to ensure that they are amply protective of human health.

The maximum and average hexavalent concentrations detected in surface dust and indoor air were used to assess the risk of non-cancer and cancer health effects to the exposed population. Additionally, as groundwater remains contaminated with hexavalent chromium and groundwater intrusion into sumps and basement areas of residences continues to occur, future exposures remain a concern to residents within the contaminated groundwater plume area.

An added concern is the potential for basements of residences designated as low usage changing in the future where they would be considered a high usage area, which would increase the exposure potential and, thus, also increase the risk to harm public health. As such, this evaluation also includes worst-case exposure scenarios in which low usage areas are converted to high usage areas, to capture these potential risks to public health.

Non-Cancer Health Effects

To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15-364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. In order to provide additional perspective on these health effects, the calculated exposure doses were then compared to observed effect levels (e.g., NOAEL, LOAEL). As the exposure dose increases beyond the MRL to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

If the NOAEL or LOAEL is not available, the BMDL (benchmark dose level) or BMCL (benchmark concentration level) can be used. The BMD or BMC is a dose or concentration that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background. The BMD or BMC can be used as an alternative to the NOAEL/LOAEL in dose-response assessment. The lower limit of the BMDL or BMCL is a characterization of the dose or concentration corresponding to a specified increase in the probability of a specified response. For example, a $BMDL_{10}$ or $BMCL_{10}$ is the lower confidence limit of the estimated dose corresponding to an increase of 0.10 in the probability of the specified response relative to the probability of that same response at dose zero (ATSDR 2008).

When MRLs for specific contaminants are unavailable, other health based comparison values, such as the US EPA's Reference Dose (RfD) and Reference Concentrations (RfC) are used. The RfD is an estimate of a daily oral exposure and the RfC is an estimate of a daily inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure.

Incidental Ingestion of Surface Dust

Surface dust contaminated with hexavalent chromium was identified in ten low usage and six high usage basement areas for residential properties investigated in 2009 by the US EPA.

Exposures are based on incidental ingestion of surface dust contaminated with hexavalent chromium during use of residential basement areas. Non-cancer exposure doses were calculated using the following formula obtained from the US EPA World Trade Center Indoor Environment Assessment study (US EPA 2003):

Exposure Dose (mg/kg/day) =

$$\frac{[(ET_{hard} \times FTSS_{hard} \times CSL_{hard}) + (ET_{soft} \times FTSS_{soft} t \times CSL_{soft})] \times SA \times FQ \times SE}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
ET = Exposure Time (hr/day) for hard and soft (carpeted) surfaces;
FTSS = Fractions Transferred from Surface to Skin (unitless)
$FTSS_{hard}$ = 50%, $FTSS_{soft}$ = 10%;
CSL = Contaminant Surface Load (mg/cm^2);
SA = Surface Area (cm^2/event);
FQ = Frequency of hand-to-mouth events (events/hr);
SE = Saliva Extraction Factor at 50% (unitless); and,
BW = Body Weight (kg)

The following site-specific exposure assumptions (US EPA 1997, 2003, 2008) were used to calculate exposure doses to child and adult residents, child students and adult employees. The exposure assumptions for the residential population are based on information provided in residential surveys and ATSDR and NJDHSS criteria classifying low and high basement usage scenarios.

General Exposure Assumptions

Exposure Setting	Exposed Population	Surface Area (mouthing area)	Hand-to-Mouth Contacts (events/hour)
Roosevelt Elementary School #7	Child (5 through 12 years)	25 to 32 cm^2 (Age Adjusted)	5 to 9.5 (Age Adjusted)
Resident	Child (1 through 18 years)	15 to 45 cm^2 (Age Adjusted)	2 to 9.5 (Age Adjusted)
	Child/Adult (1 to 31 years)	15 to 45 cm^2 (Age Adjusted)	1 to 9.5 (Age Adjusted)
Resident/Employee	Adult	45 cm^2	1

Location Specific Assumptions: Roosevelt Elementary School #7

Exposed Population	Body Weight	Exposure Time	Number of Years Exposed
Child (5 through 12 years)	20 to 34 kg (Age Adjusted)	8 hours/day 180 days/year (a)	7
Adult	70 kg		40

(a) Standard school year exposure scenario: 8 hours/day

Location Specific Assumptions: Low Usage Scenario for Basements

Exposed Population	Body Weight	Exposure Time [e]	Number of Years Exposed
Child [a] (1 through 6 years)	16.5 kg	1 hour/day 5 days/week	6
Child [b] (7 through 12 years)	34 kg	1 hour/day 2 days/week	
Child [c] (13 through 18 years)	58 kg	2.5 hours/day 5 days/week	
Adult [d]	70 kg	2.5 hours/day 5 days/week	30

(a) Child spends less than half the time that an adult does in basement.
(b) School-aged child exposed only during weekend period.
(c) Assumes child 13 to 18 years takes on laundry duties.
(d) Worst-case scenario: child exposed through and into adulthood in residence.
(e) Low Usage Assumption (i.e. unfinished basements, laundry use, storage)

Location Specific Assumptions: High Usage Scenario for Basements

Exposed Population	Body Weight	Exposure Time	Number of Years Exposed
Child (1 through 18 years)	16 to 70 kg (Age Adjusted)	12 hours/day 365 days/year [b]	18
Child/Adult (1 to 31 years) [a]	16 to 70 kg (Age Adjusted)		30

(a) Worst-case scenario: child exposed through and into adulthood in residence
(b) High Usage Assumption (i.e. living space, actively used area) at 12 hours/day

Roosevelt Elementary School #7

Hexavalent Chromium. Based on the maximum concentration of hexavalent chromium detected in surface dusts (one sample), the exposure dose calculated for school students (K through 6th grade) at 0.00015 mg/kg/day and for adult employees at the school at 0.00001mg/kg/day did not exceed the ATSDR chronic MRL of 0.001 mg/kg/day (see Table 6). Therefore, non-cancer adverse health effects are not expected to occur in children (students) or adults exposed to hexavalent chromium within the Roosevelt Elementary School #7.

Low Usage Basements

Hexavalent Chromium. The chronic oral MRL for hexavalent chromium of 0.001 mg/kg/day is based on the health effect of diffuse epithelial hyperplasia of the duodenum observed in male and female mice chronically exposed to sodium dichromate dihydrate in drinking water for one to two years. An uncertainty factor of 100 and the lowest $BMDL_{10}$ of 0.09 mg/kg/day were used to calculate the chronic oral MRL (NTP 2008).

Based on the UCL concentration of hexavalent chromium detected in surface dusts, the exposure dose calculated for children at 0.013 mg/kg/day and adults at 0.011 mg/kg/day exceeded the ATSDR chronic MRL of 0.001 mg/kg/day (see Table 6). Compared to

toxicological studies, the calculated exposure doses based on the UCL hexavalent concentration in surface dust are:

- 29 to 108 times below the LOAELs of 0.38, 0.77 and 1.4 mg/kg/day for intermediate exposures known to cause hematological effects in male and female rats and female mice (NTP 2008);
- 29 times below the LOAEL of 0.38 mg/kg/day for chronic exposures known to cause gastrointestinal and hepatic effects in male and female mice (NTP 2008); and
- 7 times below the $BMDL_{10}$ of 0.09 mg/kg/day for chronic exposures known to cause diffuse epithelial hyperplasia of the duodenum observed in male and female mice (NTP 2008).

Therefore, non-cancer adverse health effects could occur to children and adults exposed to hexavalent chromium within evaluated basements considered as low usage.

High Usage Basements

Hexavalent Chromium. Based on the UCL concentration of hexavalent chromium detected in surface dusts, the exposure dose calculated for children at 0.016 mg/kg/day and adults at 0.0013 mg/kg/day exceeded the ATSDR chronic MRL of 0.001 mg/kg/day (see Table 6). Comparisons of the calculated exposure doses based on the UCL hexavalent concentration in surface dust for children and adults are similar to those presented for low usage basements in the preceding section.

Therefore, non-cancer adverse health effects could occur to children and adults exposed to hexavalent chromium within evaluated basements considered as high usage.

Low Usage Basements Converted for High Usage: Theoretical Scenario

Low usage basements account for the highest detections of hexavalent chromium in surface dust. In the event a low usage basement is converted in the future to a high usage area (i.e. living space), the potential for exposure may increase significantly. This case would present itself specifically if no actions are taken to remediate hexavalent chromium in groundwater and/or no actions are taken to prevent contaminated groundwater from entering the basement and basement sumps. To account for these possibilities, a theoretical exposure dose was calculated using hexavalent chromium concentrations in low usage basements in a high usage exposure scenario, to demonstrate the potential increase in risk.

Hexavalent Chromium. Based on the UCL concentration of hexavalent chromium detected in surface dusts, the chronic exposure dose calculated for children at 0.094 mg/kg/day and adults at 0.073 mg/kg/day exceeded the ATSDR MRL of 0.001 mg/kg/day (see Table 6). Compared to toxicological studies, for the highest risk group (children), these theoretical doses:

- are 30 times below the LOAEL of 2.8 mg/kg/day for acute exposures known to cause hematological effects in male rats (NTP 2008**);**

- are approaching the LOAELs of 0.38, 0.77 and 1.4 mg/kg/day for intermediate exposures known to cause hematological effects in male and female rats and female mice (NTP 2008);
- are approaching the LOAEL of 0.38 mg/kg/day for chronic exposures known to cause gastrointestinal and hepatic effects in male and female mice (NTP 2008); and
- are nearly equal to and exceed the $BMDL_{10}$ of 0.09 mg/kg/day for chronic exposures known to cause diffuse epithelial hyperplasia of the duodenum observed in male and female mice (NTP 2008).

Therefore, non-cancer adverse health effects are likely to occur to children and to adults exposed to hexavalent chromium in surface dusts if low usage basement are converted to living space areas.

Inhalation of Particulates in Indoor Air

Airborne indoor air particulates contaminated with hexavalent chromium exceeding the CREG CV has been identified within low usage basement areas at two residential properties investigated in 2009 by the US EPA.

Low Usage Basements and
Low Usage Basements Converted for High Usage: Theoretical Scenario

Hexavalent Chromium. The chronic inhalation RfC of 0.1 $\mu g/m^3$ for hexavalent chromium is based on a BMCL of 34 $\mu g/m^3$ derived from data for lactate dehydrogenase activity in bronchoalveolar lavage fluid in rats exposed to sodium dichromate (ATSDR 2008). The RfC incorporates a safety factor of 300 to account for pharmacodynamic differences between species, extrapolating from subchronic to chronic exposures, and human variability (including sensitive populations, such as children) (US EPA 1998).

There were no detected hexavalent chromium concentrations exceeding the chronic RfC of 0.1 $\mu g/m^3$ for the evaluated residences including for the theoretical future high usage scenario (see Table 7). Therefore, adverse non-cancer health effects are not expected to occur for past, present and future exposures to hexavalent chromium in indoor air to adults and children. However, unless remedial actions are taken, the risk to develop adverse non-cancer health effects may increase in the future if there is an increase in concentrations of hexavalent chromium in indoor air.

Cancer Health Effects

The site-specific lifetime excess cancer risk (LECR) indicates the potential for exposure to contaminants to increase the risk of cancer. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population for a lifetime, over and above the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 46 per 100 individuals for males, and 38 per 100 for females; the lifetime risk of being diagnosed with any of several common types of cancer ranges between 1 in 100 and 10 in 100 (SEER 2005). Typically, health guideline CVs developed for carcinogens are based on one

excess cancer case per 1,000,000 individuals (expressed exponentially as 10^{-6}). ATSDR considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk.

For the purposes of this evaluation, the LECRs calculated are based on the *theoretical risk* of developing cancer and *do not* portray *actual risk*. The actual risk of developing cancer from exposure to hexavalent chromium, or any other known carcinogen, cannot be determined. Therefore, the LECRs are provided as a gauge to highlight the significance of actions that may be required to protect public health.

According to the United States Department of Health and Human Services (USDHHS), the US EPA, the U.S. Department of Health and Human Services, National Toxicology Program (NTP) and the International Agency for Research on Cancer, the cancer class of hexavalent chromium is listed as a known human carcinogen regarding inhalation exposure.

Regarding oral exposure, the NTP has recently completed a two-year study indicating clear evidence that ingestion of drinking water contaminated with hexavalent chromium caused malignant tumors in mice and rats. A two-year study on laboratory animals is considered the primary method to determine the potential to be hazardous to humans. NTP rodent studies are used by regulatory agencies to promulgate regulations to protect human health and are used in the hazard identification process for risk assessment (NTP 2008).

Incidental Ingestion of Surface Dust

The risk of cancer was evaluated for incidental ingestion of surface dust contaminated with hexavalent chromium based on the location-specific exposure scenarios used to assess non-cancer health effects. Cancer exposure doses were calculated using the non-cancer exposure dose and adjusting for the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \textit{Non-cancer Exposure Dose} \times \frac{ED}{AT}$$

where ED = exposure duration representing the location-specific scenario (years); and
AT = averaging time (years).

The LECR for adults was calculated by multiplying the cancer exposure dose by the cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

The CSF regarding ingestion exposure was obtained from the NJDEP. The NJDEP derived a CSF of 0.5 $(mg\ hexavalent\ chromium/Kg/day)^{-1}$ using chronic bioassay data of male mice from the 2008 NTP study and US EPA cancer assessment guidelines (NJDEP 2009). Alternatively, the California Department of Health Services has also developed a CSF of 0.42 $(mg\ hexavalent\ chromium/Kg/day)^{-1}$ for ingestion exposure based on a 1968 study by Borneff, et. al. (Cal EPA 2009). Currently, the California Environmental Protection Agency (Cal EPA) has developed a revised (draft) CSF of 0.6 $(mg\ hexavalent\ chromium/Kg/day)^{-1}$ for ingestion

exposure based on the 2008 NTP study (Cal EPA 2009). At the time of this report preparation, the Cal EPA draft CSF for ingestion is under review for public comment.

Roosevelt Elementary School #7

Based on the maximum hexavalent chromium concentration detected in surface dust, the LECRs for school students (K through 6th grade) and adult employees were approximately 5 in 1,000,000 and 3 in 1,000,000, respectively, which is considered a very low increased risk of cancer (see Table 8).

Low Usage Basements

Based on the UCL hexavalent chromium concentration detected in surface dust, the LECRs for children and adults were approximately 2 in 1,000, which is considered an increased risk of cancer (see Table 8).

High Usage Basements

Based on the UCL hexavalent chromium concentration detected in surface dust, the LECRs for children and adults were approximately 2 in 1,000, which is considered an increased risk of cancer (see Table 8).

Low Usage Basements Converted for High Usage: Theoretical Scenario

Low usage basements account for the highest detections of hexavalent chromium in surface dust. As with the assessment for non-cancer health effects, a theoretical LECR was calculated to assess the future risk where a low usage basement is converted to a living space. Based on this theoretical exposure assumption, the highest UCL hexavalent chromium concentration detected in surface dust would present a LECR for children and adults of approximately 1 in 100, which would be considered an increased risk of cancer (see Table 8).

Inhalation of Particulates in Indoor Air

Exposure concentrations to hexavalent chromium particulates in indoor air and LECRs were calculated using the following formulas (US EPA 2009):

$$EC = \frac{EPC \times ET \times EF \times ED}{AT}$$

where EC = exposure concentration ($\mu g/m^3$);
EPC = exposure point concentration of contaminant in air ($\mu g/m^3$);
ET = exposure time (hours/day);
EF = exposure frequency (days/year);
ED = exposure duration (years); and
AT = averaging time (years).

LECR = EC x IUR

where EC = exposure concentration ($\mu g/m^3$); and
IUR = inhalation unit risk of contaminant in air $(\mu g/m^3)^{-1}$;

The LECR for residents was calculated by multiplying the cancer exposure concentration in indoor air by the inhalation unit risk (IUR). The IUR is defined by the US EPA as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air (US EPA 2008b).

Low Usage Basements and
Low Usage Basements Converted for High Usage: Theoretical Scenario

Based on the UCL hexavalent chromium concentration detected in indoor air, the LECRs for adults were less than 1 in 1,000,000, which is considered to be no expected increased risk of cancer (see Table 9).

Based on the theoretical exposure assumption of low usage basements being converted to living space, using the maximum hexavalent chromium concentration detected in indoor air, the LECR for children and adults would be approximately 3 in 1,000,000, which is considered a very low increased risk of cancer (see Table 9).

Child Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults. They also play outdoors and often bring food into contaminated areas. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The NJDHSS and ATSDR evaluated the potential risk for children residing in homes that use the basement area as a living space (high use areas) where hexavalent chromium is present primarily in surface dust and indoor air. Based on the UCL hexavalent chromium concentrations detected, there is an increased risk of cancer for children.

As basement areas considered low usage typically had the highest hexavalent chromium concentrations, additional consideration was given to assess the theoretical exposure risk to children if these areas were converted to living space. Based on the maximum hexavalent chromium concentrations detected in surface dust, the theoretical future exposure assumption posed an increased risk of cancer to children.

Conclusions

This conclusion is for houses that have levels of hexavalent chromium that present a health concern. The conclusion assumes that there will be no change in how the basement is used and the condition of the basement in the future.

NJDHSS and ATSDR conclude that children and adults were, are, and will continue to be exposed to hexavalent chromium at levels that can harm their health. People can be exposed to the harmful levels of hexavalent chromium by accidentally swallowing contaminated dust. This is a public health hazard. Hexavalent chromium was also found in indoor air and sump water, but we believe breathing indoor air and infrequent skin contact with sump water is not likely to harm health.

Tests of dusts and sump water indicate that groundwater contaminated with high levels of hexavalent chromium has entered the basements of some of the residences located above the contaminated groundwater. Based on concentrations of hexavalent chromium in dusts and assumptions about basement usage, non-cancer health effects could occur among children and adults, and the lifetime risk of cancer may be increased. The amount of exposure to chromium and consequent health risk depends in part on the degree to which residents access contaminated areas.

As long as groundwater remains contaminated with high levels of hexavalent chromium and groundwater continues to infiltrate into the basements of residences, children and adults can continue to be exposed to hexavalent chromium in the residences.

This conclusion is for: 1) houses that have levels of hexavalent chromium that present a health concern where basement use changes in the future; 2) houses over the contaminated groundwater where new contamination or re-contamination occurs in the future; and 3) houses that have not been tested, but which may presently be contaminated at levels that may cause people to have higher exposures to hexavalent chromium unless actions are taken to prevent exposures.

NJDHSS and ATSDR conclude that, if basement usage changes or concentrations of hexavalent chromium increase, the accidental swallowing of surface dusts contaminated with hexavalent chromium could be very harmful to people's health. This could pose an urgent public health hazard.

The highest amounts of hexavalent chromium in surface dust were found in basements that were not frequently used by residents. However, if people begin to use those basements more often, both children and adults may be exposed to hexavalent chromium at levels that could significantly increase their risk of adverse health effects.

For tested homes, if no actions are taken to prevent the infiltration of contaminated groundwater, basements may become more contaminated or re-contaminated if cleaned.

Additionally, because some of the tested houses (whose basements are not used much) have very high amounts of hexavalent chromium in dust, it is possible that there are untested

houses where basements are used frequently and have high concentrations of hexavalent chromium. This scenario could result in exposures at levels of very high concern.

This conclusion is for the Roosevelt Elementary School #7.

NJDHSS and ATSDR conclude that accidentally swallowing surface dusts contaminated with hexavalent chromium for past, present and future exposures at the Roosevelt Elementary School #7 is not expected to harm people's health.

Hexavalent chromium was detected in surface dust from one of five samples collected from a floor surface within the school. At this time it is not known if hexavalent chromium contaminated groundwater is present below the school area. Based on available data, the level of hexavalent chromium children (K through 6th grade) and adult employees may be exposed to in surface dust did not indicate there is an increased concern for health effects, including cancer, dermatitis, and other illnesses.

Recommendations

1. The following short-term and long-term actions should be taken by the US EPA to dissociate residents from exposure to surface dust contaminated with hexavalent chromium at levels that present a health concern.

2. Actions should be taken in the short term by the US EPA to minimize or prevent resident exposures to surface dust contaminated with hexavalent chromium from occurring. The US EPA should clean the basements of residences where chromium was found at levels that present a health concern. Residences that are cleaned should be monitored regularly to determine if recontamination occurs as a result of infiltration of chromium contaminated groundwater. Additional long-term cleanup activities may be necessary to address recontamination.

   Residents of homes with hexavalent chromium concentrations above levels that present a health concern have already been advised by the US EPA to take the following precautions:
   - Limit use of the basement as much as possible.
   - If the basement is used:
     - remove shoes before re-entering the rest of the house and clean the bottom of shoes with a wet wipe or paper towel.
     - wash hands.
     - if cleaning, use wet cleaning techniques, such as mopping, as opposed to sweeping and dusting.
   - Frequently wash items that come in contact with a child's mouth, such as toys.

In the long term, it should be US EPA's priority to take the steps necessary to expedite groundwater remedial actions to prevent groundwater contaminated with hexavalent chromium from entering residences.

3. Because some of the houses that were tested have very high amounts of hexavalent chromium in dust in basements that are not used very much, it is quite possible that there are untested, frequently used basements with similar high concentrations of hexavalent chromium. This can also result in exposures at levels of very high concern. The US EPA should offer to test additional houses with water infiltration problems in the affected area that have not been tested already. Residents whose houses have water infiltration problems that have not yet been tested should follow the recommendations listed above.

4. Although direct dermal contact with sump water does not appear to pose a risk to harm people's health, precautions should be taken by residents to limit their exposure to contaminated sump water.

5. The US EPA should follow through with its assessment that additional investigation is required to determine if hexavalent chromium contaminated groundwater is present below the Roosevelt Elementary School #7, to prevent potential impacts to the school interior in the future.

Public Health Action Plan

The purpose of a Public Health Action Plan is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the ATSDR and the NJDHSS to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented by the ATSDR and NJDHSS are as follows:

Public Health Actions Taken

1. The ATSDR and NJDHSS reviewed information and relevant data to evaluate the potential health implications for exposures to hexavalent chromium detected in surface dust, sediment, sump water and indoor air at residences within the hexavalent chromium groundwater plume associated with the E.C. Electroplating site.

2. A letter health consultation was completed by the ATSDR and NJDHSS in September 2007 evaluating the potential health implications for exposures to hexavalent chromium associated with the E.C. Electroplating site (ATSDR 2007).

3. The NJDHSS attended a public meeting held in September 2008 by the US EPA to discuss site investigations planned for the residential area within the impacted groundwater plume area.

Public Health Actions Planned

1. The US EPA has indicated they will clean the basements of residences where hexavalent chromium was found at levels that present a health concern. Residences that are cleaned will also be monitored regularly to determine if recontamination occurs as a result of infiltration of hexavalent chromium contaminated groundwater.

2. The US EPA will offer to test all houses with water infiltration problems in the affected area that have not currently been tested.

3. The US EPA will evaluate remediation alternatives available to prevent groundwater contaminated with hexavalent chromium from entering residences.

4. In anticipation of community concerns, NJDHSS will examine the incidence of cancer types potentially related to hexavalent chromium exposure, which will be summarized in a separate health consultation.

5. This health consultation will be provided to the US EPA, the NJDEP, the Bergen County Health Department and the Garfield Health Department. NJDHSS will notify area residents that these reports are available for their review and provide a copy upon request. Representatives of the ATSDR and NJDHSS are available to discuss the results of this report with interested parties.

6. NJDHSS will advise area health care providers, particularly pediatricians and family practitioners, of the findings of this report. NJDHSS will make available to them materials on hexavalent chromium, including the Case Study in Environmental Medicine – Chromium Toxicity and the chromium ToxFAQ. NJDHSS will also provide copies of the report to New Jersey Poison Information and Education System for their reference and information.

7. A groundwater investigation will be conducted by the US EPA in the near future to determine the extent of chromium contamination, its source/sources, and groundwater characteristics and hydraulics.

8. The NJDHSS and the ATSDR will continue to review data as it is made available.

References

[ATSDR] Agency for Toxic Substances and Disease Registry. September 2008. Toxicological Profile for Chromium (draft). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Letter Health Consultation for the E.C. Electroplating Site. Garfield, Bergen County, New Jersey. US Department of Health and Human Services, Atlanta, Georgia. September 2007.

[BOSWELL] Boswell McClave Engineering, Letter regarding sampling and remedial actions at Golden Age Apartment complex, February 13, 2003 to Anthony DeMarco, Garfield Housing Authority. Received via fax by NJDEP on September 21, 2007.

[BOSWELL] Boswell McClave Engineering, Letter regarding post-remedial air sampling at Golden Age Apartment complex, February 24, 2003 to Anthony DeMarco, Garfield Housing Authority. Received via fax by NJDEP on September 21, 2007.

[Cal EPA] California Environmental Protection Agency. 2009. Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. Office of Environmental Health Hazard Assessment. May 2009.

[Cal EPA] California Environmental Protection Agency. 2009. Public Health Goal for Hexavalent Chromium in Drinking Water (Draft). Office of Environmental Health Hazard Assessment. August 2009.

[DHHS] Department of Health and Human Services, National Toxicology Program. Draft May 16, 2007. Toxicology and Carcinogenesis Studies of Sodium Dichromate Dihydrate (CAS No. 7789-12-0) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies) http://ntp.niehs.nih.gov/index.cfm?objectid=E1C04561-F1F6-975E-7B21E8B231BAB44F

[DHHS] Department of Health and Human Services, National Toxicology Program. 2006. Fact Sheet Hexavalent Chromium.

[GARFIELD] The Housing Authority of the City of Garfield, Letter regarding sampling and remedial actions at Golden Age Apartment complex, February 3, 2003 to Carmen Valenti, New Jersey Department of Housing & Urban Development. Received via fax by NJDEP on September 21, 2007.

[NJDEP] New Jersey Department of Environmental Protection, E.C. Electroplating Site - site description and background summary via fax dated October 7, 2002.

[NJDEP] New Jersey Department of Environmental Protection, Letter regarding E.C. Electroplating Site – Results of Aqueous Sampling Event, December 12, 2001 to Richard Chapin, Chapin Engineering. March 27, 2002.

[NTP] National Toxicology Program. 2008a. NTP technical report on the toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No. 7789-12-0) in F344/N rats and B6C3F1 mice (drinking water studies). Washington, DC: National Toxicology Program. NTP TR 546. August 13, 2008.
http://ntp.niehs.nih.gov/files/546_web_FINAL.pdf.

[PAS] Princeton Aqua Science. 1984. Report on Site Evaluations, E.C. Electroplating, Inc. Garfield, New Jersey. December 1984.

[US EPA] US Environmental Protection Agency. 1997. National Center for Environmental Assessment. Office of Research and Development. Exposure Factors Handbook. Washington, DC. August 1997.

[US EPA] US Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors Interim Final. Office of Emergency and Remedial Response. Washington, DC. March 25, 1991.

[US EPA] US Environmental Protection Agency. 2003. World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks. Prepared by the Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Task Force Working Group. New York, NY. May 2003.

[US EPA] US Environmental Protection Agency. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Office of Superfund Remediation and Technology Innovation. Washington, DC. July 2004.

[US EPA] US Environmental Protection Agency. 2008. National Center for Environmental Assessment. Office of Research and Development. Child-Specific Exposure Factors Handbook. Washington, DC. September 2008.

[US EPA] US Environmental Protection Agency. 2008b. National Center for Environmental Assessment. Office of Research and Development. Integrated Risk Information System, Glossary of Terms. Available from:
http://www.epa.gov/iris/help_gloss.htm#content

[US EPA] US Environmental Protection Agency, Region 2. 2008. Community Notice - Information Session Regarding Chromium Groundwater Contamination in Garfield. August 2008.

[US EPA] US Environmental Protection Agency. 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). Office of Superfund Remediation and Technology Innovation. Washington, DC. January 2009.

[US EPA] US Environmental Protection Agency, Region 2. 2009. Compiled air, sump water, and surface dust results related to the EC Electroplating site – Investigations conducted from February through September 2009.

[Weston] Weston Solutions. 2009. Risk Assessment Data Package, EC Electroplating Site, Garfield, Bergen County, New Jersey. Submitted to US Environmental Protection Agency, Region 2. May 29, 2009.

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CERTIFICATION

The health consultation for the EC Electroplating site was prepared by the New Jersey Department of Health and Senior Services 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 initiated. Editorial review was completed by the cooperative agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC

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

Team Leader, CAT, CAPEB, DHAC, ATSDR

Table 1a: Summary of Hexavalent Chromium Concentrations in Wipe Samples from the Roosevelt Elementary School #7
E.C. Electroplating Site
US EPA Sampling Date: August 20, 2008

Contaminant	Number of Samples	Number of Detections	Wipe Concentration: micrograms/m^2 (a)				Contaminant of Concern
			Minimum	Maximum	Average	US EPA Screening Value (b)	
Cr^{+6}	5	1	ND (DL<100)	178	76 (c)	4,704	**Yes** (b)

(a) Wipe sample area = 100 square centimeters
(b) Source: World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks, Table A-3, US EPA, May 2003. This screening value is for total chromium and is presented for comparison purposes only. The screening value is based on the toxicity o hexavalent chromium. Currently, there is no screening value for hexavalent chromium in surface dust. Therefore, all sample results were retained for further evaluation.
(c) Average based on 1/2 the detection limit for non-detect samples.
ND - Not Detected (Detection Limit in parenthesis)

Table 1b: Summary of Detected Hexavalent Chromium Concentrations in Residential Wipe Samples
E.C. Electroplating Site
US EPA Sampling Period: February 23, 2009 through March 29, 2009

Contaminant	Number of Residential Locations with Cr^{+6} Present	Number of Samples	Number of Detections	Wipe Concentration: micrograms/m^2 (a)				Contaminant of Concern
				Minimum	Maximum	Average	US EPA Screening Value (b)	
Cr^{+6} High Usage Areas	6	7	7	400	**29,100**	**5,457**	4,704	**Yes**
Cr^{+6} Low Usage Areas	10	13	13	250	**136,000**	**23,300**		**Yes**

(a) Wipe sample area = 100 square centimeters
(b) Source: World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks, Table A-3, US EPA, May 2003. This screening value is for total chromium and is presented for comparison purposes only. The screening value is based on the toxicity o hexavalent chromium. Currently, there is no screening value for hexavalent chromium in surface dust. Therefore, all sample results were retained for further evaluation.

Table 2: Summary of Detected Hexavalent Chromium Concentrations in Residential Basement Sediment
E.C. Electroplating Site

Contaminant	Number of Residential Locations	Number of Samples	Concentration: miligrams per kilogram				Contaminant of Concern
			Minimum	Maximum	Average	ATSDR EMEG [c]	
US EPA Investigations - Sampling Period: February 23, 2009 through March 29, 2009 [d]							
Cr^{+6} High Usage Areas	1	1	1.7	1.7	1.7	50 child 700 adult	No
Cr^{+6} Low Usage Areas	4	5	1.3	74.4	21.3		**Yes** [a]
Cr^{+6} Undefined Usage Areas	8	8	1.0	4.8	2.2		No
Other Investigations - Sampling Period: January 2003							
Cr^{+6} Low Usage Area	1	1	NA	95,800	NA	50 child 700 adult	**Yes** [b]

(a) Hexavalent chromium in sediment is considered to be present due to deposition from contaminated groundwater infiltration, the same mechanism responsible for the contaminant's presence in basement surface dust. Based on detected concentrations and the limited amount of sediment observed in basements, hexavalent chromium in surface dust presents the greatest exposure potential. Therefore, the health effects evaluation concerning exposure to contaminated surface dust is considered to encompass exposures to contaminated sediment.
(b) Basement area remediated in February 2003 following sampling event; however, this residence has been retained for evaluation based on USEPA wipe sampling data collected in 2009.
(c) Agency for Toxic Substances and Disease Registry's Environmental Media Evaluation Guide.
(d) Data presented for residences only where hexavalent chromium was detected; NA - Not Applicable

Table 3: Summary of Detected Hexavalent Chromium Concentrations in Residential Sump Water
E.C. Electroplating Site

Contaminant	Number of Residential Locations	Number of Samples	Sump Water Concentration: micrograms/liter				Contaminant of Concern
			Minimum	Maximum	Average	Comparison Value [a]	
US EPA Investigations - Sampling Period: February 23, 2009 through March 29, 2009							
Cr^{+6} Low Usage Areas [b]	3	4	2,200	9,300	5,825	NA	**Yes**
Cr^{+6} Undefined Usage Area [b]	1	1	140	140	140		**Yes**
Other Investigations - Sampling Period: April 2000 through January 2003							
Cr^{+6} (Low and undefined usage)	3	5	54	11,300	6,235	NA	**Yes**

(a) There is no known environmental comparison value regarding dermal exposures to hexavalent chromium in sump water. However, this data provides evidence that hexavalent chromium contaminated groundwater is infiltrating the basement sumps of residences which can impact basement interiors under conditions of water intrusion.
(b) Data presented for residences only where hexavalent chromium was detected.
(c) Retained as a contaminant of concern in sump water based on the potential of this media to impact basement interiors causing contamination of surface dust and/or sediment to establish a completed exposure pathway with known public health implications.
NA - Not Available

Table 4: Summary of Hexavalent Chromium Concentrations in Residential Indoor Air - E.C. Electroplating Site
US EPA Sampling Period: August 27 and 31, 2009; September 3, 2009

Contaminant	Number of Residential Locations	Number of Samples	Number of Detections	Number of Residential Locations > CREG	Air Concentration: micrograms/cubic meter				Contaminant of Concern
					Minimum	Maximum	Average [b]	Environmental Guideline Comparison Value	
Cr^{+6} High Usage Areas	7	12	9	0	ND (<0.0000043)	0.000043	0.000013	0.00008 (CREG) [a]	No
Cr^{+6} Low Usage Areas	13	16	10	3		**0.000158**	0.000042		**Yes**
Cr^{+6} Control Homes	2	2	1	0		0.000010	0.000006		No
Cr^{+6} Ambient Air	3	3	2	NA		0.000021	0.000013		No

(a) Cancer Risk Evaluation Guide
(b) Includes 1/2 detection limit for non-detect results
ND - Not Detected; NA - Not Applicable

Table 5 – Evaluated Exposure Pathways

Pathway	Pathway Exposure Pathway Elements					Pathway Classification
	Environmental Medium	Route of Exposure	Location	Exposed Population	Point of Exposure	
Surface Contact Dust [a]	Surface Dust [b]	Ingestion	Roosevelt Elementary School #7	Children and Adults	Brown Bag Lunchroom	Past, Present & Future – Completed
			10 Residences (Low Usage)	Children and Adults	Basement	
			6 Residences (High Usage)			
Indoor Air	Indoor Air Particulates	Inhalation	3 Residences (Low Usage)	Adults [c]	Basement	

(a) Pathway includes floor sediment when present.
(b) Through intrusion of hexavalent chromium contaminated groundwater resulting in residual deposition.
(c) Potential for exposure may be present for children in the future if the basement usage changed to include this population.

Table 6: Comparison of Ingested Exposure Dose to Hexavalent Chromium in Surface Dust with Health Guideline Comparison Values (CVs) for Non-Cancer Health Effects - EC Electroplating Site.

Exposure Point/Scenario	Exposure Point Concentration [d] ($\mu g/m^2$)	Exposure Dose (mg/kg/day)		Health Guideline CVs (mg/kg/day)		Potential for Non-Cancer Health Effects
		Child	Adult	ATSDR MRL [e]	USEPA RfD [f]	
Roosevelt Elementary School #7 (K - 6th) [a]	178	1.5E-04	1.1E-05	1.0E-03	3.0E-03	No
Residential Basements Low Usage Cr^{+6} [b]	113,594	1.3E-02	1.1E-02			**Yes**
Residential Basements High Usage Cr^{+6} [c]	19,704	1.6E-02	1.3E-02			**Yes**
Residential Basements High Usage Cr^{+6} (Theoretical future use) [c]	113,594	9.4E-02	7.3E-02			**Yes**

(a) Roosevelt Elementary School #7 (source US EPA 1997, 2003):
180 days/year - school year
Duration: 7 yrs (child: K - 6th grade), 40 yrs (adult: estimated employment term)
Body Weight: Child - 20 kg (5-6 yrs) and 34 kg (7-12 yrs); Adult - 70 kg

(b) Low Usage Exposure Assumptions (source US EPA 1997, 2003):
2 hrs/day, 5 days/week - i.e. unfinished basements, laundry use
Duration: 18 yrs (child), 30 yrs (adult)
Body Weight: Child - 16.5 kg (1-6 yrs), 34 kg (7-12 yrs) and 58 kg (13-18 yrs); Adult - 70 kg

(c) High Usage Exposure Assumptions (source US EPA 1997, 2003):
365 days/year - i.e. living space
Duration: 18 yrs (child), 30 yrs (adult)
Body Weight: Child - 16.5 kg (1-6 yrs), 34 kg (7-12 yrs) and 58 kg (13-18 yrs); Adult - 70 kg

(d) Exposure Point Concentrations (micrograms per cubic meter) derived using Pro UCL Version 4.00.02 (EPA, 2007).

(e) Agency for Toxic Substances Disease Registry's Minimal Risk Level (C= Chronic > 364 days)

(f) US Environmental Protection Agency's Reference Dose

Table 7: Comparison of Inhalation Exposures to Hexavalent Chromium in Indoor Air with Health Guideline Comparison Values (CVs) for Non-Cancer Health Effects - EC Electroplating Site.

Exposure Point/Scenario	Exposure Point Concentration ($\mu g/m^3$) [b]	Health Guideline CVs ($\mu g/m^3$)		Potential for Non-Cancer Health Effects
		ATSDR MRL [c]	US EPA RfC [d]	
Low Usage Cr^{+6} and High Usage Cr^{+6} (Theoretical future use) [a]	0.000068	1	0.1	No

(a) Theoretical Future High Usage Exposure Assumptions

(b) Exposure Point Concentrations (micrograms per cubic meter) derived using Pro UCL Version 4.00.02 (EPA, 2007). Maximum concentration in parenthesis.

(c) Agency for Toxic Substances Disease Registry's Minimal Risk Level (I = Intermediate 15 - 364 days).

(d) US Environmental Protection Agency's Reference Concentration

Table 8: Calculated Lifetime Excess Cancer Risk Based on Ingestion Exposures to Hexavalent Chromium in Surface Dust EC Electroplating Site.

Exposure Point/Scenario	Exposure Point Concentration [(d)] ($\mu g/m^2$)	Exposure Duration (years)	Exposed Population	CSF [(e)] $(mg/kg/day)^{-1}$	LECR
Roosevelt Elementary School #7 (K - 6th) [(a)]	178	40	Adult	0.5	3.2E-06
		7	Child		5.0E-06
Residential Basements Low Usage Cr^{+6} [(b)]	113,594	30	Adult		1.8E-03
		18	Child		1.5E-03
Residential Basements High Usage Cr^{+6} [(c)]	19,704	30	Adult		2.2E-03
		18	Child		2.1E-03
Residential Basements High Usage Cr^{+6} [(c)] (Theoretical future use)	113,594	30	Adult		1.3E-02
		18	Child		1.2E-02

Notes:

(a) Roosevelt Elementary School #7 (source US EPA 1997, 2003):
180 days/year - school year
Duration: 7 yrs (child: K - 6th grade), 40 yrs (adult: estimated employment term)
Body Weight: Child - 20 kg (5-6 yrs) and 34 kg (7-12 yrs); Adult - 70 kg

(b) Low Usage Exposure Assumptions (source US EPA 1997, 2003):
2 hrs/day, 5 days/week - i.e. unfinished basements, laundry use, adults only
Duration: 18 yrs (child), 30 yrs (adult)
Body Weight: Child - 16.5 kg (1-6 yrs), 34 kg (7-12 yrs) and 58 kg (13-18 yrs); Adult - 70 kg

(c) High Usage Exposure Assumptions (source US EPA 1997, 2003):
365 days/year - i.e. living space
Duration: 18 yrs (child), 30 yrs (adult)
Body Weight: Child - 16.5 kg (1-6 yrs), 34 kg (7-12 yrs) and 58 kg (13-18 yrs); Adult - 70 kg

(d) Exposure Point Concentrations (micrograms per cubic meter) derived using Pro UCL Version 4.00.02 (EPA, 2007).

(e) Source: NJDEP 2009

Table 9: Calculated Lifetime Excess Cancer Risk Based on Indoor Air Concentrations of Hexavalent Chromium - EC Electroplating Site.

Exposure Point/Scenario	Exposure Point Concentration ($\mu g/m^3$) (a,b)	Exposure Duration (years)	TWA Exposure Duration (years) (c)	Exposed Population	USEPA IUR (d) $(\mu g/m^3)^{-1}$	LECR
Low Usage Cr^{+6} (e)	0.000068	30	2	Adult	8.4E-02	1.5E-07
High Usage Cr^{+6} (f) (Theoretical future use)	0.000158 *	30	15	Adult/Child		2.8E-06 *

Notes:

* Values expressed for maximum hexavalent concentrations

(a) micrograms per cubic meter.

(b) Exposure Point Concentrations derived using Pro UCL Version 4.00.02 (EPA, 2007).

(c) Time Weighted Average based on exposure assumptions.

(d) Inhalation Unit Risk (cancer slope factor) for human inhalation exposure.

(e) Low Usage exposure assumptions: 2 hours/day, 260 days/year, 30 years residency, 70 years averaging time.

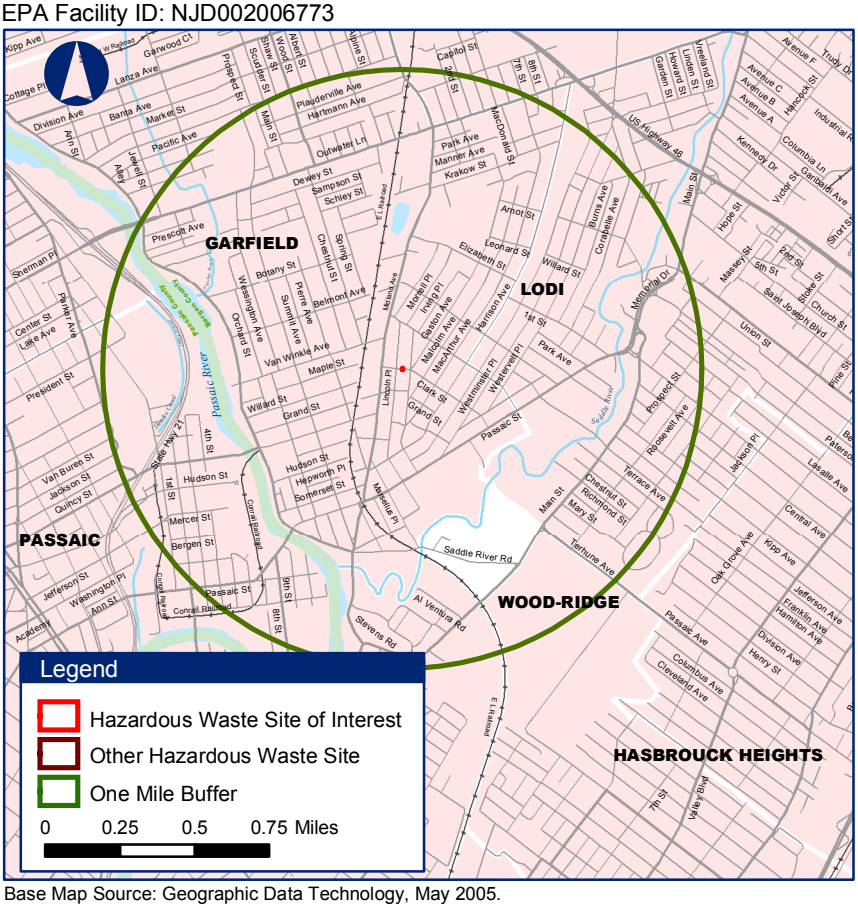
(f) High Usage exposure assumptions: 12 hours/day, 365 days/year, 30 years residency, 70 years averaging time.

Proposed Area of Study

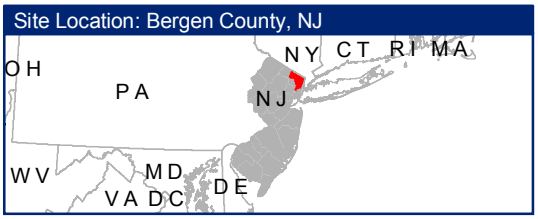
Figure 2: Overview of USEPA proposed residential study area for the E.C. Electroplating site.

Garfield Chromium Groundwater
Garfield, NJ

EPA Facility ID: NJD002006773



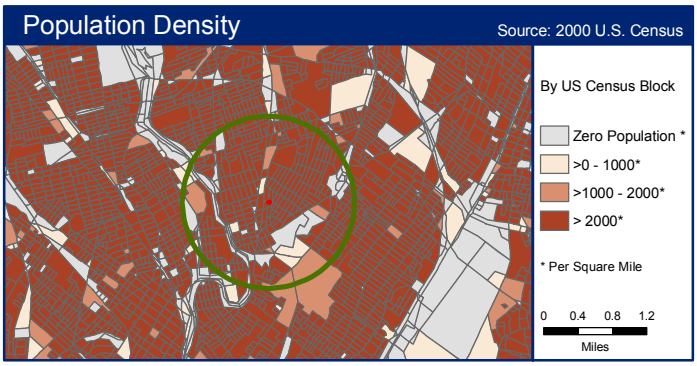
Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

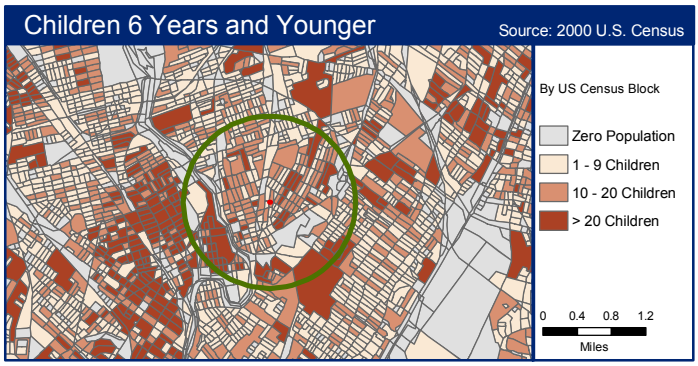


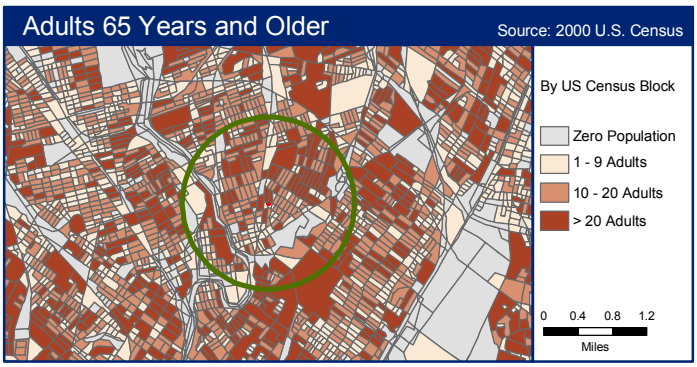
Demographic Statistics
Within One Mile of Site*

Total Population	41,955
White Alone	28,672
Black Alone	2,140
Am. Indian & Alaska Native Alone	218
Asian Alone	1,743
Native Hawaiian & Other Pacific Islander Alone	8
Some Other Race Alone	7,402
Two or More Races	1,771
Hispanic or Latino**	13,922
Children Aged 6 and Younger	4,311
Adults Aged 65 and Older	5,011
Females Aged 15 to 44	9,690
Total Housing Units	15,804

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.







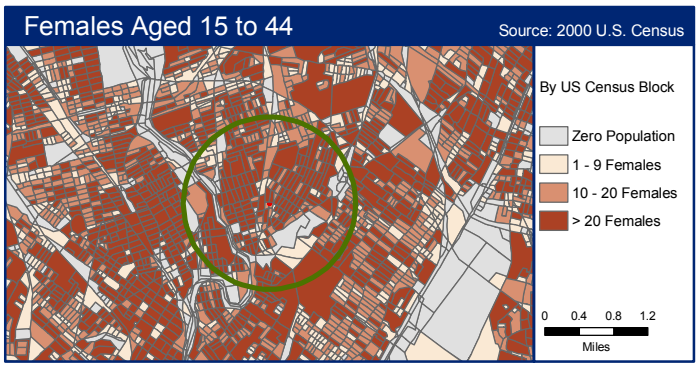


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Figure 3: Demographics information for the E.C. Electroplating site based on 2000 census data.

Appendix A

Toxicological Summary

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ATSDR Glossary of Terms

The toxicological summary for hexavalent chromium provided in this appendix is based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html) and USEPA literature. Health effects are summarized in this section for hexavalent chromium found in surface dust, sump water, and indoor air within the basements of investigated residences. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Chromium (including Trivalent and Hexavalent forms). Chromium is a naturally-occurring element found in rocks, animals, plants, and soil. The three main forms of chromium are chromium(0), chromium(III) (trivalent form), and chromium(VI) (hexavalent form). Small amounts of chromium(III) are considered to be a necessity for human health. Chromium (III) is an essential nutrient that occurs naturally in food and helps the body process sugar, protein, and fat.

Chromium is widely used in manufacturing processes. Chromium can be found in many consumer products such as wood treated with copper dichromate, leather tanned with chromic sulfate, and stainless steel cookware. Chromium can be found in air, soil, and water after release from the manufacture, use, and disposal of chromium-based products, and during the manufacturing process. Chromium does not usually remain in the atmosphere, but is deposited into the soil and water. Chromium can change from one form to another in water and soil, depending on the conditions present.

When you breathe air containing chromium, some of the chromium will enter your body through your lungs. Some forms of chromium can remain in the lungs for several years or longer. A small percentage of ingested chromium will enter the body through the digestive tract. When your skin comes in contact with chromium, small amounts of chromium will enter your body. Most of the chromium leaves the body in the urine within a week, although some may remain in cells for several years or longer.

Chromium compounds are stable in the trivalent state, and occur in nature most commonly at this oxidation level. Hexavalent chromium compounds are the next most stable form; however, these rarely occur in nature and are typically associated with industrial sources. The hexavalent form of chromium is much more toxic than the trivalent form.

The most common health problem in workers exposed to chromium involves the respiratory tract. These health effects include irritation of the lining of the nose, runny nose, and breathing problems (asthma, cough, shortness of breath, wheezing). Workers have also developed allergies to chromium compounds, which can cause breathing difficulties and skin rashes.

The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for chromium(VI) compared to chromium(III) . However, the concentrations causing respiratory problems in workers are at least 60 times higher than

levels normally found in the environment. Respiratory tract problems similar to those observed in workers have been seen in animals exposed to chromium in air.

The main health problems seen in animals following ingestion of chromium(VI) compounds are to the stomach and small intestine (irritation and ulcer) and the blood (anemia). Oral absorption of chromium compounds in the human body is low, estimated at approximately 0.5 to 2 percent. Trivalent chromium is absorbed in the human body at a rate about one quarter of that of hexavalent chromium. Hexavalent chromium is rapidly transformed to trivalent chromium within the stomach limiting its systemic availability; however, hexavalent chromium can still cause kidney and liver toxicity through ingestion. The degree of toxicity of hexavalent chromium greatly lies within its ability to readily penetrate cellular membranes while trivalent chromium is less able to do so. The reduction of hexavalent chromium to the trivalent form outside the cellular membrane is considered a major mechanism of protection. Ingestion of hexavalent chromium can cause stomach ulcers, convulsions, kidney and liver damage, and, at high concentrations, death.

Sperm damage and damage to the male reproductive system have also been seen in laboratory animals exposed to chromium(VI).

The International Agency for Research on Cancer (IARC) has determined that chromium(VI) compounds are carcinogenic to humans. The National Toxicology Program 11th Report on Carcinogens classifies chromium(VI) compounds as known to be human carcinogens. In workers, inhalation of chromium(VI) has been shown to cause lung cancer. An increased in stomach tumors was observed in humans exposed to chromium(VI) in drinking water. In laboratory animals, chromium(VI) compounds have been shown to cause tumors to the stomach, intestinal tract and lung.

There are no studies that have looked at the effects of chromium exposure on children. It is likely that children would have the same health effects as adults. We do not know whether children would be more sensitive than adults to the effects of chromium.

There are no studies showing that chromium causes birth defects in humans. In animals, some studies show that exposure to high doses during pregnancy may cause miscarriage, low birth weight, and some changes in development of the skeleton and reproductive system. Birth defects in animals may be related, in part, to chromium toxicity in the mothers.

ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-422-ATSDR (1-888-422-8737).
The glossary can be accessed online at http://www.atsdr.cdc.gov/glossary.html

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

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