PUBLIC HEALTH ASSESSMENT

EVALUATION OF EXPOSURE TO HISTORIC AIR RELEASES
FROM THE ABEX/REMCO HYDRAULICS FACILITY,
WILLITS, MENDOCINO COUNTY, CALIFORNIA

CERCLIS CAD000097287

Prepared by:

California Department of Health Services
Under Cooperative Agreement With the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Table of Contents

Summary

The Environmental Health Investigations Branch (EHIB), within the California Department of Health Services (CDHS), has prepared this public health assessment under a cooperative agreement with the federal Agency for Toxic Substance and Disease Registry (ATSDR). This public health assessment addresses the public health implications from exposure to historic (1963 – 1995) air releases of hexavalent chromium from the Abex/Remco Hydraulics facility (hereafter "Remco") in Willits, California. CDHS will prepare a second, comprehensive public health assessment evaluating all potential routes of exposure (ingestion, inhalation, dermal contact, etc.) to Remco-related contaminants.

The Remco site is located at 934 South Main Street, in the City of Willits, California. Ownership of the facility changed several times in its 55-year history, with Whitman Corporation (formerly IC Industries) becoming the last owner in 1988. In 1997, as a result of a law suit filed by the City of Willits against the former owners of the site, the Federal District Court for Northern California ordered a Consent Decree*, establishing the Willits Remediation Trust (hence forth referred to as the Willits Trust). The Willits Trust is responsible for site investigation and clean-up activities set forth in the Consent Decree. Under the Consent Decree, site investigation and cleanup must follow the National Contingency Plan (NCP) rules (see glossary Appendix A). The Consent Decree also includes a provision for medical monitoring.

In addition to the Consent Decree, the Remco site is currently under investigation by the Regional Water Quality Control Board, North Coast Region (RWQCB), for contamination of the soil and groundwater.

In June 2000, due to ongoing community health concerns about the Remco site, the United States Environmental Protection Agency (USEPA) requested assistance from CDHS to evaluate the potential health impact posed by the facility. Since that time, CDHS has been conducting public health assessment activities and working with the Willits community.

In July 2003, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDHS responses are provided in Appendix G.

The public health assessment process includes an evaluation of existing environmental data and identification of exposure pathways to determine whether the release of contaminants (chemicals) from a hazardous waste site or industrial facility impacts or has impacted the health of people in the surrounding communities. An important element of the public health assessment process is documenting and responding to community health concerns. CDHS has conducted a number of community outreach activities in an effort to collect and understand health concerns that community members believe are related to operations and/or contamination from the Remco facility. Community members have expressed health concerns about various types of cancer, reproductive issues, and a number of other noncancer health effects. In this public health

* A Consent Decree is a legal document, approved and issued by a judge, that formalizes an agreement reached between the City of Willits and the former owners (potentially responsible parties [PRPs]), where PRPs will conduct the cleanup action at the Remco site; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform and may be subject to a public comment period.

assessment, CDHS responds to these concerns by including general information about the health effects of site contaminants, and whether studies have shown the health effects to be associated with chromium exposure.

Remco operated as an industrial machine shop from 1945 through 1995. Remco's operations expanded to include chrome plating from 1963 through 1995, during which time the number of chrome plating tanks operating on the site increased from two to seven. Two of the tanks (Nos. 1 and 2) were horizontal in orientation and located above the ground. The remaining five tanks (Nos. 3 – 7) were vertical in orientation and installed underground. From 1963 to 1967, two horizontal tanks operated in a semi-temporary structure (lean-to), using fume suppressing foam for pollution control. At some time between 1967 and 1968 the horizontal plating tanks were enclosed in a building and plating operations expanded. From 1968 through 1975, both of the horizontal tanks and three of the vertical tanks operated without pollution control. The three vertical tanks operated outdoors until about 1976, when they were enclosed in the building. From 1976 through 1989, all tanks were connected to a pollution control device (demister); the demister used from 1976 through 1989 had an approximate efficiency (amount of hexavalent chromium removed before reaching the outside air) of 83%. The pollution control device (scrubber) used from 1990 through 1995 had an approximate efficiency of less than 98.8% to 99.991%, under optimal conditions.

During the years of Remco plating operations, no actual measurements of chemicals in the air around the facility or in the Willits area were required or taken. Chromium electroplating was the primary plating operation at the site. Hexavalent chromium is the primary chemical of concern that was released. To a lesser extent, other chemicals such as volatile organic chemicals, cadmium, nickel, zinc, and lead were released. In the absence of air measurements/sampling of hexavalent chromium, CDHS used the results of computer air modeling to estimate exposure and evaluate how the health of Willits community members might have been impacted by air releases of hexavalent chromium (there are insufficient data to model releases of other contaminants). Computer air modeling is a mathematical way to estimate how much hexavalent chromium was released from the Remco facility in the past, as well as what the concentrations of hexavalent chromium were in different areas of the Willits community.

CDHS evaluated air model data generated for three different time periods of Remco operations (1963 – 1975, 1976 – 1989, 1990 – 1995) and the time periods combined (1963 – 1995). The three time periods evaluated were defined based on the efficiency/level of the air pollution control devices used at the facility. During the three time periods (1963 – 1975, 1976 – 1989, and 1990 – 1995), the estimated airborne levels of hexavalent chromium in the Willits community ranged between 0.05 to 10 micrograms per cubic meter ($\mu g/m^3$), 0.003 to 0.2 $\mu g/m^3$, and 0.00002 to 0.0005 $\mu g/m^3$ respectively. In general, hexavalent chromium levels decrease the further away from the site.

Exposures to airborne hexavalent chromium during these time periods were evaluated for four different groups: Willits residents; people who worked in Willits (not including Remco workers); Baechtel Grove Middle School students and; Blosser Lane Elementary School students and staff for the latest time period, 1990 – 1995 (the school opened in 1990).

Exposure to hexavalent chromium is currently known to cause both noncancer and cancer health effects. Noncancer health effects include, asthma, bloody nose, nasal septum scarring and perforation, runny nose, mild decreased lung function, bronchitis, gastric irritation, and subtle changes in kidney function (affects primarily the proximal tubule). Lung cancer is the primary cancer associated with hexavalent chromium exposure; other cancers (nasal, stomach) have been suggested, but are not well studied. (Exposure to hexavalent chromium is not the only cause of these noncancer and cancer health effects.)

During 1963 – 1975, estimated exposures to airborne hexavalent chromium could have resulted in noncancer health effects to residents (adults and children), workers, and Baechtel Grove Middle School staff who lived or worked in a large area of the Willits[†]. Depending on where a person lived or worked in the community, his/her estimated exposure to hexavalent chromium presented a low to high theoretical increased lifetime cancer risk. An individual's theoretical increased cancer risk would be less if she/he did not live in Willits for the entire time period evaluated (1963 – 1975).

During 1976 – 1989, estimated exposures to airborne hexavalent chromium were much lower than previous years (1963 – 1975). In limited areas of Willits, estimated exposures to hexavalent chromium could have resulted in noncancer health effects to residents (adults and children) and workers. Depending on where a person lived or worked in the community, his/her estimated exposure to hexavalent chromium presented a very low to moderate theoretical increased lifetime cancer risk. An individual's theoretical increased cancer risk would be less if she/he did not live in Willits for the entire time period evaluated (1976 – 1989).

During 1990 – 1995, estimated exposure to airborne hexavalent chromium would not be expected to result in noncancer health effects in children or adults in Willits.

CDHS evaluated the increased cancer risks from 1963 through1995, for the 32 years that Remco conducted chrome-plating operations. Depending on where a person lived or worked in the community, his/her estimated exposure to hexavalent chromium presented a low to high increased lifetime cancer risk. An individual's increased cancer risk would be less if she/he did not live in Willits for the entire time period evaluated (1963 – 1995).

Cancer risk estimates are a tool to help characterize risk and cannot be interpreted as the actual number of cancer cases that will occur. Since 1988, the California Cancer Registry has collected information on the number of people who get cancer. In order to evaluate cancer occurrence in Willits, CDHS reviewed the number of cancer cases for lung and other cancers between 1988 and 2000 (the years data are available). The review showed that the number of cancer cases in Willits during those years was not higher than expected for that population. The number of lung cancer cases was somewhat higher, although not statistically greater, than expected. Due to limitations with this type of data, the cancer review is not an effective tool for studying and characterizing how exposure to hexavalent chromium increased the risk of cancer (primarily

[†] Refers to both the City of Willits and unincorporated areas.

lung) in the Willits community. Thus, CDHS concludes that community members, particularly those exposed prior to the time when emissions controls were implemented, experienced some increase in their risk of developing cancer.

CDHS concludes that releases of airborne hexavalent chromium posed a public health hazard in the past (1963 – 1995). There is an indeterminate health hazard both currently and in the future from exposure to hexavalent chromium and lead in dust that may be generated during site/building remediation or demolition activities.

Based on an evaluation of the data, CDHS/ATSDR recommend the following be considered:

- The feasibility of medical monitoring/clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to air releases of hexavalent chromium from Remco between 1963 and 1995. CDHS is currently consulting with in-house experts (physicians) to determine the types of medical tests that would be beneficial for the community. If medical monitoring is undertaken, CDHS recommends that an expert work group with community representation be established to develop a protocol for medical monitoring/clinical services, including criteria for participation and an overall implementation plan. These activities could fall under the medical monitoring provision of the Consent Decree.
- Counseling and stress support services for impacted residents and workers, as needed. These activities could fall under the medical monitoring provision of the Consent Decree.
- The Willits Trust implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health.

Background and Statement of Issues

The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services (CDHS), under cooperative agreement with the Agency for Toxic Substances and Disease Registry, is conducting a public health assessment for the Abex/Remco Hydraulics (hereafter "Remco") facility in the City of Willits, California. ATSDR, located in Atlanta, Georgia, is a federal agency of the U.S. Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 to conduct public health assessments at hazardous waste sites. The public health assessment process includes an evaluation of existing environmental data and identification of exposure pathways to determine whether the release of contaminants (chemicals) from a hazardous waste site or industrial facility impacts or has impacted the health of people in the surrounding communities. The public health assessment process also includes gathering and responding to concerns that community members have about their health as it relates to the industrial facility. Lastly, through the public health assessment process, recommendations are made to reduce or prevent possible exposures.

Remco released several contaminants into the surrounding environment. This public health assessment will focus on exposure to air releases of hexavalent chromium. CDHS will prepare a second comprehensive public health assessment that will summarize this report and evaluate all potential routes of exposure (ingestion, inhalation, dermal contact, etc.) to Remco-related contaminants.

In this document, CDHS and ATSDR will evaluate exposures and determine whether health effects are likely to occur because of past exposure to hexavalent chromium in the air. The conclusions of this public health assessment for the Remco site are based on four types of information collected or developed for the site: a) air modeling data; b) estimates of exposure; c) cancer data for the area; and d) community concerns. This information was evaluated using epidemiological and toxicological data.

The document is divided into the following sections:

- A background section presents an overview of the historical operations at the facility related to releases of chromium to the air;
- A review of environmental data for chromium air releases. Because no air sampling occurred, air modeling was used to estimate past exposure levels;
- A toxicological review of the estimated exposures for noncancer and cancer health effects;
- A review of cancer surveillance data for the area around the facility;
- A summary of the outreach efforts for collecting community concerns;
- A response based on the toxicological evaluation or cancer statistics review to some of the community concerns;
- A conclusion section that describes the hazard posed by the site;
- A recommendations section outlining suggested follow-up actions including additional sampling, health education, and other public health actions;

- A public health action plan that describes site activities completed, ongoing, or planned for the future.

The most pertinent information about health impacts from the site is presented in the main body of text. Additional information is presented in the appendices, including a glossary of terms (Appendix A).

The document contains a great deal of information from a variety of scientific fields. In order for the information to flow logically, it is necessary to present background information for each section. For example, at the beginning of the section about cancer risk evaluation, the science and assumptions behind risk calculations are described.

Information about Remco

The Remco site is located at 934 South Main Street in the City of Willits, California (Appendix B, Figure 1). The Remco facility operated from 1945 through 1995 as an industrial machine shop, and in 1959 began manufacturing hydraulic cylinders (1). During the early 1960s, operations were expanded to include electroplating of hydraulic cylinders, and continued until the facility closed in 1995 (Appendix B, Figure 2). Electroplating is the process of applying a metal coating to an object by placing the object in an electrolyte solution and passing an electric current through the solution. Chromium electroplating was the primary plating operation at the site, with cadmium, phosphate, manganese, and zinc plating occurring less frequently (1).

Ownership of the facility changed several times in its 55-year history, with MC Industries (parent company of Remco Hydraulics, Inc.) becoming the last owner in 1988. Remco Hydraulics, Inc. and MC Industries declared bankruptcy in 1995 (1). Whitman Corporation/Pepsi Americas, Inc. has been identified as the party responsible for funding the clean-up activities at the site, as result of various acquisitions and/or corporate mergers (2). In 1997, as a result of a lawsuit filed by the City of Willits against the former owners of the site, the Federal District Court for Northern California ordered a Consent Decree[‡], establishing the Willits Remediation Trust (hence forth referred to as the Willits Trust). The Willits Trust is responsible for site investigation and clean-up activities set forth in the Consent Decree. Under the Consent Decree, site investigation and cleanup must follow the National Contingency Plan (NCP) rules (see glossary Appendix A). The Consent Decree also includes a provision for medical monitoring.

In addition to the Consent Decree, the Regional Water Quality Control Board, North Coast Region (RWQCB) is investigating Remco for contamination of soil and groundwater. Chromium releases to Baechtel Creek were first reported to the California Department of Fish and Game in 1970. In 1974, the RWQCB found evidence of chromic acid discharges in storm water runoff. In response, the RWQCB adopted a National Pollutant Discharge Elimination System (NPDES) permit that required Remco to eliminate all discharges except discharges from rainfall runoff. Contamination of the groundwater with diesel fuel was first discovered in 1979. As a result, the

---

[‡] A Consent Decree is a legal document, approved and issued by a judge, that formalizes an agreement reached between the City of Willits and the former owners (potentially responsible parties [PRPs]), where PRPs will conduct the cleanup action at the Remco site; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform and may be subject to a public comment period.

RWQCB prohibited Remco from any future discharges to surface water (1). Subsequent investigations revealed hexavalent chromium and volatile organic chemical (VOC) contamination in the groundwater (3). In 1993, the RWQCB issued a cleanup and abatement order that required Remco to define the extent of off-site contamination in the groundwater and to implement remedial (clean-up) activities (1). Since that time, a number of investigations have been conducted. In 1998, the Willits Trust initiated remedial activities with the removal of a number of sumps, tanks, pits, and trenches at the site. A remedial investigation report was completed in 2001. As of this writing, a final remediation plan has not yet been completed.

In June 2000, because of ongoing community health concerns about the Remco site, the United States Environmental Protection Agency (USEPA) requested that CDHS assist with evaluating the potential health impact posed by the facility. Since then, CDHS has been conducting public health assessment activities in the Willits community.

In July 2003, a public comment draft of the public health assessment was released to the public and other stakeholders for review and comment. The comments and CDHS responses are provided in Appendix G.

Since the public comment release of the public health assessment, CDHS has obtained information (not previously known or available to CDHS), resulting in a better understanding of past chrome-plating operations at Remco. This information has been incorporated into the public health assessment. While some of the assumptions used in the public comment draft PHA have changed, the conclusions and recommendations have not been altered from those presented in the public comment draft public health assessment.

Land Use

The Remco site occupies approximately 7 acres. The site is located in a mixed residential and commercial area along Main Street (US Highway 101) (Appendix B, Figure 1). The Luna Market and Motel and a residential area bordered the site on the north until 2002, when the Willits Trust acquired and subsequently demolished these buildings. Currently, the nearest residence is about 100 feet north of the site fence line. A residential area, Howard Memorial Hospital and Baechtel Grove Middle School are located south of the facility; the school is located approximately 500 feet from the facility's fence line. Blosser Lane Elementary School is located approximately 1/3 mile to the south west of the fence line. A vacant lot and commercial and residential areas are located to the west of the facility. To the east of the site is a commercial area and Baechtel Creek (1).

Demographics

Based on 2000 census data, approximately 15,000 people live in the Willits area, with 5,073 people living within the city limits or the incorporated area. The ethnic makeup is roughly 3% Native American Indian, 14% Hispanic or Latino, and 83% white. In 1995, 33% of the total population was under age 19 and 13% was over age 65.

CDHS also gathered general demographic information on the City of Willits (city limits) and the unincorporated areas of Willits during the years of chrome-plating operations at Remco, as well as information about Baechtel Grove Middle School and Blosser Lane Elementary because of their proximity to the Remco site.

The population of the City of Willits was estimated to be 3,410 in the 1960s, 3,091 in the 1970s, 4,008 in the 1980s, 5,006 in the 1990s, and 5,073 in 2000 (A. Falleri, City of Willits, personal communication, May 29, 2002).

The population of the unincorporated areas of the City of Willits was estimated to be 9,935 in the 1980s and 13,155 in the 1990s (3). Population data for the Willits area could not be located for the 1960s and 1970s (A. Falleri, City of Willits, personal communication, June 13, 2002).

Baechtel Grove School opened in 1954 and housed grades 5 through 7 until 1989. Since then, the school has housed grades 6 through 8 (S. Jorgensen, Willits Unified School District, personal communication, September 12, 2002). During the years of Remco operations (1960s – 1990s), the school population ranged from 520 to 580 students (F. Brant, Principal, Baechtel Grove Middle School, personal communication, May 20, 2002). Blosser Lane Elementary School opened in 1990 and houses grades 3 through 5. The school population has remained relatively constant at about 600 students (4).

A discussion of the estimated population size potentially exposed is presented later, after the Environmental Contamination section.

History of Chrome-Plating Operations and Pollution Control at Remco

Remco conducted a type of chromium electroplating called hard chrome plating. In hard chrome plating, a base metal and another substance made of a lead alloy are immersed in a tank of chromic acid solution. An electric current is passed through this solution, causing the chromium to adhere to the base metal. This process creates gases that bubble to the tank surface and create a mist of chromic acid (hexavalent chromium) in the air. This mist can be inhaled.

Hard chrome-plating operations began in approximately 1963 and continued through 1995, when the facility closed. The plating operations began with two above ground horizontal tanks and expanded over the years to include the addition of five below-ground vertical tanks. The vertical tanks were located outdoors until about 1976, when the area was enclosed as part of a building expansion (5-7). Historical information relating to the installation dates of the vertical tanks and the dimensions of the early horizontal tanks is inconsistent. CDHS utilized all available information and conducted interviews with former workers to establish the most accurate timeline possible. Table 1 below provides the chrome tank dimensions and installation timeline (R. Wake, Remco employee [1972 – 1991], personal communication, November 19, 2003) (F. Vincent, Remco employee [1967 – 1995], personal communication, January 6, 2004) (8-12).

Table 1. Remco Chrome-Plating Tank Installation Timeline and Dimensions, Willits, CA

Tank No.—Orientation	Year	Dimensions
1—horizontal	~ 1963	14' 5' x 7' deep—3500 gallon capacity
2—horizontal	~1963	~ 4' x 6' x 4.5' deep—800 gallon capacity*
2—horizontal (replaced original)	~1968	12' x 5.5' x 7' deep—3200 gallon capacity
3—vertical	1968	3' diameter x 32' deep
4—vertical	1973	4' diameter x 38' deep
5—vertical	1970	3' diameter x 20' 6" deep
6—vertical	1977	4' diameter x 48' 8" deep
7—vertical	1982	4' diameter x 70' deep

*Dimensions estimated based on limited information on capacity (1, 11, 12)

Over the years, Remco utilized various types of emission (pollution) control equipment/ techniques to reduce the amount of hexavalent chromium in the air (Table 2). The efficiency of the equipment is a measure of how much contaminant the equipment removes from the air. The only site-specific technical documentation relating to the efficiency of the air pollution control equipment used at Remco is from the later years of operation, 1989 – 1995 (13, 14). To gain an understanding of the type and efficiency of the emission control equipment used at Remco prior to 1989, CDHS utilized available site-related information, reviewed USEPA literature, and interviewed former workers and experts in the air quality field (Table 2).

During the early years of chrome plating (industry wide), the main concern was to reduce worker exposures to hexavalent chromium inside the workplace (D. Wolbach, Mendocino County Air Quality Management District, personal communication, April 4, 2002). In California, chrome-plating facilities were not required to reduce the amount of hexavalent chromium that they released to the outdoor air until the late 1980s.

From about 1963 through 1967, the plating operation was located in a temporary structure, termed a "lean to" (15). Emissions were controlled by the use of surface tension reducers (foam and styrofoam Ts), which have an estimated efficiency of 80% (F. Vincent, Remco employee [1967 – 1995], personal communication, January 6, 2004) (15, 16).

From about 1968 through 1975, indoor horizontal plating tanks were attached to a type of collection system that pulled the vapors from the tanks and discharged them through the roof of the facility. From about 1972 through 1976 (prior to the outdoor vertical tanks being enclosed in the building), Remco reportedly had a collection system located on the outside of the building near the vertical tanks that pulled the vapors from the tanks and discharged them up into the air at a height of 10-12 feet (R. Wake, Remco employee [1972 – 1991], personal communication, November 19, 2003). This type of equipment is not efficient at removing hexavalent chromium from the air (D. Wolbach, Mendocino County Air Quality Management District, personal communication, November 25, 2003). Emissions from this time period (1968 – 1975) are considered uncontrolled. There is no site-specific technical information that would indicate otherwise.

From 1976 through 1989, the plating tanks were attached to demisters or mist eliminators, consistent with sinusoidal wave-type blades, which have an efficiency range of 83% to 91% (R. Wake, Remco employee [1972 – 1991], personal communication, November 19, 2003) (16). For the purpose of the air modeling and exposure assessment (discussed later in the Public Health Implications section), CDHS assumed the lower level of efficiency (83%) for this time period, based on Abex Corporation documentation indicating the demisters were ineffective (17, 18). This assumption is consistent with expert testimony, in which the efficiency of these types of systems have been estimated to range between 40% and 80% (19).

Emission control equipment evolved over the years, becoming most efficient with the development of "scrubbers". A scrubber (wet collector) was installed at Remco in 1989, in response to new State of California regulations that required facilities to reduce hexavalent chromium emissions (Table 2). The efficiency of the new scrubber was estimated between less than 99.8% and 99.991% (13, 14).

Table 2. History of Emission Control Equipment and Efficiency used at Remco, Willits, CA

Tank Nos.	History and Type of Emission Control Equipment	Control/Removal Efficiency (%)
1, 2	**1963 – 1967**: surface tension reducer, foam/styrofoam Ts	80
1, 2, 3, 4, 5	**1968 – 1975**: vapor collection system (not efficient at removing hexavalent chromium)	0
1, 2, 3, 4, 5, 6, 7	**1976 – 1989:** demister (mist eliminator)	83
1, 2, 3, 4, 5, 6, 7	**1990 – 1995**: scrubber	<99.8−99.991

Efficiency of emission control estimates for time periods: 1963 − 1967 based on USEPA Emission Factor Documentation for AP-42 (16); 1968 − 1975 based on expert testimony and interviews with former workers (D. Wolbach, Mendocino Air Quality Management District, personal communications, November 25, 2003) (R. Wake former Remco employee, personal communication, November 19, 2003); 1976 − 1990 based on USEPA Emission Factor Documentation for AP-42 (16); 1991 − 1995 based on source tests (14).

In summary, both Remco operations and the amount of hexavalent chromium that was released to the surrounding air changed overtime. During the earliest years of operation (about 1963 − 1967) two horizontal tanks operated, using surface tension reducers that suppressed an estimated 80% of the hexavalent chromium rising from the tank. Between 1968 and 1975, two indoor and three outdoor tanks were used. These tanks were not connected to any devices that reduced the amount of hexavalent chromium released to the outside air. Between 1976 and 1989, seven indoor tanks were used, all connected to pollution control devices that removed 83% of the hexavalent chromium in the air before venting it outside. Between 1990 and 1995, the seven indoor tanks were connected to pollution control devices that removed between 99.8% and 99.991% of the hexavalent chromium in the air before venting it outside.

Exposure Pathways, Environmental Contamination, and Public Health Implications

This section presents information about how much hexavalent chromium the Willits community might have been exposed to, and when and where the exposure might have occurred. Also, this section will evaluate the public health implications of this exposure.

Exposure pathways are the means by which people in areas surrounding an industrial or hazardous waste site could have been or could be exposed to contaminants from the site (20). A completed exposure pathway must be present for a population to be exposed to a contaminant. A completed exposure pathway consists of five elements: 1) a source of contamination; 2) an environmental medium and transport mechanism; 3) a point of exposure; 4) a route of exposure; and; 5) the group of people exposed (receptor population). The following is an example of a completed inhalation exposure pathway: a contaminant from a hazardous waste site (source) is released to the air (medium, transport mechanism) and the wind blows the contaminant through the air and into the community (point of exposure), where community members breathe the air (route of exposure and receptor population) (Appendix C, Table 3).

Not all exposure pathways are complete. Exposure pathways that are either not currently complete but could become complete in the future, or are indeterminate due to a lack of information, are called potential exposure pathways. Eliminated exposure pathways are missing one or more elements and for that reason are never likely to exist (20).

Current/Future Inhalation Exposure Pathway

CDHS has identified a potential exposure pathway to hexavalent chromium and lead[§] from resuspension of contaminated soils or dust residue on building surfaces that may become entrained in the air during remedial and other activities at the site. High levels of chromium (46,100 parts per million [ppm]) and lead (28,600 ppm) have been detected in dust samples collected inside the Remco facility by the Department of Toxic Substances Control and in wipe samples collected by the Willits Trust (1, 4).

Past Completed Exposure Pathway

CDHS identified a completed exposure pathway to air releases of hexavalent chromium from the Remco facility between the years 1963 – 1995, when Remco conducted plating operations.

CDHS identified four groups who may have been exposed to hexavalent chromium between 1963 and 1995: 1) people who lived in Willits; 2) people who worked in Willits (not including Remco workers); 3) staff and students at Baechtel Grove Middle School; and 4) staff and students at Blosser Lane Elementary School.

[§] A lead anode is used in chrome plating, creating the potential for lead contamination. Soil and dust sampling results support this assertion (1).

CDHS did not consider the past exposure to Remco workers while on the job. Typically, a worker's exposure is much higher than exposure in the surrounding community. For those workers who live in the Willits community, their exposure while at home is captured in the residential exposure evaluation. Exposure to toxic chemicals in the workplace is governed by the Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH), and is outside the scope of this evaluation.

CDHS evaluated the potential health impact to these groups of people from exposure to hexavalent chromium released during Remco plating operations (1963 – 1995). A key factor in evaluating exposure is understanding the amount of hexavalent chromium released to the air and the amount of hexavalent chromium to which people have been exposed. The following sections describe the process involved in characterizing these exposures.

Characterization of Exposure

Whether exposure to hexavalent chromium impacted the health of Willits community members depends, in part, on how much they were exposed to. No air measurements of hexavalent chromium in the Willits area were required or taken during the years of Remco chrome-plating operations. In the absence of information on historical air concentrations of hexavalent chromium, CDHS used the results of computer air modeling to evaluate how the health of the Willits community might have been impacted by exposure to hexavalent chromium. Computer air modeling is a mathematical way to estimate how much hexavalent chromium was released from the Remco facility in the past, as well as what the concentrations of hexavalent chromium were in different areas of the Willits community.

The following sections will provide information on the methods, assumptions, results, and uncertainty of the computer air modeling.

Overview of Computer Air Modeling

Through an interagency agreement with USEPA Environmental Response Team Center, ATSDR requested the Response, Engineering, and Analytical Contract (REAC) of Lockheed Martin, Inc., to develop an air model that would estimate the historic air quality impacts of hexavalent chromium during three different time periods of Remco operations (21). These time periods were: 1963 – 1975, 1976 – 1989, and 1990 – 1995. Since the public comment release of the PHA, CDHS has obtained information (not previously known or available to CDHS) regarding the installation dates of the plating tanks, the emission control equipment used at the site, source configuration, and the local meteorological (weather) data. This resulted in revisions to the three time periods. The scenario for the early time period (1963 – 1975) has been updated to reflect limited emission controls on some of the tanks, and a change in source configuration. The middle time period (1976 – 1989) has been updated to reflect a lower level of control than had been previously assumed. The latest time period (1990 – 1995) has been updated to reflect a starting date 1 year earlier than previously assumed. All the time periods have been updated to reflect modified meteorological data. The revisons to the air model were conducted by ATSDR rather than Lockheed Martin due to budgetary considerations. There are insufficient data to estimate releases from other plating contaminants such as lead (anode), cadmium, nickel, and zinc.

Using models in the absence of analytical data is a reasonable and accepted practice for estimating exposure concentrations. However, models are only estimates; their accuracy is limited by the assumptions made in recreating what past conditions might have been. Appendix D contains information regarding the limitations of the model used at this site. Briefly, a two-compartment model was used to estimate emission and dispersion of chromium. Emission rates were based on standard USEPA methodology. In projecting dispersion, the model considers the half life of hexavalent chromium in air and assumes that all particles are of respirable size and neutral buoyancy. It is more likely that chromium particles were of varied size (not all respirable) and heavier than air. Therefore, the model may over estimate exposure concentrations.

ATSDR used the following information to construct an air model of historical levels of hexavalent chromium: 1) the types of activities carried out at the facilities; 2) the types of emission control equipment used; 3) source test information; 4) how contaminants were released into the air; and 5) meteorological data. CDHS has discussed the type of activities and emission control equipment in the previous section. The next sections will present information on source test information, how contaminants were released into the air, and meteorological data.

Source Tests at Remco

Source tests provide information on how much hexavalent chromium Remco released into the surrounding air. Source tests were conducted at Remco in 1989 and in 1991.

In 1989, Galson Technical Services, Inc., with oversight by Mendocino County Air Management District staff, conducted source testing at Remco to determine the amount of hexavalent chromium emissions in the scrubber exhaust (13). The testing was prompted by the emission control regulations adopted in 1988, which required that scrubbers have a minimum efficiency of 99.8%, or that emissions not exceed 0.006 milligram per amperage-hour (mg/amp-hr). (Source test results are expressed in terms of weight emitted per amperage-hour because the amount of hexavalent chromium mists generated is proportional to electrical current [amperage] being applied and to the length of time [hours] required to plate the object.)

In 1989, source tests were conducted while five tanks (Tanks Nos. 2 – 6) were in operation, which was considered to be near maximum operating conditions, according to Remco workers (13). Emissions ranged from 0.090 to 0.11 mg/amp-hr and averaged 0.096 mg/amp-hour. Galson Technical Services, Inc. noted that these sample results might have been biased on the low side due to long holding times before the lab analysis was conducted. The new emission laws for chromium required maximum scrubber exhaust limit of (0.006 mg/amp-hr) or less. The Galson Technical Services source test exceeded this limit, requiring Remco to improve its emission control (13).

In 1991, Advanced Systems Technology, Inc., an USEPA contractor, conducted source tests for hexavalent chromium to evaluate the efficiency of a coalescing mesh pad (a type of filter) that had been added to the scrubber (14). The coalescing mesh pad was believed at that time to be the "state-of-the-art technology" for controlling chromic acid (hexavalent chromium) mists (14). Source tests were conducted while six tanks (Tanks Nos. 1 – 6) were in operation. Emissions averaged 0.004 mg/amp-hr and the efficiency of the scrubber averaged 99.991% (14).

ATSDR evaluated both the 1989 and 1991 source tests, noting failures with the air pollution control system that required constant attention during the tests. It was further noted that these adjustments interfered with work demands, requiring Remco to operate the tanks overnight (14) (Appendix D). If these items were not diligently attended to during normal operations, the scrubber would not operate at the level of efficiency achieved during these tests (Appendix D). In other words, it is highly unlikely that these efficiencies were achieved during average working hours.

How Contaminants Were Released Into the Air

Contaminants from an industrial facility are commonly released to the outside air through roof-top stacks, which are like chimneys. In addition, emissions can also occur from openings and cracks in buildings and uncontrolled tanks (tanks with no pollution controls or scrubbers). Releases that occur from openings and cracks in buildings and uncontrolled tanks are referred to as area sources. Stacks on roof-tops are referred to as point source releases. The main difference between an area source and a point source release relates to the dispersion and dilution of the contaminant in the air. Area sources (like a camp fire) generally occur at ground level. Contaminants released from area sources tend to have higher concentrations in the near field (the area closest to the source or tank) and do not disperse as far into the air. Point source releases typically occur above ground level. Contaminants released from point sources tend to disperse farther in the air than those released from area sources and concentrations tend to be lower in the near field (close to the stack). In both cases (areas and point sources), concentrations decrease with distance from the source.

Meteorological Data

The way in which contaminants disperse in the air is known as aerial dispersion. Aerial dispersion is a complex process governed by many factors such as wind direction, wind speed, turbulence, mixing height, diffusion, terrain, biota presence, particle size, and chemistry. Generally, the transport of air pollutants are more dependent on wind direction than any other factor (22).

The Mendocino Air District collects meteorological information in the Willits area. The predominant wind direction in Willits blows from the west-northwest toward the east-southeast directions. ATSDR staff evaluated local meteorological data collected between 1996 and 2000, and identified inconsistencies in the data at various times in all five years. To address these inconsistencies and reduce uncertainty, ATSDR used the data from 1996 through 2000 to create a “typical” year to be used in the air model.

Air Modeling of Hexavalent Chromium Concentrations, 1963–1995

ATSDR modeled and mapped hexavalent chromium concentrations during three time periods—1963 (8) – 1975, 1976 – 1989, and 1990 – 1995—which correspond to different levels of chrome plating operations, emission control devices, and hexavalent chromium releases at Remco. These differences are discussed in the previous sections. ATSDR used primarily the source test data to model the different time periods; USEPA emission factors were utilized in limited situations deemed appropriate by the air modeler (Appendix D). The same meteorological data were used for all three time periods (Appendix D).

The computer air model incorporated information on chrome-plating operations and weather patterns to produce estimates of hourly ground-level hexavalent chromium concentrations for an entire year at 17,000 different points (locations) in the Willits area. These hourly estimates are averaged for the entire year to produce an "annual average," which is plotted on a map in the form of contours. Maps representing annual average concentrations during these time periods are provided in Appendix B, Figures 3 – 5. A copy of the ATSDR air dispersion modeling report is provided in Appendix D. [Note: the shape and location of the contours (graphical depiction of the plume) have changed since the public comment draft of this health assessment. This is due in part to the revised meteorological data, source configuration, and the coordinate systems used for plotting the contours. The two coordinate systems used for the initial mapping were incompatible, which resulted in the contours being drawn off-center (about 200 meters towards the south). The mapping error has been corrected.]

There are a number of factors that add uncertainty to the model. Therefore, the estimated concentrations should be viewed as the best central estimate with error bounds on either side (Appendix D). There is an added degree of uncertainty in the modeled concentrations for homes directly adjacent to the facility due to the occurrence of micro-meteorological events (influences caused by buildings, trees, or other localized obstructions). Concentrations in these areas could have been higher or lower depending on location and circumstances on a given day. Further, the air model does not provide specificity as to the form (mist or particulate) of hexavalent chromium released at the receptor. A more detailed discussion about uncertainty with the air model can be found in Appendix D.

<u>Estimated Hexavalent Chromium Concentrations from Air Model (1963 – 1975)</u>

The modeled concentrations of hexavalent chromium have been plotted on a map as contours, which show the annual average concentration from 1968 – 1975, relative to a location in the community (Appendix B, Figure 3). On the basis of the modeling results, the annual average concentrations of hexavalent chromium for 1968 – 1975 ranged between 0.05 micrograms per cubic meter of air ($\mu g/m^3$) and 10 $\mu g/m^3$, depending on the location in the community (Appendix B, Figure 3). The concentrations decrease further away from the facility. For example, as shown in Figure 3, the estimated concentration of hexavalent chromium within the yellow contour is 1.0 $\mu g/m^3$. Areas north of Commercial Street are located within the lowest northern concentration contour (blue), with an estimated concentration of 0.01 $\mu g/m^3$, which is 1,000 times less than the yellow contour (Appendix B, Figure 3).

In addition to the 1968 – 1975 time period, ATSDR modeled the estimated concentrations of hexavalent chromium from 1963 – 1967, when only two horizontal plating tanks were in operation (23). The annual average concentrations of hexavalent chromium ranged between 0.005 $\mu g/m^3$ and 0.1 $\mu g/m^3$ (23). Concentrations would have been higher if surface tension reducers (method of pollution control) were not used on the tanks at all times (see previous section, History of Chrome Plating Operations and Pollution Control at Remco). These data are not shown in Figure 3; however, these concentrations were included in the exposure evaluation for the 1963 – 1975 time period.

ATSDR determined that under a range of plausible scenarios for the 1968 – 1975 time period, average hexavalent chromium concentrations in the adjacent community could have been between 1 $\mu g/m^3$ and 50 $\mu g/m^3$ (Appendix D).

Estimated Concentrations of Hexavalent Chromium from Air Model (1976 – 1989)

In 1976, the plating tanks were enclosed in a building and emissions/fumes from the plating tanks were captured, pulled through a scrubber system, and vented through the roof. This resulted in lower estimated levels of hexavalent chromium released from the facility, when compared with previous years. The annual average concentration of hexavalent chromium was estimated to range between 0.02 $\mu g/m^3$ and 1.0 $\mu g/m^3$, depending on the location in the community (Appendix B, Figure 4).

ATSDR determined hexavalent chromium concentrations during this time period were likely higher than modeled, due to operational issues identified during the source test (Appendix D). In considering these issues, the average value in the community nearest to the facility could be as high as 20 $\mu g/m^3$ (Appendix D). Further, if a lower emission control efficiency (40%) were assumed for this time period, rather than 83%, then the estimated hexavalent chromium concentrations would be almost double (19).

Estimated Concentrations of Hexavalent Chromium From Air Model (1990 – 1995)

Between 1990 and 1991, Remco improved the efficiency of the scrubber system, resulting in lower estimated levels of hexavalent chromium being released. The annual average concentration of hexavalent chromium was estimated to range between 0.00002 $\mu g/m^3$ to 0.0005 $\mu g/m^3$, depending on the location in the community (Appendix B, Figure 5).

ATSDR determined that hexavalent chromium concentrations during this time period were likely 450 times higher than modeled, due to operational issues identified during source testing (Appendix D). Thus, these estimations should be viewed as minimum.

Estimation of the Size of the Populations within Different Exposure Contours

To gain an understanding of the approximate size of the populations that could have been affected by airborne exposures within the different modeled contours, we estimated population size from the census, using census block data for the relevant areas (Table 4, below). Because census block areas did not correspond to the modeled contours, we used geographical information system software to sum the block population for each contour area (24). The contour areas are exclusive of each other ("donuts"). Where contour area boundaries cross a block, the block population is split based on area percentage. Because the more detailed census information was only readily available for the 2000 census, we created an estimate for earlier time periods based on this information by applying the percentage change in the Willits city population to estimate roughly the percentage that would have been present in previous decades.

The total number of residents estimated to have been exposed during the earliest time period is 4,228 (this means exposure to levels of hexavalent chromium of 0.05 $\mu g/m^3$ or greater) (Appendix B, Figure 3). Table 4 shows estimates for population sizes within specific contours (the circle or "donut" which does not include other color contours). For example, within the dark blue contour ("donut"), we estimated about 2,474 residents would have been present during the

1963 – 1975 time period. This means that approximately this many persons may have had inhalation exposure to estimated annual levels of airborne hexavalent chromium of 0.1 μg/m^3 during those years (Appendix B, Figure 3). A smaller number of persons (162) are estimated to have had exposure to estimated levels of 0.7 μg/m^3 during that time. Yet closer to the facility, within the yellow contour line, there would have been about 214 residents in the earliest time period (1963 – 1975). This means that about 214 people may have been exposed to levels of hexavalent chromium estimated at 1.0 μg/m^3 during that early period. In the innermost contour, also during that time period, approximately 24 people may have been exposed to levels estimated at 10 μg/m^3.

Table 4 below provides population estimates for each time period and contour location. Please refer to Figures 3–5 for the contour locations (Appendix B).

Table 4.	**1963–1975**	**1976–1989**	**1990–1995**
Contour (exclusive of concentric contours inside)	**Estimated to be 67% of 2000 population** (1960 census in Willits is approximately 67% of 2000 census)	**Estimated to be 79% of 2000 population** (1980 census in Willits is approximately 79% of 2000 census)	**Estimated to be equal to 2000 population** (1990 census in Willits is approximately the same as the 2000 census)
Purple contour	1,060	638	1,281
Dark blue contour	2,474	3,193	2,543
Light blue contour	259	2,600	1,750
Green contour	162	243	883
Yellow contour	214	87	965
Orange contour	35	21	57
Red contour	24	6	10
Total population in all contours	4,228	6,786	7,489

Note: Census blocks did not specifically correspond with the contour lines, so geographic information software was used to estimate the proportion of the population within contours (24).

Public Health Implications

As discussed in the previous section, CDHS has identified different populations in the Willits area that were exposed to different amounts of hexavalent chromium overtime. In this section, CDHS will determine the public health implications of those exposures for each of the groups identified.

To determine the public health implications of exposure, CDHS will review several kinds of information including: information reported in the scientific literature on the health effects of hexavalent chromium; toxicological information relating to dose, duration, route of exposure, etc.; theoretical increased cancer risk estimates; and, the available health outcome information (information on cancer incidences/cases). In this section, each of the types of information will be discussed.

Each of these types of information has some limitations (see Limitations of Evaluation section). Because of these limitations, CDHS considers the combined body of knowledge, all the types of information mentioned here, in formulating conclusions regarding the potential for exposures to impact public health for each of the different groups of people with in the Willits area who were exposed or potentially exposed to hexavalent chromium.

Health Effects of Hexavalent Chromium

Studies of both humans and animals have demonstrated that inhalation of hexavalent chromium can cause lung cancer. Several national and international agencies that classify chemicals according to their ability to cause cancer have designated certain hexavalent chromium compounds to be known human carcinogens when inhaled. Details on these compounds, the various agency designations, and the type and certainty of evidence supporting these designations are provided in Table 5, at right.

Inhalation of hexavalent chromium has also been associated with nasal and stomach cancer; however, these cancer effects have not been well studied. A more detailed discussion of current scientific understanding of the relationship between inhalation exposure to hexavalent chromium and cancer can be found in Appendix E.

Table 5. Cancer Classification for Hexavalent Chromium

Agency	Compound(s)	Evidence
U.S. Department of Health and Human Services	Calcium chromate Chromium trioxide Lead chromate Strontium chromate Zinc chromate	Sufficient evidence from studies of humans
International Agency for Research on Cancer	Hexavalent chromium compounds used in chromate production, Chromate pigment production and chromium plating industries	Sufficient evidence from studies of humans
	Calcium chromate Lead chromate Strontium chromate Zinc chromate	Sufficient evidence from animal studies
	Chromium acid Sodium dichromate	Limited evidence from animal studies
Environmental Protection Agency	Hexavalent chromium	Sufficient evidence from studies of humans

Inhalation of hexavalent chromium has been linked to health conditions other than cancer, including: nasal septum perforation, nasal ulcerations, scarring, bronchitis, asthma exacerbation (aggravation), hematological and gastrointestinal effects, kidney effects, and reproductive effects. (These health conditions will be referred to as “noncancer health effects” in this document.) A detailed discussion of current scientific understanding of the relationship between inhalation exposure to hexavalent chromium and noncancer health effects can be found in Appendix E. Table 6 below provides a summary of the levels of chromium at which health effects have been associated in workers. These levels can be compared to the estimated levels of hexavalent chromium produced by the model (Appendix B, Figures 3 – 5). In the following sections, CDHS will describe in more detail the health effects from inhalation of hexavalent chromium that are based on an extensive review of the scientific literature and how inhalation studies compare with the estimated exposures from Remco. It should be noted that there may be differences in toxicity depending on the form of hexavalent chromium (e.g., dissolved hexavalent chromium aerosols and mist and particulates). The health standards (comparison values) used in the toxicological evaluation are public health protective for exposure to both hexavalent chromium mists and particulates.

Table 6. Health Effects Seen in Workers at Different Levels of Hexavalent Chromium (μg/m³)*

Level (μg/m³) *	Time period of exposure	Effect
413	At least 3 years	Increased lung cancer (SMR† =3.04) (25)
413	At least 90 days but fewer than 3 years	Increased lung cancer (SMR=1.75) (25)
218	At least 3 years	Increased lung cancer (SMR=3.42) (25)
218	At least 90 days but fewer than 3 years	Increased lung cancer (SMR=1.79) (25)
80	not known	Spontaneous abortion via father's exposure (26)
6	not known	Skin irritation, ulceration from airborne chromium (27)
5	7.5 year average (range 3─16 years)	Gastric irritation (ulcer) (28)
4	7.5 year average (range 3─16 years)	Nosebleeds, runny nose, nasal septum ulceration and perforation, stomach pains, ulcers (28, 29)
4	5.3 years	Changes in kidney function, primarily affects the proximal tubule (30)
2-20	0.2─23 years (average 2.5 years)	Asthma, mild decrease lung function (31-35)

*μg/m³ = micrograms per cubic meter air; † SMR (Standardized Mortality Ratio) = the ratio of the observed number of cases to the expected number (in other words, how much excess mortality was observed). Values over 1.0 show more deaths than expected compared to a general population; values under 1.0 show fewer than expected deaths. A value of 1.75 means there were 75% more deaths than expected; a value of 3.0 means there were 300% more deaths (which is the same as 3 times more deaths) than expected.

Toxicological Evaluation

When individuals are exposed to a hazardous substance, several factors determine whether harmful health effects will result and the type and severity of those health effects. These factors include the dose (how much), the duration (how long), the route by which they are exposed (breathing, eating, drinking, or skin contact), the other contaminants to which they may be exposed, and their individual characteristics such as age, sex, nutrition, family traits, lifestyle, and state of health. The scientific discipline that evaluates these factors and the potential for a chemical exposure to adversely impact health is called toxicology.

In this toxicological evaluation, CDHS determined whether cancer or noncancer health effects were likely to occur among the various groups of people for whom a completed exposure pathway exists. These groups are: 1) residents of Willits; 2) people who worked in Willits; 3) students and staff at Baechtel Grove Middle School; and 4) students and staff at Blosser Lane Elementary School.

Noncancer Health Effects Evaluation

The approach used to evaluate the potential for adverse health effects, other than cancer, to occur in an individual or population assumes that there is a level of exposure below which noncancer adverse health effects are unlikely to occur. That level is called the threshold level or toxicity value. This public health assessment compares the concentration of the contaminant in air with the health comparison values (this is a threshold value with added uncertainty factors). These health comparison values are estimates of daily exposure to the human population, including sensitive subgroups, below which noncancer adverse health effects are unlikely to occur. They only consider noncancer effects. Because they are based only on information currently available, some uncertainty is always associated with the health comparison value. The uncertainty factor takes into account the differences in response to toxicity for a given contaminant within human and animal populations and between humans and animals, as well as the quality of the data base and the type of toxicological effects. The greater the uncertainty in CDHS knowledge, the greater the uncertainty factor, and the lower the health comparison value. Exceeding a health comparison value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration.

Health comparison values used to evaluate noncancer adverse health effects posed by historic emissions from the Remco site include California Environmental Protection Agency Office of Environmental Health Hazard (OEHHA) reference exposure levels (RELs), ATSDR minimal risk levels (MRLs), and USEPA reference concentration values (RfCs) (36-38).

ATSDR, USEPA, and OEHHA derived the chromic acid health comparison value from the lowest observable adverse effect level (LOAEL) of 2.0 μg hexavalent chromium/m^3 for upper respiratory effects in humans (31). The intermediate duration MRL for chromic acid mist is 0.005 μg/m^3. The REL for chromic acid is 0.002 μg/m^3. The RfC for chromic acid is 0.008 μg/m^3. The differences in the health comparison values arise from the different uncertainty factors that are applied to the LOAEL. ATSDR and USEPA derived a health comparison value for exposure to hexavalent chromium particulates based on respiratory effects in animals (36). The intermediate duration MRL for hexavalent chromium particulate is 1.0 μg/m^3 (36). The chronic duration RfC for hexavalent chromium particulate is 0.1 μg/m^3 (36). The differences in the health comparison values arise from the different uncertainty factors that are applied.

CDHS compared the annual average concentrations of hexavalent chromium estimated by the air model to evaluate the potential noncancer effects for each group of people during each time period. (The reader must refer to the contour maps [Appendix B, Figures 3 – 5] to determine the time period and which contour color they lived within.) The air model estimations are not specific to the form of hexavalent chromium (e.g., mist or particulate) released. CDHS compared these annual concentrations to the most public health conservative health comparison value for chromic acid (OEHHA's REL = 0.002 μg/m^3). Exposure estimates for people living, working, and going to school outside the purple contour during the 1976 – 1989 time period do not exceed the health comparison value, thus noncancer health effects would not be expected (Appendix B, Figure 5). Exposure estimates for people living, working, and going to school in Willits during the time period 1990 – 1995 did not exceed the health comparison value, thus noncancer health effects would not be expected (Appendix B, Figure 5). However, further evaluation is needed for the other groups of people/time periods when exposures exceed the health comparison. As stated above, the health comparison values are established with an uncertainty factor built in. Thus, if an exposure exceeds the health comparison values, a health effect will not necessarily occur.

In trying to further evaluate noncancer health impacts for those groups of people/time periods that exceed health comparison value, CDHS relied mostly on studies of workers exposed to hexavalent chromium. For the most part, studies of chrome platers were used as a comparison. Other worker studies (e.g., welders, chromate production) were reviewed in order to understand the range of health effects associated with exposure to hexavalent chromium. There have been only a few studies of non-occupational human studies. Animal studies were used as supporting information for the effects seen in workers. These potential health impacts will be discussed briefly below and are discussed more fully in Appendix E.

It seems that as the concentrations start to exceed 2 $\mu g/m^3$ to 4 $\mu g/m^3$, there is an increasing risk for a variety of health impacts for a healthy worker (Table 6). However, all workers did not experience these effects at the lower exposure levels and some workers did not experience these effects even as the concentrations increased ten or hundredfold. This illustrates the point that in any population including workers, there are some people who may be more susceptible and others who are fairly resistant to the same level of exposure. Some of these differences in susceptibility may relate to the person's genetic makeup and other factors that affect health, such as smoking patterns, alcohol consumption, and diet.

The following is a description of noncancer health effects for which inhalation of chromium has been associated in worker populations. If available, the information about the threshold level at which an effect may have occurred is described. There are several effects that have no dose response information.

- Effects on the nose such as scarring, ulceration, and perforation of the nose—Less severe symptoms can include rhinorrhea (runny nose), nasal itching and soreness, sneezing, and nose bleeds, which are reversible once exposure has ceased. Ulcerations of the nose have been found at fairly low levels: 4 $\mu g/m^3$ for an average of 7.5 years; 0.1 $\mu g/m^3$ to 7 $\mu g/m^3$ for an average of 26.9 months; 90 $\mu g/m^3$ to 730 $\mu g/m^3$ for less than 12 months (28, 29, 39).
- Respiratory problems, such as bronchitis and asthma—Several chromium worker studies have shown decreases in pulmonary function tests (e.g., forced expiratory flow) that are used to diagnose obstructive pulmonary disease (31, 35, 40-42). One of these studies found these lung function effects to be associated with exposure to chromium levels of 2 $\mu g/m^3$ and higher (31). Asthma has been found to develop in workers exposed to similar levels of chromium (32). Once asthma develops, it is not reversible. Exacerbation of asthma and bronchitis is reversible, once the exposure has ceased.
- Kidney effects—Excessive urinary excretion of proteins indicating that the proximal tubule part of the kidney responsible for reabsorption of proteins and minerals essential for normal bodily function has been affected in worker populations (B2-microglobulin and brush border protein) (43-45). Some studies have found changes in the kidney affect markers in current workers but not in ex-chrome workers, indicating the effects may be reversible (30, 46). These effects are not clinically relevant but are an early indication of kidney damage. These studies found effects as low as 4 $\mu g/m^3$ with a 5.3 year average work time, 4.2 $\mu g/m^3$ with a 5.8 year average work time, 50 $\mu g/m^3$ to 1,000 $\mu g/m^3$ with a 7-year average exposure (44).
- Gastrointestinal tract effects, such as stomach pain, stomach cramps, frequent indigestion, and ulcers—The workers experiencing these effects were exposed to mean concentrations of 4 $\mu g/m^3$ for 7.5 years on average (28). These effects are reversible once the exposure has ceased.

- Reproductive effects—In studies of welders, chromium exposure has been associated with effects on sperm quality and increased risk of spontaneous abortions among spouses of these welders (26, 47). Welders are exposed to other metals in addition to hexavalent chromium. The level of exposure associated with these effects was not reported. Effects on women's reproductive health have not been well studied.
- Liver effects—Alterations in liver function were observed in a study of workers in a chrome plating factory (48). Levels of exposure were not reported; however, the study took place during years when exposures may have been fairly high in the workplace.
- Skin effects—Skin ulcers develop slowly in exposed areas of the body following exposure to hexavalent chromium on the skin (27, 49, 50). An individual can become sensitive to hexavalent and trivalent chromium exposure and can develop rashes or erythema. These effects have been found at fairly low levels: 5 $\mu g/m^3$ to 170 $\mu g/m^3$ (50); 6 $\mu g/m^3$ to 289 $\mu g/m^3$ (27); 90 $\mu g/m^3$ to 100 $\mu g/m^3$ for less than 12 months (49). Skin irritation is reversible. Skin sensitization is not considered reversible.

Rather than using the threshold effect level in workers (greater than 2 $\mu g/m^3$), CDHS applied a ten-fold uncertainty factor for variation within the human population, resulting in a noncancer effect level for noncancer health effects at about 0.2 $\mu g/m^3$ for healthy adults.

There are groups of people living, working, and going to school near Remco who might be more susceptible to health effects from chromium exposure than a typical worker. Thus, the threshold for effects in workers may not be the same for the senior population or children. The National Academy of Sciences has suggested that in addition to the tenfold uncertainty factor for differences among humans, there should be an additional tenfold uncertainty factor to ensure uncertainty for children. With these two uncertainty factors applied to the worker's threshold for noncancer health effects (2 $\mu g/m^3$), the noncancer effect level for sensitive populations would be 0.02 $\mu g/m^3$.

The estimated air concentrations of hexavalent chromium for the following groups of people/time periods do not exceed these noncancer effect levels (0.2 $\mu g/m^3$ for adults; 0.02 $\mu g/m^3$ for children and other sensitive populations), thus noncancer health effects would not be expected to have occurred:

- Adults living and working outside of the dark blue contour on Figure 3 during the time period 1963 – 1975.
- Adults living and working outside of the red contour on Figure 4 during the time period 1976 – 1989.
- Children and other sensitive populations living, working, and going to school outside of the light blue contour on Figure 4 during the time period 1976 – 1989.
- Children and adults living, working or going to school anywhere in Willits[**] during the time period 1990 – 1995 (Figure 5).

The estimated air concentration of hexavalent chromium for the following groups of people/time periods exceed the threshold effect levels and noncancer health effects may have occurred:

[**] Refers to both the City of Willits and unincorporated areas.

- Children and other sensitive populations living, working, and going to school in Willits during the time period 1963 – 1975 (Figure 3).
- Adults living and working within the dark blue contour on Figure 3 during the time period 1963 – 1975.
- Children and other sensitive populations living, working, and going to school inside the light blue contour on Figure 4 during the time period 1976 – 1989.
- Adults living and working inside the red contour on Figure 4 during the time period 1976–1989.

The following table summarizes the information presented above (groups of people and time periods when exposures could have resulted in noncancer health effects).

Table 7. Population Group Most Likely To Experience Noncancer Health Effects From Historical Air Releases During Certain Time Periods

Within contour line:	1963 – 1975 (Figure 3)	1976 – 1989 (Figure 4)	1990 – 1995 (Figure 5)
Red, Line 1	Children, adults	Children, adults	
Orange, Line 2	Children, adults	Children	
Yellow, Line 3	Children, adults	Children	
Green, Line 4	Children, adults	Children	
Light Blue, Line 5	Children, adults	Children	
Dark Blue, Line 6	Children, adults		
Purple, Line 7	Children		
Outside Purple, Line 7	Children		

Blank spaces represent time periods and locations that exposures would not have resulted in noncancer health effects for adults or children.

In summary, CDHS found that in the first two time periods (1963 – 1989), at least some populations had exposures to hexavalent chromium that may have exceeded an estimated threshold level, resulting in the possibility for noncancer health effects to have occurred. The estimated threshold level is a level below which noncancer health effects would not be expected to have occurred. Thus, above the threshold level, it is possible that noncancer health effects may have occurred.

Evaluation of Cancer Health Effects: Cancer Risk Estimates

Cancer health effects are evaluated in terms of a possible increased cancer risk. Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men (about 43% combined) will be diagnosed with cancer in their lifetime (51). This is referred to as the "background cancer risk." The term "excess cancer risk" represents the risk above and beyond the “background cancer risk.” A “one-in-a-million” excess cancer risk from a given exposure to a contaminant means that if one million people are chronically exposed to a carcinogen at a certain level over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000. Cancer risk is not a prediction that cancer will occur; it merely suggests there is a possibility.

USEPA and OEHHA have developed cancer slope factors and unit risk values for many carcinogens. A slope factor/unit risk is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer. If adequate information about the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen is available, an estimate of the theoretical increased cancer risk associated with the exposure can be calculated using the cancer slope factor or unit risk for that carcinogen. Specifically, to obtain lifetime risk estimates, the air concentration is multiplied by the unit risk for that carcinogen. To obtain lifetime risk estimates for children, a chronic exposure dose is estimated, then multiplied by the slope factor for that carcinogen. USEPA and OEHHA derived an inhalation cancer slope/unit risk value from a study of lung cancer deaths among workers in a chromate production plant (Mancuso 1975) (52). The Mancuso study was based on exposure levels measured as soluble, insoluble, and total chromium (the chromium was not speciated between trivalent and hexavalent). Limitations with the 1975 study make identification of the specific form of chromium responsible for the lung cancer uncertain. In 1997, the study was updated, showing lung cancer rates clearly increased by gradient level of exposure to total chromium (53).

USEPA developed their cancer slope factor/unit risk for hexavalent chromium in 1998, using dose-response data for total chromium (53). USEPA notes that “the use of dose-response data for total chromium would result in an undersestimation of the potency of hexavalent chromium” (53). OEHHA calculated their cancer slope factor/unit risk value assuming the cancer mortality in the Mancuso study was due to hexavalent chromium exposure, which was further assumed to be one-seventh of the total chromium exposure, based on an industrial hygiene study conducted in 1949 (54, 55). This approach helps reduce some of the uncertainty in the toxicological information, while providing a more health protective value.

USEPA cancer slope factor is 42 $(\text{mg/kg-day})^{-1}$ and the unit risk value is 0.012 $(\mu g/m^3)^{-1}$; OEHHA’s cancer slope factor is 510 $(\text{mg/kg-day})^{-1}$ and the unit risk value is 0.15 $(\mu g/m^3)^{-1}$. CDHS used the OEHHA cancer slope factor and unit risk in estimating theoretical increased cancer risks.

Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). This approach uses a mathematical formula to predict an estimated number of additional cancers that could occur due to the exposure modeled. The model is based on the assumption that there are no absolutely safe toxicity values for chemicals that can cause cancer, meaning that the model assumes that no matter how low, even extremely low exposures, there is always the possibility that a true carcinogen could cause a cancer. The models typically use information from higher exposure scenarios and then extend an estimate of risk into lower exposure scenarios, using the assumption that lower levels would still be carcinogenic. The calculations take into account the level of exposure, frequency of exposure, and length of exposure to a particular carcinogen, as well as an estimate of the carcinogen's potency. These formulas are created from studies of persons who had exposures to see how much illness they developed. The studies compare the health of exposed workers to unexposed workers. In order to take into account the uncertainties in the science (such as making predictions of health outcomes at lower levels when there is only information about high exposures), the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions. In other words, the theoretical cancer risk estimates are designed to express the highest risk that is plausible for the particular exposure situation, rather than aiming to estimate what the most likely risk is. Given that there is uncertainty to these predictions, it is considered preferable to overestimate rather than underestimate risk. **Cancer risk estimates are a tool to help determine if further action is needed and should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (56).**

Increased Cancer Risk Estimates for the Willits Community

CDHS used the annual average concentrations of hexavalent chromium estimated by the air model to evaluate the theoretical increased cancer risk to the different groups of people identified. An individual's exposure and resulting risk is dependent on where he/she lives or works in the community. CDHS made different assumptions about the level of exposure, exposure frequency, and duration of exposure for the different groups of people (Appendix C, Table 8) (57). For example, a residential exposure (someone who lives near the site 365 days per year) would be different from the exposure to a teacher who worked near the site for 180 days per year. CDHS utilized site-specific information and USEPA and OEHHA guidance to develop the exposure assumptions used in the evaluation (4, 57). OEHHA's cancer slope factor [510 $(mg/kg\text{-}day)^{-1}$ and unit risk value $(0.15\ (\mu g/m^3)^{-1}]$ for inhalation of hexavalent chromium was used in estimating theoretical increased cancer risks (54).

Theoretical increased cancer risk estimates are based on the assumption that an individual is chronically exposed at a certain concentration level for a number of years. In this public health assessment, cancer risk estimates were calculated using a cancer slope factor developed from scientific studies of exposed individuals to hexavalent chromium, the estimated concentration of hexavalent chromium in the air and exposure assumptions for the different groups of people evaluated (Appendix C, Table 9) (54).

Science does not support estimating theoretical increased cancer risks for short-term exposures, as these estimates may misrepresent the actual risk (58). One reason is that cancer slope factors are developed from studies that look at exposures over a long period of time. CDHS used a recommended 9-year minimum exposure duration as basis for estimating theoretical increased cancer risks (4).

CDHS estimated the theoretical increased cancer risk (primarily lung) for adult and child residents, workers, and Baechtel Grove staff for the different time periods modeled (1963 – 1975, 1976 – 1989). CDHS discusses the cumulative cancer risk for the 32 years Remco conducted plating operations (1963 – 1995). If a person lived in Willits for a shorter portion of these time periods, his/her cancer risk would be less. CDHS did not estimate cancer risks for students who attended Baechtel Grove Middle School because their attendance was for 2 years, which is less than the minimum 9 years recommended to estimate cancer risks (4).

It is important to keep in mind that the health effects evaluation contains areas of uncertainty, as past exposures are based solely on data produced by air modeling, not on actual measurements, and that theoretical cancer risk estimates are calculated using data extrapolated from worker populations.

Willits Residents

The following lists the range of estimated lifetime increased cancer risk (primarily lung) for adult and child residents (cancer risk estimates for each contour color are provided in Appendix C, Table 9):

Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (56).

- **1963 – 1975**: The estimated theoretical lifetime increased cancer risk for adults and children range from 6 in 10,000 to 1 in 10 adults, and 6 in 10,000 to 1 in 10 children, depending on the location in the community (Appendix B, Figure 3; Appendix C, Table 10). These are considered low to high increased cancer risks. This means that 6 in 10,000 adults who lived within the purple contour during 1963 – 1975 could develop lung cancer if they were exposed to the estimated level of hexavalent chromium in air for 24 hours per day, 7 days per week, 350 days per year, for 12 years. For residents who lived within the red contour during 1963 – 1975, 1 in 10 adults could develop lung cancer if they were exposed to the estimated level of hexavalent chromium in air for 24 hours per day, 7 days per week, 350 days per year, for 12 years (Appendix C, Table 8). Cancer risk estimates for each contour color are provided in Appendix C, Table 9.

  The theoretical cancer risk estimates that follow are interpreted in the same manner, noting that different exposure assumptions were used depending on the time period and group of people evaluated. The exposure assumptions are presented in Appendix C, Table 8.

- **1976 – 1989**: The estimated lifetime theoretical increased cancer risk ranges from 9 in 100,000 to 6 in 1,000 adults and 9 in 100,000 to 6 in 1,000 children, depending on the location in the community. These are considered very low to moderate increased risks (Appendix B, Figure 4; Appendix C, Table 9).

- **1963 – 1995**: Presenting the estimated the cumulative lifetime theoretical increased cancer risk from 32 years of exposure for the entire Willits area is complicated because the concentration contours vary greatly in shape between the time periods and do not overlap in a consistent manner. However, the estimated cumulative lifetime increased cancer risks are similar to the risks estimated for earliest time period (1963 − 1975), when estimated exposures to hexavalent chromium were the highest (Appendix C, Table 9). This is because most of the risk occurred during that time period.

  Still, as some people may have lived in the area for this 32 year time period, in the interest of providing some information about what the risk would be over this time, we took several locations in Willits and presented the cumulative (32 years of exposure) lifetime cancer risk at each location for the 32 year time period, along with the theoretical increased risk for the 1963 – 1975 and 1976 – 1989 time periods (Appendix C, Table 10). For example, the cumulative (32 year of exposure) for adult residents who lived in the former Luna Apartments, directly behind the Remco facility, is estimated to be 1 in 10. This is the same increased cancer risk estimated for this population during the 1963 − 1975 time period (Appendix C, Table 10).

Workers in Willits

The following lists the range of estimated lifetime theoretical increased cancer risk for people who worked in Willits (cancer risk estimates for each contour color are provided in Appendix C, Table 9).

Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (56).

- **1963 – 1975**: The estimated lifetime theoretical increased cancer risk for workers ranges from 2 in 10,000 to 4 in 100, depending on where they worked in the community (Appendix B, Figure 3; Appendix C, Table 9). These are considered low to high increased risks.
- **1976 – 1989**: The estimated lifetime theoretical increased cancer risk for workers ranges from 3 in 100,000 to 2 in 1,000, depending on where they worked in the community (Appendix B, Figure 4; Appendix C, Table 9). These are considered very low to high increased risks.
- **1963 – 1995**: Presenting the estimated the cumulative lifetime theoretical increased cancer risk from 32 years of exposure for the entire Willits area is complicated because the concentration contours vary greatly in shape between the time periods and do not overlap in a consistent manner. However, the estimated cumulative lifetime theoretical increased cancer risks are similar to the risks estimated for earliest time period (1963 − 1975), when estimated exposures to hexavalent chromium were the highest (Appendix C, Table 9).

  Still, as some people may have worked in the area for this 32 year time period, in the interest of providing some information about what the risk would be over this time, we took several locations in Willits and presented the cumulative (32 years of exposure) lifetime theoretical increased cancer risk at each location for the 32 year time period, along with the theoretical increased risk for the 1963 – 1975 and 1976 – 1989 time periods (Appendix C, Table 10). For example, the cumulative (32 years of exposure) lifetime theoretical cancer risk for Safeway workers is 4 in 1,000. This is the same theoretical increased cancer risk estimated for this population during the earliest time period (1963 − 1975) (Appendix C, Tables 10).

Baechtel Grove Middle School Staff

The following lists the range of estimated lifetime theoretical increased cancer risk for staff who worked at Baechtel Grove Middle School:

Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (56).

- **1963 – 1975**: The estimated lifetime theoretical increased cancer risk for staff at Baechtel Grove Middle School is 3 in 1,000 (Appendix B, Figure 3; Appendix C, Table 9). This is considered a moderate increased risk.
- **1976 – 1989**: The estimated lifetime theoretical increased cancer risk for staff at Baechtel Grove Middle School is 5 in 10,000 (Appendix B, Figure 4; Appendix C, Table 9). This is considered a low increased risk.
- **1963 – 1995**: The cumulative lifetime theoretical increased cancer risk for staff at Baechtel Grove Middle School from 32 years of exposure is 3 in 1,000 (Appendix B, Figures 3 – 5; Appendix C, Table 10). This is considered a moderate increased risk.

Theoretical increased lung cancer cases – total estimate for Willits area

The previous sections presented estimated increased cancer risks for persons in Willits in different exposure contours. We have also presented estimates about numbers of residents in the different contours. We used this information to calculate the number of additional cancers would we predict among Willits residents. As most of the additional risk was from the earliest period when the emissions were greater (1963 – 1975), we calculated the additional number of cancers that we would predict to occur over a lifetime (based on the risk estimates) for persons living in particular contours in Willits from 1963 – 1975 (Table 11). We found we would expect an additional 13 cancers. This does not include cancers from exposures to persons who worked but did not live in Willits or exposures to Remco workers. It also does not include exposures occurring in the later time period, as the same people would then be counted twice if they lived in Willits during both time periods. However, because the later time period had much less risk, the estimated number of cancers would be much less. Again, this is just a theoretical estimate, but nevertheless useful to give a general sense of the potential magnitude of the problem.

Table 11. Theoretical Increased Lung Cancer Cases Predicted by Cancer Risk Estimates for Residents of Willits from 1963-1975

Contour	Risk to resident	Estimated number of residents per contour	Number of theoretical increased lung cancer cases
1 (red)	1 in 10	24	2
2 (orange)	6 in 100	35	2
3 (yellow)	1 in 100	214	2
4 (green)	8 in 1,000	162	1
5 (light blue)	6 in 1,000	259	2
6 (dark blue)	1 in 1,000	2,474	2
7 (purple)	6 in 10,000	1,060	1
Total		4,228	13

Comparison of Occupational Chromium Levels Associated Increased Lung Cancer Risk with Air Modeling Levels Estimated Near Remco

The 24-hour average airborne hexavalent chromium exposures estimated for the neighborhoods around the Remco facility are higher than what one would find in a typical neighborhood, where most of the time little to no hexavalent chromium would be detected. The persons estimated to live in the red-line enclosed area closest to the facility received an estimated 10 $\mu g/m^3$ in an average 24-hour exposure period, during the period of highest emissions (pre-1976). This number is based on air modeling exposure estimates performed for Willits that give estimated annual average exposure concentrations, assuming Remco operated 16 hours per day, 5 days per week. Thus, the concentrations are an average of the times Remco was operating and the times it was not.

As discussed earlier, the cancer risk estimates are one way to attempt to quantify what the risk to exposed populations might be (the cancer risk estimates are the calculations that indicate, theoretically, how many additional cancers may have occurred within a given population). Another way to try to understand what the cancer risk might have been for the community is to look directly at how much additional cancer was found among chromium workers who were exposed to certain amounts of chromium.

This information is found in a few occupational studies, which may have been conducted in other parts of the country or world, and which have information about workers' exposure levels to hexavalent chromium. Although this exposure information is limited, the air concentrations found in occupational health studies to be associated with an increased risk in lung cancer were typically higher than the air modeling estimates of the highest annual average chromium levels in Willits (Appendix B, Figures 3 – 5; Appendix E, Toxicology of Chromium). For example, in one large study of about 1,800 workers, those who were exposed to average levels of hexavalent chromium of 413 $\mu g/m^3$ on a daily basis at work for at least 3 years had about 3 times greater risk of getting lung cancer than the general population (25). That study also found that persons who worked in a setting with average chromium levels of 218 $\mu g/m^3$ for over 3 years had an increased risk of lung cancer. An increased risk of lung cancer was found for persons who worked with chromium fewer than 3 years, although only among the group who were exposed to the higher levels (413 $\mu g/m^3$), not the lower exposure group (218 $\mu g/m^3$). These studies provide some information about how high the levels of chromium were, which were associated with an increased risk of cancer in worker populations.

Historically, typical levels in occupational settings with chromium exposure tended to be quite high. For example, one occupational study estimated levels to be between 500 $\mu g/m^3$ and 2,000 $\mu g/m^3$ chromate (59). Another study estimated levels around 300 average $\mu g/m^3$ total chromium in different areas of the workplace and 500 $\mu g/m^3$ among a small group of persons who actually developed lung cancer (60). A third study estimated between 500 and 1,500 $\mu g/m^3$ total chromium (61). A detailed industrial hygiene study estimated a variety of workplace exposures in a chromate plant that ranged between approximately 50 to 1,400 $\mu g/m^3$ total chromium (55). Although these air concentrations are much higher than the annual averages estimated for Willits, there are important differences between occupational and community exposures that need to be considered before directly comparing these numbers.

Occupational exposures to chemicals often differ from community-wide exposures, not only in that occupational exposures are generally much higher, but they occur under specific-job related activities not encountered in communities (e.g., removing equipment from hot baths or mixing chemicals in vats), and tend to be more intense during the typical 8- or 10-hour workday than experienced by communities living around sites. Workers are typically only exposed for a limited number of years, only during a fraction of each 24-hour day (usually 8 hours), and only during workdays (not all 365 days a year). Therefore any toxicity that is observed in occupational situations may or may not be seen in communities.

Despite these differences, CDHS still tries to utilize information from these studies to further the understanding of the potential health consequences for exposed communities' populations. In order to do this, certain assumptions about exposure and toxic potential are often made. One such approach to make the exposure estimates from health studies comparable to those in the community is to average the exposures from the 8-hour workday across the rest of the time when workers were not at work. Although the actual exposure experience may be quite different between workers and community members, if for the purposes of this comparison CDHS assumes that making this kind of adjustment for concentration and time is reasonable, this technique could be used. This would average the exposures over all of a worker's time rather than only the working hours, to make it comparable to community exposure numbers. This technique would convert the 413 $\mu g/m^3$ hexavalent chromium from one study to 90.5 $\mu g/m^3$ (18). These levels can now be compared with the levels that were estimated for the Willits community. **It is important to note that the adjusted study levels may not be accurate; they can only be used for approximate, screening level comparisons (i.e., to be used as one piece of information within a larger approach to understanding varying risks)**.

Because these adjusted levels (90 $\mu g/m^3$) in some occupational chromium studies are within an order of magnitude to those estimated by the air modeling (10 $\mu g/m^3$), this suggests that at least some of the Willits population was exposed to levels similar to chromium worker exposures in some settings. This is consistent with the cancer risk estimate findings of increased cancer risk among residents. It cannot be known for sure if the occupational-type exposures (e.g., possibly shorter and higher) create the same level of risk as environmental exposures (e.g., longer, lower exposures). Nevertheless, this would suggest that community members, particularly those living near the facility and exposed prior to the time when emissions controls were implemented, would have experienced some increased risk of lung cancer, as supported by the cancer risk estimates.

Health Outcome Data

In evaluating a site, ATSDR and CDHS try to understand the potential health impacts on communities near sites containing hazardous chemicals. This involves determining which health effects might be caused by certain amounts of chemicals (as discussed in the toxicology section), determining if people had contact with contaminants (as discussed in the Pathway Evaluation section), and understanding what health problems people in the community are experiencing. In addition to asking community members directly about their health concerns (as reported in the Health Concerns section), CDHS also tried to get information about the health status of a community from other sources.

However, evaluating whether past hexavalent chromium releases from the Remco site affected the health of people living in Willits poses challenges. Ideally, to review the health of community members who may have been affected by Remco contaminants, it would be helpful to have thorough records about the symptoms and diseases of persons who lived in Willits during the time they could have been exposed. Information about the diseases and symptoms they had could then be compared to persons who did not live in Willits during that time. However, this type of community health surveillance system is not available because some people go to private physicians, others to health maintenance organizations, others to county services, etc. In California, a thorough health surveillance system only operates for cancer. Surveillance for birth defects was initiated for a time in the past, but is now very limited. Unfortunately, the lack of a health surveillance system for most illnesses prevents CDHS from obtaining a complete and objective understanding of how much illness Willits residents may have experienced.

The next section describes CDHS review of the cancer surveillance data. Although it is informative to understand the numbers of cancer cases in an area, using cancer surveillance data also is limited in its usefulness in addressing whether contaminants from Remco affected the health of the community. This will be discussed in more detail in the following section.

Cancer Review Data for Willits

Because of concerns about whether chromium exposure could have caused cancer, CDHS reviewed information on cancer cases in the area. The review attempts to address the question: "Are there more cases of cancer occurring in the Willits area than would typically be expected?"

To conduct the review, EHIB requested information on the number of cancer cases in Willits from the Cancer Registry of Northern California (Region 6 of the California Cancer Registry). This registry has been collecting information on all cancer diagnoses in the region since 1988, which allows this type of analysis to be performed.

Geographic Areas and Time Periods Reviewed

This review examines cancer cases that occurred in the Mendocino County 1990 U.S. census tract 010700, which encompasses the majority of the city of Willits (Appendix B, Figure 6). Census tracts are specific geographical areas defined by the U.S. Bureau of the Census.

This review covered January 1, 1988 through December 31, 2000 (the time periods for which data was available). The reason the registry does not include cancers diagnosed up to the present is that it takes some time to collect information from hospitals and laboratories, check its accuracy, and enter the information into their records.

Rationale for Cancer Review and Choice of Cancers

Because there are many different types of cancer, typically, in a review of cancer data, CDHS looked at cancer cases overall (all cancer types combined), and then selected certain cancers that are of interest. Cancers of interest were chosen because they have been noted in previous studies to be associated with the exposure of concern. In this case, lung and all respiratory system cancers were chosen because they are the primary cancer types associated with chromium inhalation exposure. Nasal and sinus cavity cancers also were reviewed because they have sometimes occurred more frequently among individuals occupationally exposed to chromium.

The review also included: prostate, lymphoma, Hodgkin's disease, leukemia, bone, stomach, urinary tract, renal, bladder, testicular, and liver cancer (some of these are specific cancers that fall within broader categories). The evidence for an association between chromium and these cancers varies considerably. However, a number of them were included—even in the absence of meaningful evidence—because they have been identified as cancers that possibly might be related to chromium by a frequently cited researcher, Dr. Max Costa, who reviewed and reported on other people's studies. The fact that a cancer appeared on this list does not mean that the cancer is necessarily related to chromium exposure. Despite the lack of specific evidence relating chromium exposure to these types of cancers, they were chosen so that all outcomes possibly related to chromium exposure could be evaluated.

Information Provided by the Cancer Review

The cancer review reports two main pieces of information: 1) the number of new cases of cancer that occurred in a particular area within a specific time; and 2) an estimate of how many cases would typically be expected for that area, given the number of people who live there and other factors. These two figures are compared to see if the number of cancer cases that occurred in a particular area is greater than what would typically be expected.

The first number (the number of new cancer cases) is taken from the cancer records for the specific geographical area studied (in this case, the main census tract for Willits). The second number, the expected number of cancer cases, is estimated on the basis of several other sources of information. Because the number of expected cancer cases depends on the number of people in the area, it is necessary to know the size of the population. Fewer cancers would be expected in a small town than in a large city. The estimate of the expected number also takes into account the age, race, and sex of the population. This is important because different groups of people have different risks of cancer. For example, as cancer cases increase with age, the number of expected cancers would be different in a retirement community when compared with a neighborhood where many young people live.

The cancer registry uses information about how many people are getting cancer in the northern California region generally, in order to estimate how many cancers would be expected to occur in this particular census tract. (Cancer incidence data are from Cancer Registry Region 6; this region covers the 16 northern California counties). The estimate of the number of people in the census tract (and their age, race, and sex) was based on 1990 census data for the 1988 – 1995 cases. The 1996 – 2000 estimates were based on the 2000 census figures. The results are reported for three time periods: 1988 – 1995, 1996 – 2000, and a summary of the whole time period, 1988 – 2000.

Description of Range of Cancers

Another important aspect of assessing whether the observed number of cancers is greater than the expected number is the unpredictability of how many cancers may actually occur. The number of cancers that occur will vary due to the many different factors that are not known, but must be taken into account. To do this, the cancer registry uses statistics to create a range called a confidence interval. If a number (in this case, the number of observed cancers) is greater than the confidence interval, this means it is statistically unlikely that this result occurred by chance.

Results of Analysis of all Cancer Types Combined, 1988 – 2000

CDHS looked at the number of observed cancers compared to the number of expected cancers for the three time periods noted. The number of observed cases (363) was very similar to the number of expected cases (370) (Appendix C, Table 12).

Analysis of Respiratory Cancers, 1988 – 2000

CDHS looked at the number of respiratory system cancers, finding that observed number (77) was somewhat higher than the expected number (about 66), but still within the expected range (56.1 – 102.4). A similar finding was observed for lung cancer alone, because lung cancers make up a very large portion of respiratory system cancers. The number of nasal cavity, middle ear, and sinus cancers was too small to report.

Other Cancer Types (Lymphomas, Leukemia, Urinary Tract, Testes, and Liver)

The number of other cancers were within the expected range (some higher and some lower than the specific expected number).

Summary of Findings

For all individual cancer types reviewed, the number of new cases actually observed during this period, 1988 – 2000, was within the range of what would be expected, as was the overall number of cancer cases observed. This type of review is not able to determine whether any cases of cancer were caused by chromium exposure, but it does not rule out this possibility.

Note: The California Cancer Registry does not release information on fewer than five cases in a small geographic or sparsely populated area in order to protect patient confidentiality. Although not presented in detail in the table, comparison of observed-with-expected case numbers was also conducted for these less commonly occurring cancers. Again, no statistical difference existed between the observed and expected number of cases.

Limitations of the Cancer Rate Review

There are a number of reasons why it is difficult to tell from this type of review whether specific exposures caused cancer in a community. Cancer takes a long time to develop (usually many years), so people may have cancer for a long time before they learn about it. If people moved away, their cancer would not be included. The expected numbers of cancers are based on the census, and if the census is inaccurate, the cancer estimate would be too. Finally, there is no information on whether any of the people diagnosed with cancer smoked, and smoking causes lung cancer (85% of lung cancer is caused by cigarette smoking).

Discussion of Cancer Review Results in Comparison to Cancer Risk Estimates

As presented above, the cancer review did not find that the number of cancers was greater than would typically be expected. The number of respiratory system cancers was greater than the specific estimate of the number expected, but not outside the range of what would be expected to occur typically. However, the cancer risk estimate suggested high increased risks of developing cancer.

The cancer risk estimation appears at first not to correspond to the cancer review, and raises the question of why the cancer review did not find more cancers than expected (why the number of observed cancers was within the range of what would typically be expected). There are several relevant issues. Among small groups of people, it is difficult to tell if the number of cancers observed is greater than would typically be expected. It is possible that there was an increase in the number of cancers that was related to chromium exposure, but because the group of people is so small, an increase cannot be distinguished from the natural variability in how cancers occur.

To illustrate this, assume for example that 10 people were exposed to a hazard that might possibly cause cancer. Only one cancer was expected in that group, but if two people got cancer, it would be hard to conclude that the exposure caused the cancer, since there could be so many reasons why those two people happened to get cancer. However, if 100,000 people were exposed to the same potential hazard and 10,000 were expected to get cancer, but 20,000 did get cancer, that is a much more significant finding. This is because it is unlikely that just by chance those additional 10,000 people got cancer. It does not prove that the exposure caused twice as many people to get cancer, but it does suggest that there was some important factor (maybe the hazard) that influenced why so many more people got cancer than expected.

It is also possible to approach the answer to this seeming discrepancy between the cancer review and risk estimates by looking at these estimations. A risk estimate is a tool that can provide a systematic approach to characterizing the nature and magnitude of a risk. It is based on scientific information, but uses many assumptions to make (in this case) theoretical estimates about the number of cancers that could occur. As such, these risk estimates should not be interpreted as an accurate prediction of an exact number of cancers that actually would occur. Its value lies in how it helps compare risks of different activities or situations and quantify those comparisons.

In the case of the Remco exposures, the degree of risk (according to the cancer risk estimates) varied depending on the location in the community, what time period the person lived there and for how long. The greatest risks were in small areas close to the Remco facility. Given that the estimated average air levels in the community could be considered similar to some low-level occupational exposures (based on averaging the worker exposure levels over time), it is possible that chromium in the air, especially close to the facility, could have contributed to the development of lung cancer among residents. The level of risk in the community would vary, similar to how smokers have a greater risk of lung cancer than those who are only exposed to secondhand tobacco smoke. However, because this is a small population, the cancer registry review may not have shown this effect.

The increased cancer risk estimates and the cancer review reveal different sets of information. The cancer risk estimates help to understand the magnitude of cancer risk in the area and compare cancer risks in different areas in the community. The cancer review explains how much cancer actually occurred, and compares this to what would be expected in this population if it had the same cancer experience as did the rest of northern California residents.

Other Potential Sources of Exposure Not Evaluated (Data Gaps)

This public health assessment evaluated exposure to past air releases of hexavalent chromium from Remco plating operations. Considering that chrome plating was the primary operation carried out at Remco, it is probable that air releases of hexavalent chromium account for the majority of exposure in the community. However, there were other contaminant sources at Remco that could not be evaluated for potential exposure to the community because of a lack of data. The following is a list and brief description of the activities/sources identified to date:

- Other types plating and/or metals released during the chrome-plating process (cadmium, manganese, zinc, nickel, lead, and antimony);
- Open system cooling tower located at north side of facility (mid-1960s – early 1980s) used to cool plating tanks (potential source of additional hexavalent chromium releases) (5);
- Evaporation unit in the northern bermed area of the site, used to evaporate chrome and VOC wastewater in the late 1980s (potential source of additional hexavalent chromium releases) (C. Nickerman, former Remco employee (1984 – 1986), personal communication, November 11, 2003) (62);

- Burning of trash behind/alongside Remco using spent solvents (mid-1960s) (62);
- VOC releases from activities utilizing solvents (machine shop, cleaning cylinders prior to plating, paint shop, etc.).

Quality Assurance and Quality Control

In preparing this public health assessment, ATSDR and CDHS used information in the referenced documents and assumed that adequate assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures and data reporting. ATSDR evaluated these data, noting some issues that could potentially bias the air model results if not addressed (Appendix D). As a result, ATSDR utilized USEPA emission factor data to supplement and better refine the data used to construct the air model (Appendix D). The air model used for this health assessment is USEPA approved.

Limitations of Evaluation

The identification and analysis of environmental exposure is difficult and inexact. This public health assessment was prepared using different sources of information. There are varying degrees of uncertainty associated with each source of information. The following describes four broad areas where uncertainties may be found and provides examples of some of these uncertainties.

- **Air Dispersion Modeling**
  A major source of uncertainty in the air dispersion model relates to the accuracy of the data used to generate the model. The data used to create the air model for this public health assessment were determined to be of good quality and capable of producing accuracy of results to within a factor of two (Appendix D). The air model estimated concentrations should be considered the best central estimate with error bounds on either direction. ATSDR determined that airborne hexavalent chromium concentrations were likely 3 – 450 times higher, depending on the time period, than estimates used in this health assessment, due to operational factors identified during ATSDR's evaluation of available data (Appendix D). Without actual air measurements, there is no way to precisely know what the levels were in the Willits community in the past. A more detailed discussion of the uncertainties is presented in the air model report in Appendix D.

- **Exposure Assessment**
  Different exposure assumptions were used to assess past exposures. A major source of uncertainty in estimating exposure is the assumption that all individuals within a particular group and location will be exposed to the same amount of hexavalent chromium, as estimated by the model. Other factors that add uncertainty is the assumption that hexavalent chromium concentrations in indoor air are the same as concentrations estimated in outdoor air and biological variability in absorption, breathing rates, etc. will also exist even in narrowly define age groups or sensitive populations identified. The exposure assumptions used in the public health assessment are meant to provide conservative results for the exposure evaluated. However, if concentrations of airborne hexavalent chromium were higher during the later time periods (1976 − 1989 and 1990 − 1995) as indicated by ATSDR,

then exposures would have been higher than those evaluated. Additionally, other potential site related sources of exposures could not be evaluated because of a lack of data, limiting the ability for evaluation of other potential health effects.

- **Hexavalent Chromium Toxicity**
  Toxicity information for hexavalent chromium has been generated from both animal studies at high doses and epidemiological studies of adult male worker populations. Unlike many other chemicals, much of the toxicity information comes from worker studies, especially in the past when industrial hygiene was not a priority consideration. A great deal has been learned about the association between hexavalent chromium and lung cancer, allowing for a better understanding of dose response. Other health effects, both cancer and noncancer, and effects on females, have not been as well studied. Areas of uncertainty in the toxicity information also relate to the chemical properties of hexavalent chromium (e.g., soluble and insoluble) and the valence state or form of chromium (e.g., trivalent and hexavalent). CDHS reviewed the literature and considered information relating to solubility and valence state when available.

- **Limitations of the Cancer Rate Review (already said above)**
  There are a number of reasons why it is difficult to tell from this type of review whether specific exposures caused cancer in a community. Cancer takes a long time to develop (usually many years), so people may have cancer for a long time before they learn about it. If people moved away, their cancer would not be included. The expected numbers of cancers are based on the census, and if the census is inaccurate, the cancer estimate would be too. Finally, there is no information on whether any of the people diagnosed with cancer smoked, and smoking causes lung cancer (85% of lung cancer is caused by cigarette smoking).

Community Health Concerns/Health Concerns Evaluation

Introduction and Purpose

The collection, documentation, and response to community health concerns are critical to the public health assessment process. The purpose of this section is to: 1) list the concerns that have been voiced by Willits community members; 2) provide a response to the concerns with educational information; and 3) specifically address the health and other concerns within the framework and limitations of the public health assessment.

Process for Gathering Community Health Concerns

CDHS staff first became aware of community health concerns in Willits in April 2000, when contacted by USEPA about the site. In May of 2000, CDHS staff members visited the site visit with representatives from the Willits Trust, the Mendocino County Health Department, USEPA, and the City of Willits, to better understand the layout of the facility and to meet involved agency representatives. CDHS also met with several community members to discuss their concerns and determine how they would like to be involved in the public health assessment process. Several community members had already documented many concerns and were worried about the health status of the town's residents. One resident had conducted over 100 community interviews and constructed a map that listed the types and location of health concerns. CDHS also met with members of the Willits Environmental Health Center.

After these initial meetings, CDHS spent several months conducting face-to-face interviews with community members, including small business owners, school district personnel, residents, and medical providers. CDHS also received calls on a regular basis from citizens expressing their concerns. Some community members involved in a lawsuit were instructed by their lawyers not to speak with CDHS staff. CDHS contacted the lawyer for these members to inquire about the best approach for CDHS to document the health concerns of his clients. The lawyer sent CDHS a list of clients/residents that should not be interviewed, resulting in the lack of documentation of health concerns of residents involved in the lawsuit. Some lawsuit participants did receive an informational flyer describing the public health assessment process.

At the suggestion of the community, CDHS held an all-day public availability session on November 8, 2000, at the Willits Library. CDHS staff documented the concerns of 15 community members at this session. In addition to these outreach efforts, Whitman Corporation community office staff referred several community members with health concerns to CDHS for interviews.

Willits community members access a variety of medical and other health service options available to them. These private and public providers are located in Willits and in other nearby communities. During the fall of 2000, CDHS spoke with a small group of some of these medical providers at one of their regular meetings in Willits. (Although their comments provided valuable insight, CDHS understands that they do not speak for all medical providers in Willits.) At that time, they were concerned that the actions of community members, such as distributing flyers at a local school that warned parents about the school's drinking water, might be creating hysteria. They were not certain that Remco was causing the health problems of their patients, especially considering that the facility was closed. However, it became clear during the meeting that some providers did not have much information about chromium contamination and adverse health effects. One medical provider said he knew of only one study that showed increase lung cancer in chromium workers, but it was not proved to be statistically significant. Another provider said he was hearing his colleagues say that chromium did not present a health risk and that it is very toxic in low concentrations if inhaled. He found this information contradictory. One felt it would be helpful to know more about the health status of workers and another said that if there is a health problem, the medical providers must keep the best interest of the people in mind.

On October 30, 2000, the federal judge overseeing the Consent Decree held a public forum to listen to community concerns. Over 200 people, including CDHS staff, attended the meeting and 38 people made formal public statements regarding their concerns. Health-related statements made at that meeting are also included in this public health assessment (i.e., they are incorporated into the summary of health concerns.

Community Involvement and the Development of the Site Team

In November 2000, CDHS convened a site team, which is a group of stakeholders interested in the work at the Remco site. The purposes of the site team/public meetings are to conduct health education in order to help the community understand all aspects of the public health assessment, provide information to the community, bring the community and other agencies involved at the site together and provide a forum for sharing health concerns. The site team is comprised of representatives from Mendocino County Health Department, the School District, California

Department of Health Services, City of Willits, community members with a variety of health concerns, a local physician, and other local and state agency representatives. Since November 2000, site team meetings were held regularly at the Willits City Hall. Site team meetings have been held on the following dates: November 30, 2000; January 18, 2001; May 24, 2001; September 24, 2001; January 10, 2002; July 25, 2002; September 21, 2002, and March 31, 2003. A draft of this health assessment was released for public comment and the findings were presented at a meeting of the site team and community on August 5, 2003. An additional site team/community meeting was held on November 20, 2003.

Two additional, more informal meetings occurred with members of the site team and other interested community residents. The purpose of these meetings was to provide additional information and education about the goal and limitations of the public health assessment. Future meetings will be scheduled after this public health assessment is released.

Community Concerns and Health Effects Evaluation

The community described a number of concerns and health effects that have occurred or are occurring. CDHS documented the health concerns of approximately 75 residents and stakeholders. The following section discusses these concerns in greater detail. Because this public health assessment focuses on chromium exposure via the inhalation pathway, CDHS discusses the specific health effects and concerns as they might relate to inhalation of hexavalent chromium. A discussion of the community concerns and information about cancer and noncancer health effects that have not been studied or proven to be associated with chromium is presented in Appendix F. The potential health effects related to chemicals other than hexavalent chromium, including VOCs, will be discussed in a future, comprehensive public health assessment of the Remco site. The following table presents the health effects and concerns expressed by community members:

Table 13. Health Concerns/Effects Expressed to CDHS

Noncancer health effects\concerns	Cancer health effects\concerns
Reproductive concerns: irregular and painful menstrual cycle tumors spontaneous abortion endometriosis polycystic ovary syndrome	Breast cancer Testicular cancer Lung cancer Leukemia
Nose bleeds	Cervical cancer
Asthma	Colon cancer
Allergies	Brain tumor/cancer
Developmental disabilities	
Kidney Disease	
Birth defects	
Headaches/migraines	
Diabetes	
Chronic fatigue	

Note: The following section provides very brief information about cancer in general, lung cancer, and other health effects that have been found to be associated with exposure to hexavalent chromium. In Appendix F, CDHS describes a number of other cancer types and noncancer health effects that have not been associated with exposure to hexavalent chromium. CDS has reviewed a number of health concerns but undoubtedly, all of the concerns that may exist cannot be covered. For each health effect described, CDHS discusses what is known or not known about the link between the disease and environmental causes, in particular, chromium exposure. This information should not be used as a diagnostic tool. If you believe you are suffering from any of the cancers or other health effects described herein, please notify your doctor.

Cancer Health Effects

There are many different types of cancers, and different cancers have different causes. It is rarely possible to know why a particular individual developed cancer, but studies have found certain risk factors to be associated with specific cancers. For example, in the body there are natural hormones that play a role in whether or not someone gets cancer (63)(64). Exposure to sunlight is a factor in causing skin cancer (65). Drinking alcohol can be the cause of some cancers (66). Some cancers are caused by viruses (67). For example, cervical cancer can be caused by a sexually transmitted virus (68).

Usually, there are several factors that work together to cause cancer (69). For example, there are several possible factors that might make a person more or less likely to get lung cancer: 1) smoking cigarettes; 2) having a genetic susceptibility to cancer; 3) exposure to another agent that can cause cancer, such as asbestos or hexavalent chromium; and 4) a poor diet (70).

Different groups of people will be more or less at risk for cancer, depending on various characteristics or behaviors they may have. For example, people of different ethnic and racial backgrounds get cancer following different patterns (71). Some of these differences may be due to biological genetic differences. Others may be due to lifestyle differences. An example of a difference due to lifestyle is how some cancers increase among immigrants from less developed countries when they move to more developed countries such as the United States and change their dietary patterns (72).

Men are more likely to get certain cancers, and women are more likely to get other cancers (73). Some of these differences are due to hormones, and some are due to differences in behaviors. For example, more men than women smoke, so men as a group, are more likely to get lung cancer (70).

Age is important because people at different ages are more or less likely to get certain cancers than people at other ages. In general, the older a person gets, the more likely he/she is to get cancer. Thus, more cancer cases will occur in populations that have a greater proportion of elderly persons.

According to current California incidences, 41.5% of women and 45.4% of men will be diagnosed with cancer in their lifetimes (74). The older someone gets, the more likely it is that he/she will eventually get cancer. Breast cancer is the most common cancer among women, and prostate cancer is the most common cancer among men (74). Lung cancer is the second most common cancer for both men and women (74). It is estimated that 85% of lung cancer is caused by cigarette smoking (not including being exposed to smoke from others) (74).

Several interviewees reported having received a diagnosis of a variety of cancers including lung and leukemia.

Lung Cancer

Cancers that begin in the lungs are divided into two major types, non-small cell lung cancer and small cell lung cancer, depending on how the cells look under a microscope. Each type of lung cancer grows and spreads in different ways and is treated differently. Common signs and symptoms of lung cancer include having a persistent cough that worsens over time, constant chest pain, coughing up blood, shortness of breath, wheezing, hoarseness, repeated problems with pneumonia or bronchitis, swelling of the neck and face, loss of appetite or weight loss, and fatigue.

Researchers have discovered several causes of lung cancer—mostly related to the use of tobacco. Some of the main causes are smoking cigarettes, cigars and pipes; environmental tobacco smoke (commonly known as secondhand smoke); exposure to radon; exposure to asbestos; exposure to pollutants (e.g., by-products of the combustion of diesel and other fossil fuels). Certain lung diseases, such as tuberculosis, increase a person’s chance of developing lung cancer, as does having a previous family history of lung cancer (75).

There is a tremendous amount of evidence from scientific studies that show chromium inhalation exposure can cause lung cancer. Over 30 scientific studies were located that noted excesses in lung or respiratory system cancers among people who work with chromium. Seven additional studies were located in which an excess of lung or respiratory cancer was not found, although some of these included workers who had shorter exposure periods, and some involved only exposure to trivalent chromium, not hexavalent chromium (76-79).

In many of the occupational studies that found elevated lung cancer to be associated with chromium exposure, other cancers were also evaluated, but lung cancer was the only cancer that was found to be elevated. The International Agency for Research on Cancer has evaluated chromium and concluded that "There is sufficient evidence in humans for the carcinogenicity of chromium[VI] compounds as encountered in the chromate production, chromate pigment production and chromium plating industries." (80). Within its evaluation of epidemiological studies at the time of publication (1989), it stated that "[f]or cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds." Similarly, in 1988, the World Health Organization did not find enough evidence to classify chromium as a causative agent of cancers other than lung (47).

However, although inconsistent, some studies have found elevations of cancers other than lung, nasal, and sinus cavity. ATSDR identifies oral cavity cancer and stomach cancer to be potentially related to chromium inhalation exposure (81).A high number of precancerous oral cavity lesions were found among a group of Czech chromium platers (81). Stomach cancer has been found to be significantly elevated in some studies of platers (44, 82) and other chromium-exposed workers (44, 82-85). An early study of chromate production workers at five plants in the U.S. found rates of cancer of the digestive tract to vary from 0 to 3.04/1000 compared to 0.59/1000 for controls (Machle & Gregorius 1948, reported in WHO document 1988). Also, several studies have found a significant association between chromium and bladder cancer, including a case-control study of bladder cancer and occupation that identified this relationship, which adds strength to the validity of this potential association (84, 86, 87). Two studies found liver cancer mortality to be significantly elevated among chromium exposed workers (82, 88). Additional data on other cancer sites would be helpful in understanding these questions." Occasionally, however, elevations of cancers other than lung were noted. These included cancer of the nasal cavity and sinuses, oral cavity, stomach, bladder, and liver.

Some residents and workers in Willits may be at increased risk of developing lung cancer based on the air estimates of past exposure to hexavalent chromium between 1963 and 1995.

Noncancerous Health Effects (All Other Effects Besides Cancer)

<u>Reproductive</u>

Community concerns related to fertility are discussed below. Other reproductive health effects that are not known to be associated with chromium exposure are discussed in Appendix F.

Fertility Issues

Infertility can occur in both men and women. Most infertile men have no symptoms. Some men with hormonal problems may note a change in their voice or pattern of hair growth, enlargement of breasts, or difficulty with sexual function. Infertility in women may be signaled by irregular menstrual periods or associated with conditions that cause pain during menstruation or intercourse (89).

Male Infertility

A number of causes exist for male infertility that ultimately may result in impaired sperm count or mobility, or an impaired ability to fertilize the egg. The most common causes of male infertility include problems with the delivery of sperm from the penis into the vagina. Also, more than 90% of male infertility cases are due to abnormal sperm production or function. Low sperm count and low-quality sperm can lead to male infertility. Other factors that can affect male fertility include general health and lifestyle, malnutrition, obesity, cancer and its treatment, alcohol and drugs, other medical conditions, and age. Overexposure to certain environmental elements such as heat, toxins, chemicals, and infections can reduce sperm count either by direct effects on testicular function or indirectly by altering the male hormonal system. However, the debate over environmental exposure and infertility remains controversial (89). In studies of welders exposed to chromium, an association has been shown on sperm quality and quantity and increased risk of spontaneous abortions among spouses of these welders (26, 47). Further studies have not found the basis for the increased risk as no sperm quality or quantity differences were found.

Female Infertility

The most common causes of female infertility include: tubal occlusion (or obstructed fallopian tube), a condition that is usually caused as a result of pelvic inflammatory disease (PID); endometriosis; hypothalamic-pituitary disorders (affecting the synthesis and/or secretion of hormones involved in reproductive cycle, e.g. the regulation of menstrual cycle, water balance, milk ejection, and uterine contraction); direct injury to the hypothalamus or pituitary gland; medical conditions that disturb their regulation (such as kidney failure, cirrhosis of the liver, or pituitary tumors); excessive exercise; and anorexia nervosa. Factors that may be associated with polycystic ovary syndrome are: early menopause (premature ovarian failure); low levels of certain growth factors produced by the ovaries; radiation therapy and anticancer agents; autoimmune disease; other rare causes such as mumps, tuberculosis, and sexually transmitted diseases; radiation or chemotherapy for the treatment of cancer; cigarette smoking; use of certain medications; thyroid problems; cancer and its treatment; and other medical conditions (89).

Many of the risk factors for both male and female infertility are the same. These include: age; emotional factors, including depression and stress; occupational and environmental risks (studies suggest that prolonged exposure to high mental stress, high temperatures, chemicals, radiation, or heavy electromagnetic or microwave emissions may reduce fertility in both men and women); unprotected sex; smoking; alcohol use; obesity; and being underweight (89).

An association between exposure to chromium and infertility in men has been shown in limited studies of welders who were exposed to hexavalent chromium and other metals; other studies have not shown this association. There are no data on reproductive health effects among chromium platers or their spouses. No studies thus far have shown an association between exposure to chromium and infertility in women. It is unclear at what levels these reproductive effects occur, making it difficult to draw conclusion as to possibility of reproductive effects on male residents and workers in Willits.

Nosebleeds

Many community members, including former Baechtel Grove Elementary School students, residents who lived near the facility, and former workers complained of severe respiratory problems such as nosebleeds, allergies, and asthma during the time Remco was in operation.

Nosebleeds are very common. Most nosebleeds are mere nuisances, but a few can be a sign of a more serious problem. Nosebleeds can be caused by allergies, infections, or dryness that cause itching and lead to picking of the nose and vigorous nose blowing. More serious causes include clotting disorders that run in families or are due to medications, injuries to the nose or head, and sometimes tumors, especially in older patients or smokers (90). The majority of nosebleeds are unrelated to chromium or other occupational exposure.

Nosebleeds have been known to occur in workers exposed through inhalation of hexavalent chromium (28, 29). It is possible that residents and workers experienced nosebleeds from exposure to hexavalent chromium between 1963 and 1995.

Allergies

An allergy refers to an abnormal reaction to certain allergens. A person can get allergies from coming into contact with allergens. These allergens may be inhaled, swallowed, or contacted by the skin to trigger a reaction from the body's immune system. The causes of allergies are not fully understood. Some of the more common allergens are pollens, molds, house dust mites, animal dander and saliva, chemicals used in industry, and some foods and medicines. Symptoms of allergies include a congested or runny nose with sneezing, itchy, watery eyes, coughing, and wheezing. Venom from insect stings may cause a more severe reaction called anaphylaxis, which includes a sense of warmth, flushing, itching, hives, swelling in the throat, wheezing, light-headedness, irregular heart rhythm, nausea or vomiting, abdominal cramping, or shock. This condition is considered a medical emergency (91).

Studies have shown that workers exposed to hexavalent chromium through inhalation have experienced allergy-like symptoms, sometimes resulting in asthma (32, 35, 40). Hexavalent chromium has not been shown to be associated with anaphylaxis. It is possible that residents and workers experienced allergies from exposure to hexavalent chromium between 1963 and 1995.

Asthma

Asthma is a lung disease that causes breathing problems. It can be life threatening. The airways in the lungs become blocked, causing the lungs to get less air than normal. Symptoms of an "asthma attack" can be difficulty with breathing, a tight feeling in the chest, and coughing and wheezing. In the United States, about 15 million people have asthma. Asthma can occur at any age, but is more common in children than adults. Asthma attacks can be caused by something that bothers the lungs. These are called asthma triggers. There are many kinds of asthma triggers. Two major categories of asthma triggers are allergens and irritants. Allergens are substances that cause no problem for a majority of people but which trigger an allergic reaction in some people, which in turn causes asthma episodes. Irritants such as cold air, cigarette smoke, industrial chemicals, perfume, paint, and gasoline fumes can trigger asthma (36).

Chromium-induced asthma has been documented in several reports and may occur in some sensitized individuals exposed to elevated concentrations of chromium in air (32, 35, 40).

However, the number of sensitized individuals is low and the number of potentially confounding variables in the chromium industry is high. Depending on the location in the community, it is possible that estimated exposures to hexavalent chromium in Willits could have caused asthma in residents and workers, particularly between 1963 and 1975, when estimated exposures were the highest.

Kidney Disease / Kidney Failure

The kidneys are two bean-shaped organs located at the back of the upper abdomen on either side of the spine. Their main function is to eliminate excess fluid and waste material from the blood. When the kidneys lose this ability, fluid imbalance and waste accumulation can occur. This condition is called "renal failure".

The signs and symptoms of kidney failure vary, depending on whether the failure is acute or chronic. Acute kidney failure occurs when the kidneys stop filtering fairly abruptly. The signs and symptoms may include: fluid retention; bleeding, often in the stomach or intestines; confusion; seizure; and coma. Factors that can cause the kidneys to suddenly shut down include: complicated surgery, severe burns, or trauma; renal ischemia (low oxygen state); drugs that are toxic to the kidneys; exposure to toxic substances, such as heavy metals, solvents, and excessive amounts of alcohol; heat stroke; and multiple organ failure.

According to the National Kidney Foundation, almost 20 million adult Americans have chronic kidney disease; another 20 million adults are at risk of developing it. Unlike acute kidney failure, chronic kidney failure slowly destroys the nephrons (the functional units of the kidneys) in the kidneys over a period of years. Over time, chronic kidney failure can lead to congestive heart failure, weak bones, stomach ulcers, and damage to the brain and spinal cord. Unfortunately, signs and symptoms often don't appear until irreversible damage has occurred. They include: abnormal urine tests; high blood pressure; unexplained weight loss; anemia; nausea or vomiting; malaise or fatigue; headaches that seem unrelated to any other cause; decreased urine output; decreased mental sharpness; muscle twitches and cramps; bleeding in the intestinal tract; yellowish-brown cast to the skin; unusual itching; and sleep disorders. Diabetes is the single greatest risk factor for chronic renal failure in the U.S. Other medical conditions that increase the risk of kidney failure include high blood pressure, sickle cell disease, lupus erythematosis, atherosclerosis, chronic glomerulonephritis, congenital nephrotic syndrome, and polycystic kidney disease. In addition, drug overdose, excessive use of alcohol, long-term use of pain medications such as aspirin, acetaminophen (Tylenol, others) and ibuprofen (Advil, Motrin, others), and treatment with the antibiotics streptomycin or gentamicin can make you more vulnerable to kidney failure. An association between chromium exposure and proximal tubule damage in kidneys has been shown in occupational studies.

Studies of workers exposed to hexavalent chromium have been shown to affect the proximal tubules in the kidney. These effects were detectable with tests even though the worker did not report any symptoms. These effects may be reversible after exposure ceases, though this is not well studied. It is not clear if more serious damage can occur. There are no data showing kidney failure (the most serious renal endpoint, and one that is not reversible) can result from exposure to chromic acid mist generated during chrome plating. Depending on the location in the community, it is possible for residents and workers to have experienced effects to the proximal tubules of the kidney from exposure to hexavalent chromium in the air between 1963 and 1975.

Headaches and Migraines

A headache is defined as pain in the head from any cause. Tension headache and migraine headaches account for 90% of all headaches. The different types of headaches are usually caused by muscle contraction (tension headaches), vascular problems (migraine headache or cluster headache) or a combination of these two causes. Tension headaches are a common headache pattern that may or may not be associated with psychosocial stressors. They are characterized by: pain usually felt in the back of the head and neck, and usually not one-sided; pain that lasts for weeks or months with only brief periods of relief, although it may fluctuate in severity; attacks that begin at any time of the day; and pain that is often described as a "tight band," pressing, but rarely throbbing, and never accompanied by fever. Migraine headaches, which are often preceded by fatigue, depression, and visual disturbance (light flash, loss of peripheral vision, etc.), are characterized by: pain that is characteristically only on one side at a time, but may involve the entire head; pain that is throbbing in nature and usually develops in the morning and gradually becomes worse after an hour or so; and attacks that may occur every few days or weeks, or not for months. Migraines often continue for hours, but rarely last longer than a day or two; pain that may be aggravated by stress, alcohol, or certain foods (such as chocolate), and are frequently accompanied by nausea and vomiting and relieved by sleep. Having a family history of migraine headaches are a factor of migraine occurrence (90).

In one study, headaches (but not specifically migraines) were shown to have occurred in workers who were exposed to "excessively high concentrations of chromium trioxide", because of poor ventilation at the plant (36). *Based on the limited information, it is not likely that Willits residents experienced headaches from exposure to hexavalent chromium in the air between 1963 and 1995.*

General Community Concerns

Several general community concerns were provided in addition to the health specific concerns. Those concerns are listed below with a response.

Air

Residents who live/lived near Remco reported there were times when they could see a yellow mist in the air, which made it hard to breathe. One resident reported that this mist damaged the paint on their car. According to the resident, Remco repainted their car.

Stress

Stress is defined as the state of physical or psychological strain or tension. Several community members reported that they felt a great deal of stress regarding the Remco site. They were concerned about the impact of the contamination on their health. They were also worried that "unknown" problems at Remco might affect their health. Also, community residents reported a high level of distrust and concern that decisions relating to clean-up of the Remco site will not be protective of health for the future.

In September 1995, ATSDR, Emory University, and the Connecticut Department of Health co-sponsored an expert panel workshop on the psychological responses to hazardous substances (92). The purpose of this workshop was to thoroughly explore and examine all that is known about how communities and individuals respond socially and psychologically to hazardous substances and the possible effects of those responses on their health. The workshop pointed out that the first scientific studies on the health effects of stress were related to the Three Mile Island accident (92). Baum and colleagues found levels of psycho-physiological effects from stress such as psychological distress, sub-clinical anxiety disorders, and depression were elevated compared to controls. This comparison also revealed increased blood pressure and higher than normal levels of urinary cortisol and norephrine metabolites. These findings were similar to those found by Baum and colleagues in chronic stress response in a community located near a leaking hazardous waste site (92).

Given the possible health impacts from stress that may already be occurring in the Willits community, CDHS anticipates that hearing the findings in this public health assessment will create additional stress for Willits residents. Therefore, stress support and counseling services should be available to the community, as needed.

In August 2003, CDHS coordinated a training between ATSDR and Mendocino County Mental Health staff on community/individual psychological responses to exposure issues from hazardous substances. The purpose of the training was to better equip local mental health workers in addressing stress related issues resulting from an awareness of potential exposure concerns from Remco.

Residents Wanted To Know More About the Characteristics, Attributes, and Consequences of Chromium.

Chromium is a naturally occurring element that is found in soil and volcanic dust and gases. It occurs in the environment in three major states: metallic chromium, trivalent chromium and hexavalent chromium. Trivalent chromium occurs naturally in the environment, where as hexavalent chromium and metallic chromium are generally produced by industrial processes. (36).

Increased risk of lung cancer from inhalation of hexavalent chromium is the primary health concern. Other cancers (nasal, stomach) have also been suggested, but are not as well studied. Noncancer health effects associated with inhalation of hexavalent chromium include nasal septum perforation, nasal ulcerations, bronchitis, asthma exacerbation, hematological and gastrointestinal effects, and kidney and reproductive effects. (Refer to earlier section on noncancer and Appendix E for detailed discussion.)

Effects of Chromium Mixed with VOCs

VOCs are carbon-containing compounds that evaporate easily and quickly from water to air. In general, people may be exposed to VOCs in air through skin contact and potentially in drinking water. VOCs are contaminants of concern in Willits groundwater. They will be evaluated in a future, more comprehensive PHA regarding Remco. CDHS recognizes there were releases of VOCs to the air as a result of Remco operations; unfortunately, there is insufficient data to quantify those VOC releases. VOCs volatilize and disperse rapidly in the atmosphere.

Some community members were concerned about the synergistic interaction from exposure to chromium and Remco related VOCs. Exposure to chemical mixtures is not well studied. Synergism occurs when the combined toxic effects of two or more chemicals are greater than each chemical alone. This issue has not been studied and it is uncertain if there is a synergistic effect between the mixture of VOCs at Remco and chromium. Antagonistic effects occur when two chemicals interfere with each other's actions, leading to a less toxic compound. It is not known if there is an antagonistic effect from exposure to chromium and Remco related VOCs.

There has been very limited toxicological study of the effects of chromium in combination with other chemicals. Most of the knowledge on health effects from hexavalent chromium exposure comes from studies of workers. These studies are typically based on workers in a particular facility. Although such workers often have more than one chemical exposure, the studies generally address the main exposure thought to be responsible for any health effects found, although the authors may note the possibility for another workplace contaminant to be contributing to any effect seen.

In animal studies on the other hand, the researcher can control the animal's environment and better isolate the exposure. In one study, for example, the effects of trivalent chromium and hexavalent chromium (sodium chromate VI) on liver toxicity from exposure to carbon tetrachloride (not a Remco related VOC) were studied by pretreating cultures of mouse hepatocytes (36). Results showed pretreatment of hexavalent chromium significantly reduced cell toxicity and lipid peroxidation caused by carbon tetrachloride exposure. Pretreatment with trivalent chromium did not have any effect on cell toxicity (36).

Household Dust in Willits

Some residents were concerned that household dust may be a source of hexavalent chromium contamination. An important way contaminants get into household dust are from contaminated soil that is tracked-in to the home, or from surface soil that becomes resuspended in the air (93). Hexavalent chromium has been shown to convert to non-toxic trivalent chromium after interacting with organic material in soil. Hexavalent chromium has not been detected in off-site surface soil or near surface soil in Willits (82, 94, 95). Therefore, hexavalent chromium would not be expected to have built up in one's home in Willits.

The other potential way for hexavalent chromium to have contaminated household dust is from releases of hexavalent chromium that blew directly into the home. CDHS considered this scenario and the likelihood for hexavalent chromium to still be present, since the facility has been closed for 8 years. As stated earlier, hexavalent chromium has been shown to convert in the presence of organic matter. Household dust is composed of varying degrees of both inorganic and organic matter (96). Thus, hexavalent chromium would not be expected to be found now in household dust due to its conversion potential and housecleaning activities over the past 8 years.

CDHS reviewed the scientific literature about dust sampling for hexavalent chromium and concluded that difficulties in sampling techniques, high laboratory detection limits, and limitations in the ability to interpret the results, seriously compromise the usefulness of dust sampling for hexavalent chromium. If residents are concerned about contaminated dust, the most prudent step is to remove the dust. This can be achieved by recommended housecleaning activities such as wet mopping, avoiding dry sweeping, and using a vacuum cleaner with a HEPA (high efficiency particulate air filter) filter.

Bio-monitoring for Hexavalent Chromium and/or Medical Testing

Residents wanted to know whether bio-monitoring would be useful for determining potential health problems. Bio-monitoring is the measurement of chemicals in biological materials (blood, urine, breath, etc.) to determine if chemical exposure in humans, animals, or plants has occurred. There are several tests for assessing exposure. There are tests to measure chromium in hair, blood, and urine. These tests cannot determine the exact level of chromium to which a person has been exposed or predict how the chromium level in body tissues will affect a person's health. The tests are useful only if the exposure has been as recent as a few months (79).

CDHS supports the Consent Decree's provision for medical monitoring. In this public health assessment, CDHS recommends a process be implemented for medical screening, physician education, and community education about hexavalent chromium exposure. Specifically, CDHS is developing a process outlining a variety of medial tests that could be provided to the community. This process will be made available for community and stakeholder review. CDHS will work with the community to implement these recommendations and provide the appropriate technical assistance.

Children's Health Considerations

CDHS and ATSDR recognize that, in communities with contaminated water, soil, air, or food—or all of these combined (depending on the substance and the exposure situation), infants and children can be more sensitive than adults to chemical exposures. This sensitivity results from several factors: (1) children might have higher exposures to environmental toxins than adults because, pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; (2) children play outdoors close to the ground, which increases their exposure to toxins in dust, soil, surface water, and ambient air; (3) children have a tendency to put their hands in their mouths, thus potentially ingesting contaminated soil particles at higher rates than adults; some children even exhibit an abnormal behavior trait known as "pica," which causes them to ingest non-food items, such as soil; (4) children are shorter than adults, which means they can breathe dust, soil, and vapors close to the ground; (5) children's bodies are rapidly growing and developing, thus they can sustain permanent damage if toxic exposures occur during critical growth stages; and (6) children and teenagers more readily than adults can disregard no trespassing signs and wander onto restricted property.

CDHS evaluated the noncancer and increased cancer risk to children from past exposure to emissions from the Remco facility. It is important to recognize that the toxicological information used in the evaluation is primarily derived from adult worker studies and, in most cases it is not clear what other potential risks exposure may pose to children. In evaluating potential health impacts to children, an additional uncertainty factor was applied for interpretation of noncancer known impacts of chromium exposure.

Conclusions

CDHS evaluated air modeling data generated for three different time periods of Remco operations; these time periods were based on the efficiency of the air pollution control devices used at the facility. CDHS evaluated these time periods both separately and combined. It is important to keep in mind that the health effects evaluation contains areas of uncertainty, as past exposures are based solely on data produced by air modeling, not actual measurements; and noncancer health comparison values and theoretical cancer risk estimates are calculated using data extrapolated from worker populations.

- **1963 − 1975**: estimated exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some increased risk of cancer for residents and workers over a large area of Willits.
- **1976 − 1989**: estimated exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some increased risk of cancer for residents and workers over a limited area of Willits.
- **1990 – 1995**: estimated exposure to airborne hexavalent chromium would not be expected to result in noncancer health effects in children or adults in Willits.
- **1963 − 1995**: estimated cummulative exposure to airborne hexavalent chromium could have resulted in noncancer health effects and some theoretical increased risk of cancer for residents and workers over a large area of Willits.

CDHS reviewed the numbers of lung and other cancers that actually occurred in the Willits area between 1988 and 2000. The review showed that the number of cases of cancer in Willits during those years was not higher than expected for that population. The number of lung cancer cases was somewhat higher, although not statistically greater, than expected. However, the cancer review is not an effective tool for studying and characterizing how exposure to hexavalent chromium may have increased the risk of cancer in the Willits community. Thus, CDHS concludes that community members, especially those exposed prior to the time when emissions controls were implemented, experienced some increase in their risk of cancer.

CDHS and ATSDR conclude that releases of airborne hexavalent chromium posed a public health hazard in the past (1963 – 1995). There is an indeterminate health hazard both currently and in the future from exposure to hexavalent chromium and lead in dust that may be generated during site/building remediation or demolition activities.

Recommendations

1. CDHS/ATSDR recommend that the feasibility of medical monitoring/clinical evaluation be considered for Willits residents and people who worked in Willits, who may have been exposed to air releases of hexavalent chromium from Remco between 1963 and 1995. CDHS is currently consulting with in-house experts (physicians) to determine the types of medical tests that would be beneficial for the community. If medical monitoring is undertaken, CDHS recommends that an expert work group with community representation be established to develop a protocol for medical monitoring/clinical services, including criteria for participation and an overall implementation plan.

2. CDHS/ATSDR recommend counseling and stress support services be considered for impacted residents and workers, as needed. These activities could fall under the medical monitoring provision of the Consent Decree.

3. CDHS/ATSDR recommend that the Willits Trust implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health.

Public Health Action Plan (PHAP)

The PHAP for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS or others at and near the site. The purpose of the PHAP is to ensure that this public health assessment 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. The first section of the PHAP contains a description of actions completed. The second section is a list of additional public health actions that are planned for the future.

Actions Completed

1. CDHS/ATSDR formed and convened a site team to guide the public health assessment process, communicate with the larger public, and bring the stakeholders together for increased information sharing with the public.

2. CDHS/ATSDR gathered community concerns through community interviews and by conducting public availability session for the community.

3. CDHS/ATSDR have provided health education to the community by convening several community meetings. Topics included an overview of the public health assessment process and air modeling, an introduction to toxicology and chromium health effects, the health effects of VOCs, and information about groundwater hydrogeology and the movement of Remco-related contaminates and biological monitoring.

4. CDHS/ATSDR developed and distributed a fact sheet that summarized the findings of this public health assessment.

5. CDHS/ATSDR conducted a needs assessment with local health care providers to determine future training needs relative to hexavalent chromium exposure and resulting health effects.

6. At the request of CDHS, the RWQCB conducted additional off-site surface soil sampling for hexavalent chromium in areas that were subject to the highest estimated air levels of hexavalent chromium. The sampling was conducted to further address potential soil impacts from aerial deposition.

7. CDHS reviewed additional off-site surface soil sampling conducted by the RWQCB in June 2003. (July 2003)

8. CDHS reviewed the work plan for removal of VOC contaminated soils and recommended the Willits Trust implement additional air monitoring. (September 2003)

9. CDHS provided environmental health education/training to local health care providers about chromium exposure and related health effects. (August 2003, March 2004, and April 2004)

On-going Actions

1. CDHS/ATSDR will continue to provide health outreach and education to the community and recommend that health education activities be tailored to meet the community's

needs. CDHS will initiate discussion with the community to allow for input in the development of that education approach.

2. CDHS/ATSDR will continue to consult with inhouse experts (physicians, epidemiologists, etc) to determine what study options, if any, are suitable for the site. If a scientifically grounded, feasible health study can be conducted at the site, CDHS/ATSDR recommend, and will solicit, community input in the development of any health study activities at the site. These activities could fall under the medical monitoring provision of the Consent Decree. It is unclear whether the Consent Decree will need to be amended for the medical monitoring provision to move forward.

Actions Planned

1. CDHS/ATSDR will conduct a comprehensive public health assessment for the site.

References

1. Montgomery Watson Harza. Final remedial investigation report. Prepared for Willits Remediation Trust. Santa Rosa (CA): Regional Water Quality Control Board, North Coast Region. 2002 Apr.
2. Briggs and Morgan. Letter to Janice M. Goebel, California Regional Water Quality Control Board, North Coast Region from Thomas A. Larson concerning former Remco Hydraulics Facility. Minneapolis, Minnesota. May 12, 2004.
3. California Regional Water Quality Control Board, North Coast Region. Cleanup and abatement order No. 93-104 for Whitman Corporation, Abex Corporation, M-C Industries, Inc., Remco Hydraulics, Inc. 934 South Main Street, Willits. Santa Rosa, California.
4. Office of Environmental Health Hazard Assessment. Technical support document for exposure assessment and stochastic analysis. Oakland: California Environmental Protection Agency. 2000 Sep.
5. Deposition of Jimmy Wisdom. Santa Rosa (CA): Regional Water Quality Control Board. 1996 Jul.
6. Deposition of John Almida. Sant Rosa (CA): Regional Water Quality Control Board. 1997 Mar.
7. Deposition of Ron Wake. Santa Rosa (CA): Regional Water Quality Control Board. 1996 Dec.
8. Glaser U, Hochrainer D, Kloppel H. Low level chromium(VI) inhalation effects on alveolar macrophages and immune functions in Wistar rats. Arch Toxicol 1985;57:250-56.
9. Abex/Remco. Data summary concerning chrome tank cost breakdown. Willits, California. 1986 May 5.
10. Abex/Remco. Data summary concerning chrome tank installation time line. Willits, California.
11. Remco Hydraulics, Inc. Letter to Johh Hannum from F.A. Morrell concerning waste sources at Remco. Willits, California. January 20, 1971.
12. Appraisal of Remco Hydraulics Inc., equipment. Oakland (CA): California Department of Health Services. 1966.
13. Galson Technical Services, Inc. Source testing of plating tanks scrubber exhaust stack at Remco Hydraulics, Inc. Prepared for Remco Hydraulics, Inc. Ukiah (CA): Mendocino County Air Quality Management District. 1989 May.
14. Avanced Systems Technology, Inc. Hexavalent chromium emissions evaluation: Remco Hydraulics. Prepared for United States Environmental Protection Agency, Emission Management Division. Ukiah (CA): Mendocino County Air Quality Management District. 1992 May.
15. Deposition of John Figg-Hoblyn. Santa Rosa (CA): Regional Water Quality Control Board. 1997 Apr.
16. Office of Air Quality Planning Standards Emission Factor and Inventory Group. Emission factor documentation for AP-42 section 12.20, electroplating final report. Washington, D.C.: United States Environmental Protection Agency. 1996 Jul.
17. Abex Corporation Environmental Control. Memorandum to R.G. Strait from C.H. Borcherding concerning chrome tank ventilation. Chicago, Illinois. April 28, 1986.
18. Abex Corporation. Letter to E.W. Drape from John Bassano, Jr. concerning Abex environmental inventory. Chicago, Illinois. April 24, 1986.

19. Deposition of C. Dean Wolbach. Santa Rosa (CA): Regional Water Quality Control Board. 2003 Sep.
20. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: U.S. Department of Health and Human Services: 1997.
21. Lockheed Martin, Inc. Atmospheric dispersion modeling-Remco Hydraulics, Inc. Site, Willits. Atlanta (GA): Agency for Toxic Substances and Disease Registry. 2002 Sep. Report No.: U.S. EPA Contract No.: 68-C99-223.
22. Stern A, Babble, R, Turner, B, Fox D. Fundamentals of Air Pollution. Florida: Academic Press, Inc;1984.
23. Agency for Toxic Substances and Disease Registry. Contour map concerning two tanks 80% controlled: Remco Hydraulics, Inc. Site Willits California. 2004 Apr.
24. Caliper. Maptitude V4.6 [computer program]. Newton (MA). March 5, 2003.
25. Braver ER, Infante P, Chu K. An analysis of lung cancer risk from exposure to hexavalent chromium. Teratog Carcinog Mutagen 1985;5:365-78.
26. Bonde JPE, Olsen JH, Hansen KS. Adverse pregnancy outcome and childhood malignancy with reference to paternal welding exposure. Scand J Work Environ Health 1992;18:169-77.
27. Pastides H, Austin R, Lemeshow S. Occupational Epidemiology Unit, University of Massachusetts School of Public Health. An epidemiologic study of Occidental Chemical Corporation's Castle Hayne chromate production facility. Boston (MA). 1991.
28. Lucas JB, Kramkowski RS. U.S. Department of Health, Education, and Welfare, Center for Disease Control, National Institute for Occupational Safety and Health. Health hazard evaluation determination. Cincinnati (OH). 1975. Report No.: 74-87-221.
29. Cohen SR, David DM, Kramkowski RS. Clinical manifestations of chromic acid toxicity: nasal lesions in electroplate workers. Cutis 1974;13:558-68.
30. Lindberg E, Vesterberg O. Urinary excretion of proteins in chromeplaters, exchromeplaters, and referents. Scand J Work Environ Health 1983;9:505-10.
31. Lindberg E, Hedenstierna G. Chrome plating: symptoms, findings in the upper airways, and effects on lung function. Arch Environ Health 1983;38:367-74.
32. Bright P, Burge PS, O'Hickey SP. Occupational asthma due to chrome and nickel electroplating. Thorax 1997;52:28-32.
33. Park HS, Yu HJ, Jung K-S. Occupational asthma caused by chromium. Clinical and Experimental Allergy 1994;24:676-81.
34. Olaguibel JM, Basomba A. Occupational asthma induced by chromium salts. Allergol Immunopathol (Madr) 1989;17(3):133-36.
35. Langard S. A survey of respiratory symptoms and lung function in ferrochromium and ferrosilicon workers. Int Arch Occup Environ Health 1980;46:1-9.
36. Agency for Toxic Substances and Disease Registry. Toxicological profile for chromium. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
37. Office of Environmental Health Hazard Assessment. Determination of noncancer reference exposure levels batch 2A: chronic toxicity summary hexavalent chromium. Oakland: California Environmental Protection Agency. 2000 Dec.
38. Office of Environmental Health Hazard Assessment. Technical support document for the determination of noncancer chronic reference exposure levels. Oakland: California Environmental Protection Agency. 2000 Apr.
39. Kleinfeld M, Rosso A. Ulcerations of the nasal septum due to inhalation of chromic acid mist. Ind Med Surg 1965;24:242-43.

40. Kuo H-W, Lai J-S, Lin T-I. Nasal septum lesions and lung function in workers exposed to chromic acid in electroplating factories. Int Arch Occup Environ Health 1997;70:272-76.
41. Bovet P, Lob M, Grandjean M. Spirometric alterations in workers in the chromium electroplating industry. Int Arch Occup Environ Health 1977;40:25-32.
42. Erkinjuntti-Pekkanen R, Slater T, Fishwick D, Bradshaw L. Two year follow up of pulmonary function values among welders in New Zealand. Occupational and Environmental Medicine 1999;56:328-33.
43. Mutti A, Lucertini S, Valcavi P. Urinary excretion of brush-border antigen revealed by monoclonal antibody: Early indicator of toxic nephropathy. Lancet 1985;ii:914-17.
44. Franchini I, Mutti A. Selected toxicological aspects of chromium(VI) compounds. Sci Total Environ 1988;71:379-87.
45. Wang X, Qin Q, Xu X. Chromium-induced early changes in renal function among ferrochromium-producing workers. Toxicology 1994;90:93-101.
46. Liu C-S, Kuo H-W, Lai J-S. Urinary N-acetyl-B-glucosaminidase as an indicator of renal dysfunction in electroplating workers. Int Arch Occup Environ Health 1998;71:348-52.
47. Mortensen JT. Risk for reduced sperm quality among metal workers, with special reference to welders. Scand J Work Environ Health 1988;14:27-30.
48. Pascale LR, Waldstein SS, Engbring G. Chromium intoxication with special reference to hepatic injury. J Am Med Assoc 1952;149:1385-89.
49. Gomes E. Incidence of chromium-induced lesions among electroplating workers in Brazil. Ind Med 1972;41(12):21-25.
50. PHS. U.S. Public Health Service. Health of workers in chromate-producing industry: a study. Washington (DC). Report No.: 192.
51. Cancer in California, 2000: a decade of cancer surveillance. Sacramento: California Cancer Registry. 2000 Jun.
52. Mancuso TF. Consideration of chromium as an industrial carcinogen. International Conference of Heavy Metals in the Environment; 1975 Oct 27-31; Toronto, Ontario, Canada: p. 343-56.
53. U.S. Environmental Protection Agency. Toxicological review of hexavalent chromium in support of summary information on the Integrated Risk Information System (IRIS). Washington, D.C.: 1998 Aug.
54. Office of Environmental Health Hazard Assessment. Technical support document for describing available cancer potency factors. Oakland: California Environmental Protection Agency. 2002 Dec.
55. Bourne HG, Yee HT. Occupational cancer in a chromate plant: an environmental appraisal. Ind Med Surg 1950;19:563-7.
56. U.S. Environmental Protection Agency. Guidelines for carcinogen risk assessment. Washington: 1986 Sep. Publication No.: 630/R-00/004.
57. Office of Research and Development. Exposure factors handbook. Washington D.C.: U.S. Environmental Protection Agency. 1997 Aug.
58. Halmes N, Roberts S, Tolson J, Portier C. Reevaluating cancer risk estimates for short-term exposure scenarios. Toxicological Sciences 2000 (58):32-42.
59. Hayes RB, Sheffet A, Spirtas R. Cancer mortality among a cohort of chromium pigment workers. Am J Ind Med 1989;16:127-33.
60. Langard S, Norseth T. A cohort study of bronchial carcinomas in workers producing chromate pigments. Br J Ind Med 1975;32:62-65.

61. Langard S, Andersen A, Glyseth B. Incidence of cancer among ferrochromium and ferrosilicon workers. Br J Ind Med 1980;37:114-20.
62. Deposition of Ron Budish. Santa Rosa (CA): Regional Water Quality Control Board. 1997 May.
63. Bernstein L, Henderson BE. Exogenous hormones. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 462-88.
64. Henderson BE, Pike MC, Bernstein L, Ross RK. Breast cancer. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 1022-39.
65. Armstrong BK, English DR. Cutaneous malignant melanoma. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 1313-30.
66. Jensen OM, Paine SL, McMichael AJ, Ewertz M. Alcohol. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 290-318.
67. Mueller NE, Evans AS, London WT. Viruses. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 502-31.
68. Schiffman MH, Brinton LA, Devesa SS, Fraumeni JF. Cervical cancer. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 1090-116.
69. Rothman KJ, Poole C. Causation and causal inference. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 3-10.
70. Blot WJ, Fraumeni JF. Cancers of the lung and pleura. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 637-65.
71. Horm JW, Devesa SS, Burhansstipanov L. Cancer incidence, mortality, and survival among racial and ethnic minority groups in the United States. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 192-235.
72. Thomas DB, Karagas MR. Migrant studies. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 236-54.
73. Gloeckler LA, Hankey BF, Harras A, Devesa SS. Cancer incidence, mortality, and patient survival in the United States. In: Schottenfeld D, Fraumeni JF Jr., Schottenfeld D, Fraumeni JF Jr.s. Cancer epidemiology and prevention. 2nd ed. Oxford: Oxford University Press; 1996. p. 168-91.
74. Perkins CI, Cohen R, Morris CR, Allen M, Kwong SL, Schlag R, Wright WE. Cancer in California: 1988-1995. Sacramento (CA): California Department of Health Services, Cancer Surveillance Section.
75. What you need to know about lung cancer. Information about detection, symptoms, diagnosis, and treatment of lung cancer. National Cancer Institute, producers. NIH Publication No. 99-1553; Available online: http://www.cancer.gov/cancerinformation/cancertype/leukemia/. Accessed: 2002 Dec 03.
76. Frentzel-Beyme R. Lung cancer mortality of workers employed in chromate pigment factories. J Cancer Res Clin Oncol 1983;105:183-88.

77. Dalager NA, Mason TJ, Fraumeni FJ. Cancer mortality among workers exposed to zinc chromate paints. J Occup Med 1980;22:25-29.
78. Pippard EC, Acheson ED, Winter PD. Mortality of tanners. Br J Ind Med 1985;42:285-87.
79. Korallus U, Ehrlicher H, Wustefeld E. Trivalent chromium compounds. Results of an industrial medecine study. Part 3: clinical studies. Arb Soz Prev 1974;9:248-52.
80. Hjollund NHI, Bonde JPE, Jensen TK. A follow-up study of male exposure to welding and time to pregnancy. Reprod Toxicol 1998;12(1):29-37.
81. Brenner H, Arndt V, Bode G, Stegmaier C, Ziegler H, Stumer T. Risk of gastric cancer among smokers infected with helicobacter pylori. Int J Cancer 2002;98:446-49.
82. Sorahan T, Burges DCL, Waterhouse JAH. A mortality study of nickel/chromium platers. Br J Ind Med 1987;44:250-58.
83. Sheffet A, Thind I, Miller AM. Cancer mortality in a pigment plant utilizing lead and zinc chromates. Arch Environ Health 1982;37(1):44-52.
84. Rosenman KD, Stanbury M. Risk of lung cancer among former chromium smelter workers. Am J Ind Med 1996;29:491-500.
85. Kusiak RA, Ritchie AC, Muller J. Mortality from stomach cancer in Ontario miners. Br J Ind Med 1993;50:117-26.
86. Becker N, Chang-Claude J, Frentzel-Beyme R. Risk of cancer for arc welders in the Federal Republic of Germany: results of a second follow-up (1983-8). British Journal of Industrial Medecine 1991 (48):675-83.
87. Kunze E, Chang-Claude J, Frentzel-Beyme R. Life style and occupational risk factors for bladder cancer in Germany - A case control study. Cancer 1992;69(7):1776-90.
88. Blair A. Mortality among workers in the metal polishing and plating industry, 1951-1969. Journal of Occupational Medicine 1980;22(3):158-62.
89. The Merck manual of diagnosis and therapy, section 2. endocrine and metabolic disorders, chapter 6. hypothalamic-pituitary relationships. Merck & Co., Inc., producers. Available online: http://www.merck.com/pubs/mmanual/section2/chapter6/6a.htm. Accessed: 2002 Nov 22.
90. March of Dimes; Available online: http://www.marchofdimes.com/professionals/681_1206.asp. Accessed: 2002 Nov 21.
91. Costa M. Toxicity and carcinogenicity of Cr(VI) in animal models and humans. Critical Review of Toxicology 1997;27(5):431-42.
92. Agency for Toxic Substances and Disease Registry. Report of the Expert Panel workshop on the psychological responses to hazardous substances. Atlanta: U.S. Department of Health and Human Services: 1995.
93. Paustenbach DJ, Finley BL, Long TF. The critical role of house dust in understanding the hazards posed by contaminated soils. International Journal of Toxicology 1997;16:339-62.
94. Office of Air Quality Planning Standards Emission Factor and Inventory Group. Compilation of air pollutant factors AP-42. Volume I: stationary point and area sources. Washington D.C.: U.S. Environmental Protection Agency. 1996 Jul.
95. Mancuso TF. Chromium as an industrial carcinogen: part II. Am J Ind Med 1997;312:129-39.
96. Butte W, Heinzow B. Pollutants in house dust as indicators of indoor contamination. Rev Environ Contam Toxicol 2002;175:1-46.
97. Weber H. Long-term study of the distribution of soluble chromate-51 in the rat after a single intratracheal administration. J Toxicol Environ Health 1983;11:749-64.

98. Teraoka H. Distribution of 24 elements in the internal organs of normal males and the metallic workers in Japan. Arch Environ Health 1981;36(4):155-64.
99. Hyodo K, Suzuki S, Furuya N. An analysis of chromium, copper, and zinc in organs of a chromate worker. Int Arch Occup Environ Health 1980;46:141-50.
100. Taylor FH. The Relationship of mortality and duration of employment as reflected by a cohort of chromate workers. Am J Public Health 1966;56(2):218-29.
101. Davies J, Easton D, Bidstrup P. Mortality from respiratory cancer and other causes in United Kingdom chromate production workers. Br J Ind Med 1991;48:299-313.
102. Royle H. Toxicity of chromic acid in the chromium plating industry. Environ Res 1975;10:39-53.
103. Sassi C. Occupational pathology in a chromate plant. Med Lav 1956;47(5):314-27.
104. Shirakawa T, Morimoto K. Brief reversible bronchospasm resulting from bichromate exposure. May/June 1996;51(3).
105. Novey HS, Habib M, Wells ID. Asthma and IgE antibodies induced by chromium and nickel salts. J Allergy Clin Immunol 1983;72(4):407-12.
106. Leroyer C, Dewitte JD, Bassanets A. Occupational asthma due to chromium. Respiration 1998;65:403-05.
107. Moller DR, Brooks SM, Bernstein DI. Delayed anaphylactoid reaction in a worker exposed to chromium. J Allergy Clin Immunol 1986;77(3):451-56.
108. Bigazzi P. Renal autoimmunity induced by metals. Environmental Health Perspectives 1999;107:753-66.
109. Frenekel K, Karkoszka J. Occupational exposure to Cd, Ni and Cr modulated titers of antioxidized DNA base autoantibodies. Environmental Health Perspectives 1994;102:221-25.
110. Tanigawa T, Araki S, Sata F. Effects of smoking, aromatic amines, and chromates on CD4+ and CD8+ T lymphocytes in males workers. Environ Res 1998;78:59-63.
111. Karmaus W, Huang S, Osius N. Chromium urine concentration and effects on lymphocyte subpopulations in children. J Env Med 1999;1:153-61.
112. Tanigawa T, Shunichi A, Araki T. Decreases of CD4- and CD8-positive T lymphocytes in retired chromate worker. Am J Ind Med 1995;27:877-82.
113. Boscolo P, Gioacchino M, Bavazzano P. Effects of chromium on lumphocyte substets and imunoglobulins from normal population and exposed workers. Life Sci 1997;60(16):1319-25.
114. Snyder CA, Udasin I, Waterman SJ. Reduced IL-9 levels among individuals in Hudson County, New Jersey, an area contaminated with chromium. Arch Environ Health 1996;51(1):26-28.
115. Kuo J-W, Wu M-L. Effects of chromic acid exposure on immunological parameters among electroplating workers. Int Arch Occup Environ Health 2002;75:186-90.
116. Borella P, Manni S, Giardino A. Cadmium, nickel, chromium and lead accumulate in human lymphocytes and interfere with PHA-induced proliferation. J Trace Elem 1990;4:87-95.
117. Wang JY, Tsukayama DT, Wicklund BH. Inhibition of T and B cell proliferation by titanium, cobalt, and chromium: role of IL-6. J Biomed Mater Res 1996;32:655-61.
118. Petersen R, Mikkelsen S, Thomsen OF. Chronic interstitial nephropathy after plasma cutting in stainless steel. Occup Environ Med 1993;51:259-61.
119. Nuyts GD, Vlem EV, Thys J. New occupational risk factors for chronic renal failure. The Lancet 1995;346:7-11.

120. Wedeen RP, Haque S, Udasin I. Absence of tubular proteinuira following environmental exposure to chromium. Arch Environ Health 1996;51(4):321-23.
121. Mutti A, Cavatorta A, Pedroni C, Borghi A, Giaroli C, Franchini I. The role of chromium accumulation in the relationship between airborne and urinary chromium welders. Occupational and Environmental Health 1976;43:123-33.
122. Littorin M, Welinder H, Hultberg B. Kidney function in stainless steel welders. Int Arch Occup Environ Health 1984;53:279-82.
123. Verschoor MA, Bragt PC, Herber RFM. Renal function of chrome-plating workers and welders. Int Arch Occup Environ Health 1988;60:67-70.
124. Greater Tokyo Bureau of Hygiene. Report concerning the effect of chromium in a health survey (10-year survey). Tokyo, Japan. 1989.
125. Moulin JJ, Wild P, Mantout B. Mortality from lung cancer and cardiovascular diseases among stainless-steel producing workers. Cancer Causes Control 1993;4:75-81.
126. Mancuso TF. Occupational cancer and other health hazards in a chromate plant: a medical appraisal: II. Clinical and toxicological aspects. Ind Med Surg 1951;20:393-407.
127. Sterekhova NP, Zeleneva NI, Solomina SN. Gastric pathology in the workers of chromium salts industries. Gig Trud Prof Zabol 1978;3:19-23.
128. Hayes RB, Lilienfeld AM, Snell LM. Mortality in chromium chemical production workers: a prospective study. Int J Epidemiol 1979;8(4):365-74.
129. Shmitova LA. The course of pregnancy in women engaged in the production of chromium and its compounds. Vliy Prof Fakt Spet Funk Zhensk Organ 1978:108-11.
130. Shmitova LA. Content of hexavalent chromium in the biological substrates of pregnant women and women in the immediate post-natal period engaged in the manufacture of chromium compounds. Gig Trud Prof Zabol 1980;2:33-35.
131. Hjollund NHI, Bonde JPE, Hansen KS. Male-mediated risk of spontaneous abortion with reference to stainless steel welding. Scand J Work Environ Health 1995;21:272-76.
132. Hjollund NHI, Bonde JPE, Jensen T. Male-mediated spontaneous abortion among spouses of stainless steel welders. Scand J Work Environ Health 2000;26(3):187-92.
133. Hojollund NHI, et al. Semen quality and sex hormones with reference to metal welding. Reprod Toxicol 1998;12:91-95.
134. Bonde JPE, Ernst E. Sex hormones and semen quality in welders exposed to hexavalent chromium. Human & Experimental Toxicology 1992;11:259-63.
135. Hong L, Chen Q, Li S, Yao W, Li L, Shi X, Wang L. Effect of Cr (VI) exposure on sperm quality: human and animal studies. Annals of Occupational Hygiene 2001;45(7):505-11.
136. Lee KP, Ulrich CE, Geil RG. Inhalation toxicity of chromium dioxide dust to rats after two years exposure. Sci Total Environ 1989;86:83-108.
137. Kleiner AM, Stolbun BM, Likhacheva LI. Indices of the functional status of the myocardium and hemodynamics in chronic occupational poisoning with chromium compounds. Gig Trud Prof Zabol 1970;14:7-10.
138. International Agency for Research on Cancer, Lyon, France. IARC monographs on the evaluation of carcinogenic risks to humans: chromium, nickel, and welding. Oakland (CA): California Department of Health Services. 1990.
139. World Health Organization, Geneva, Switzerland. Chromium - environmental health criteria. Oakland (CA): California Department of Health Services. 1988.
140. Moulin JJ, Portefaix P, Wild P. Mortality study among workers producing ferroalloys and stainless steel in France. British Journal of Industrial Medecine 1990;47:537-43.

141. Axelsson G, Rylander R. Mortality and incidence of tumours among ferrochromium workers. Br J Ind Med 1980;37:121-27.
142. Zhang J, Li S. Cancer mortality in a chinese population exposed to hexavalent chromium in water. J Occ Env Med 1997;39:315-19.
143. Testicular cancer: questions and answers. a fact sheet about testicular cancer, including risk factors, symptoms, diagnosis, treatment, and follow-up care. Available online: http://www.cancer.gov/cancer_information/cancer_type/testicular/. Accessed: 2002 Dec 03.
144. What you need to know about brain tumors. Information about detection, symptoms, diagnosis, and treatment of brain tumors. National Cancer Institute, producers. NIH Publication No. 95-1558; Available online: http://www.cancer.gov/cancer_information/cancer_type/brain_tumor/. Accessed: 2002 Dec 03.
145. What you need to know about leukemia. Information about detection, symptoms, diagnosis, and treatment of leukemia. National Cancer Institute, producers. NIH Publication No. 95-3775; Available online: http://www.cancer.gov/cancerinfo/wyntk/leukemia. Accessed: 2002 Dec 03.
146. American College of Obstetricians and Gynecologists. Real Patient Cases from JAMA 'Clinical Crossroads' Case History: Menstrual Irregularities. San Francisco (CA). [URL: www.medem.com, accessed: 2002 Nov 02.]
147. Mendocino County Air Quality Management District. Field inspection report for Remco Hydraulics. Willits: 1983 Apr.
148. Mendocino County Air Pollution Control District. Letter to R. Chiantelli from Robert F. Swan concerning Remco Hydraulics emission source analysis. Ukiah, California. June 28, 1983.
149. Abex Corporation. Letter to R.G. Wickline from C.H. Borcherding concerning environmental evaluation 4/6/83. Chicago, Illinois. April 15, 1983.
150. California Regional Water Quality Control Board, North Coast Region. Memorandum to John R. Hannum from Cecile N. Bryant concerning Abex-Remco inspection memo. Santa Rosa, California. May 27, 1988.
151. Gibb H. Lung cancer among workers in chromium chemical production. American Journal of Industrial Medicine 2000 (38):115-26.
152. Luippold RS, Mundt KA, Austin RP, Liebig E, Panko J, Crump C, Crump K, Proctor. Lung cancer mortality among chromate production workers. Occup Environ Med 2003 (560):451-57.
153. Proctor DM. Workplace airborne hexavalent chromium concentrations for Painesville, Ohio, chromate production plant (1943-1971). Applied Occupational and Environmental Hygiene 2003;18(6):430-49.
154. Remco Hydraulics, Inc. Duct Layout for Mist Eliminator Chrome Building. Willits, California. August 9, 1973 (revision).
155. Mendocino County Air Quality Management District. Letter to Tracy Barreau from Dean Wolbach concerning meteorological data problems. Ukiah, California. January 15, 2004.

Preparers of Report

Environmental and Health Effects Assessors

Tracy Barreau, REHS
Environmental Scientist
Environmental Health Investigations Branch
California Department of Health Services

Marilyn C. Underwood, PhD
Chief, Site Assessment Section
Environmental Health Investigations Branch
California Department of Health Services

Sumi Hoshiko, MPH
Epidemiologist
Environmental Health Investigations Branch
California Department of Health Services

Designated Reviewer

Marilyn C. Underwood, PhD, Chief
Site Assessment Section
Environmental Health Investigations Branch
California Department of Health Services

Community Relations Coordinators

Tivo Rojas, MPH
Impact Assessment contractor to the
Environmental Health Investigations Branch
California Department of Health Services

Jay LaPlante
Impact Assessment contractor to the
Environmental Health Investigations Branch
California Department of Health Services

ATSDR Regional Representatives, Region IX

Gwen Eng
Libby Levy
Regional Representatives

ATSDR Technical Project Officer

Tammie McRae, MS
Environmental Health Scientist
Division of Health Assessment and
Consultation

ATSDR Air Dispersion Modeler

Greg Zarus
Atmospheric Scientist
Division of Health Assessment and
Consultation, Exposure Investigation Section

Certification

This Public Health Assessment**, Evaluation of Exposure to Historic Air Releases from the Abex/Remco Hydraulics Facility, Willits, California,** was prepared by the California Department of Health 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 public health assessment was begun.

____

Tammie McRae, MS
Technical Project Officer, Cooperative Agreement Team
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with the findings.

____

Roberta Erlwein
Cooperative Agreement Team Leader
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Appendix A—Glossary

Absorption
How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin or has been breathed in.

Acute Exposure
Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Adverse Health Effect
A change in body function or the structures of cells that can lead to disease or health problems.

Anaphylaxis
Severe allergic reaction, which includes a sense of warmth, flushing, itching, hives, swelling in the throat, wheezing, light-headedness, irregular heart rhythm, nausea or vomiting, abdominal cramping or shock. This condition is considered a medical emergency.

ATSDR
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.

Background Level
An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Cancer Risk
The potential for exposure to a contaminant to cause cancer in an individual or population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of the exposure. This approach is based on the assumption that there are no absolutely "safe" toxicity values for carcinogens. USEPA and the California EPA have developed cancer slope factors and inhalation unity risk factors for many carcinogens. A slope factor is an estimate of a chemical's carcinogenic potency, or potential, for causing cancer.

If adequate information about the level of exposure, frequency of exposure and length of exposure to a particular carcinogen is available, an estimate of excess cancer risk associated with the exposure can be calculated using the slope factor for that carcinogen. Specifically, to obtain risk estimates, the estimated, chronic exposure dose (which is averaged over a lifetime or 70 years) is multiplied by the slope factor for that carcinogen.

Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men will be diagnosed with cancer in their lifetimes (51). This is referred to as the "background cancer risk." The term "excess cancer risk" represents the risk above and beyond the "background cancer risk." A "one-in-a-million" excess cancer risk from a given exposure to a contaminant means that if one million people are chronically exposed to a carcinogen at a certain level, over a lifetime, then one cancer above the background risk may appear in those million persons from that particular exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000. Cancer risk numbers are a quantitative or numerical way to describe a biological process (development of cancer). In order to take into account the uncertainties in the science, the risk numbers used are plausible upper limits of the actual risk, based on conservative assumptions.

<u>Chronic Exposure</u>
A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

<u>Completed Exposure Pathway</u>
See Exposure Pathway.

<u>Concern</u>
A belief or worry that chemicals in the environment might cause harm to people.

<u>Consent Decree</u>
A legal document, approved and issued by a judge, that formalizes an agreement reached between the City of Willits and the former owners (PRPs), where PRPs will conduct the cleanup action at the Remco site; cease or correct actions or processes that are polluting the environment; or otherwise comply with initiated regulatory enforcement actions to resolve site contamination. The Consent Decree describes actions that PRPs are required to perform and may be subject to a public comment period.

<u>Concentration</u>
How much or the amount of a substance present in a certain amount of soil, water, air or food.

<u>Contaminant</u>
See Environmental Contaminant.

<u>Dermal Contact</u>
A chemical getting onto your skin. (See Route of Exposure.)

<u>Dose</u>
The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day.”

<u>Dose / Response</u>
The relationship between the amount of exposure (dose) and the change in body function or health that result.

<u>Duration</u>
The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant
A substance (chemical) that gets into a system (person, animal, or environment) in amounts higher than that found in Background Level, or what would be expected.

Environmental Media
Usually refers to the air, water and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an Exposure Pathway.

Exposure
Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see Route of Exposure.)

Exposure Assessment
The process of finding the ways people come in contact with chemicals, how often, and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway
A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having five parts:

1. Source of Contamination
2. Environmental Media and Transport Mechanism
3. Point of Exposure
4. Route of Exposure
5. Receptor Population

When all five parts of an exposure pathway are present, it is called a Completed Exposure Pathway.

Frequency
How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Hazardous Waste
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect
ATSDR deals only with Adverse Health Effects (see definition in this Glossary).

Indeterminate Public Health Hazard
The category is used in public health assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion
Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See Route of Exposure).

Inhalation
Breathing. It is a way a chemical can enter your body (see Route of Exposure).

LOAEL
Lowest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

National Contingency Plan (NCP)
The National Oil and Hazardous Substances Pollution Contingency Plan promulgated by the USEPA contains stringent federal guidelines for so-called "Superfund" cleanups conducted by or under the supervision of the federal government.

Noncancer Evaluation, ATSDR's Minimal Risk Level (MRL), and USEPA's Reference Dose (RfD), California EPA RELs and Reference Concentration (RfC)
The MRL, RfD, REL and RfC are estimates of daily exposure to the human population (including sensitive subgroups), below which noncancer adverse health effects are unlikely to occur. The MRL, RfD, REL and RfC only consider noncancer effects. Because they are based only on information currently available, some uncertainty is always associated with the MRL, RfD, and RfC. "Safety" factors are used to account for the uncertainty in our knowledge about their danger. The greater the uncertainty, the greater the "safety" factor and the lower the MRL, RfD, or RfC.

When there is adequate information from animal or human studies, MRLs and RfDs are developed for the ingestion exposure pathway, whereas RELs and RfCs are developed for the inhalation exposure pathway. A MRL, RfD, REL or RfC is an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse (non-carcinogenic) health effects over a specified duration of exposure. No toxicity values exist for exposure by skin contact. Separate noncancer toxicity values are also developed for different durations of exposure. ATSDR develops MRLs for acute exposures (less than 14 days), intermediate exposures (from 15 to 364 days) and for chronic exposures (greater than 1 year). The California EPA develops RELs for acute (less than 14 days) and chronic exposure (greater than 1 year). USEPA develops RfDs and RfCs for acute exposures (less than 14 days), subchronic exposures (from 2 weeks to 7 years) and chronic exposures (greater than 7 years). Both the MRL and RfD for ingestion are expressed in units of milligrams of contaminant per kilograms body weight per day (mg/kg/day). The REL and RfC for inhalation is expressed in units of milligrams per cubic meter (mg/m^3).

NOAEL
No **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard
The category is used in ATSDR's public health assessment documents for sites where exposure

to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard
The category is used in ATSDR's public health assessment documents for sites where there is no evidence of exposure to site-related chemicals.

PHA
Public health assessment. A report or document that looks at chemicals at a hazardous waste site and determines if people could be harmed from coming into contact with those chemicals. The PHA also recommends possible further public health actions if needed.

Plume
A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney, contaminated underground water sources, or contaminated surface water (such as lakes, ponds, and streams).

Point of Exposure
The place where someone can come into contact with a contaminated environmental medium (air, water, food, or soil). For example: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil or the backyard area where someone might breathe contaminated air.

Population
A group of people living in a certain area or the number of people in a certain area.

PRP
Potentially **R**esponsible **P**arty. A company, government, or person that is responsible for causing the pollution at a hazardous waste site. PRPs are expected to help pay for the clean up of a site.

Public health assessment(s)
See PHA.

Public Health Hazard
The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria
PHA categories given to a site which tell whether people could be harmed by conditions present at the site. The categories are:
1. Urgent Public Health Hazard
2. Public Health Hazard
3. Indeterminate Public Health Hazard
4. No Apparent Public Health Hazard
5. No Public Health Hazard

Qualitative Description of Estimated Increased Cancer Risks
The qualitative interpretation for estimated increased cancer risks are as follow:

Quantitative Risk Estimate	**Qualitative Interpretation**
Less than 1 in 100,000	No apparent increased risk
1 in 100,000 to 9 in 100,000	Very low increased risk
1 in 10,000 to 9 in 10,000	Low increased risk
1 in 1,000 to 9 in 1,000	Moderate increased risk
Greater than 9 in 1,000	High increased risk

Receptor Population
People who live or work in the path of one or more chemicals, and who could come into contact with them (see Exposure Pathway).

Route of Exposure
The way a chemical can get into a person's body. There are three exposure routes:
1. Breathing (also called inhalation)
2. Eating or drinking (also called ingestion)
3. Getting something on the skin (also called dermal contact)

Safety Factor
Also called Uncertainty Factor. When scientists don't have enough information to decide if an exposure will cause harm to people, they use uncertainty factors and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

Source (of Contamination)
The place where a chemical comes from, such as a smokestack, landfill, pond, creek, incinerator, tank or drum. Contaminant source is the first point of an exposure pathway.

Sensitive Populations
People who may be more sensitive to chemical exposures because of certain factors such as age, sex, occupation, a disease they already have, or certain behaviors (cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Toxic
Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology
The study of harmful effects of chemicals on humans or animals.

Uncertainty Factor
See Safety Factor.

Volatile Organic Chemical (VOC)
Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen. These substances easily volatilize (become vapors or gases) into the atmosphere. A significant number of VOCs are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids).

Appendix B—Figures

Figure 1. Location of Abex/Remco Site, Willits, California

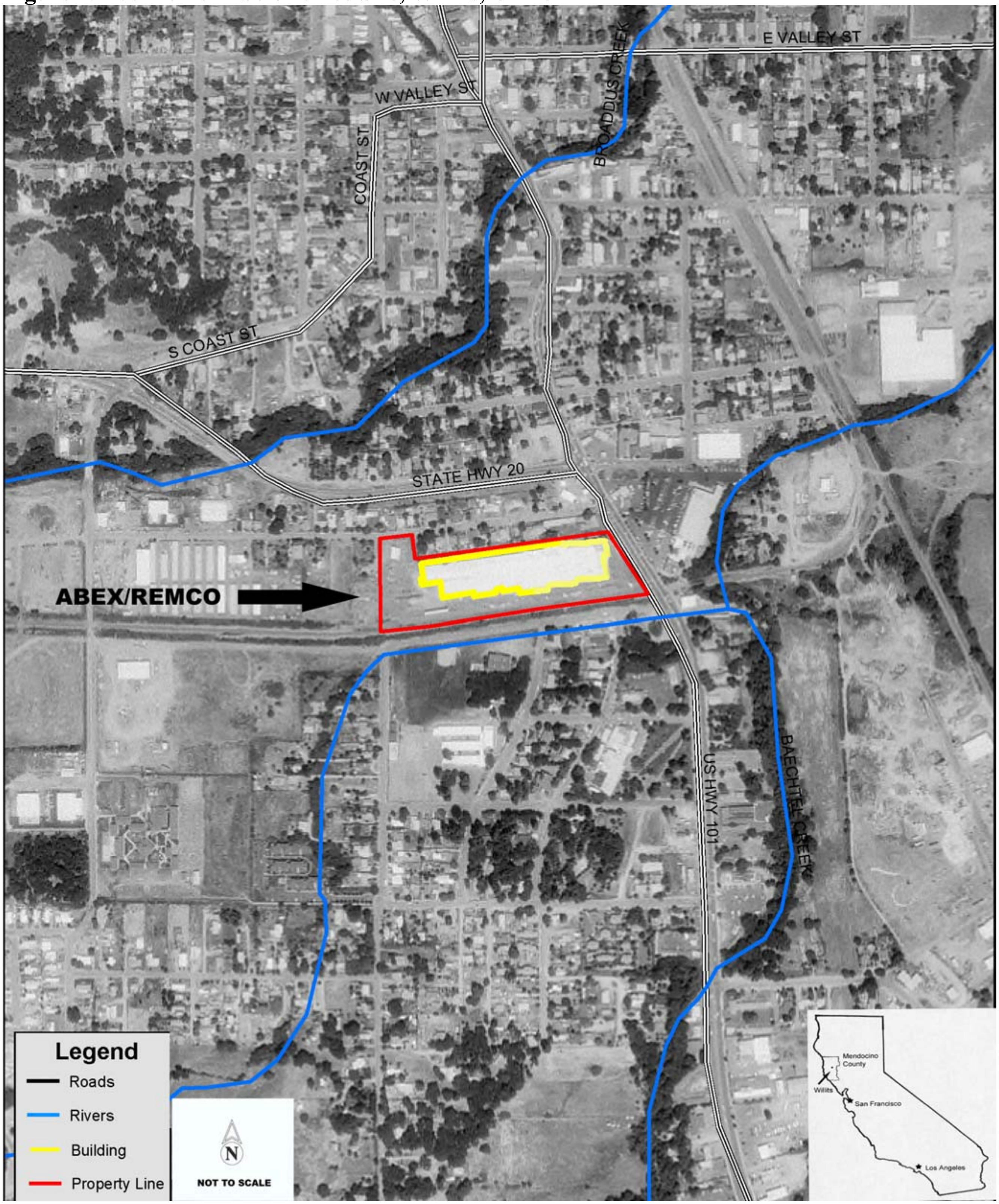


Figure 2. History of Building Expansion, Remco Hydraulics, Inc. Site, Willits, California

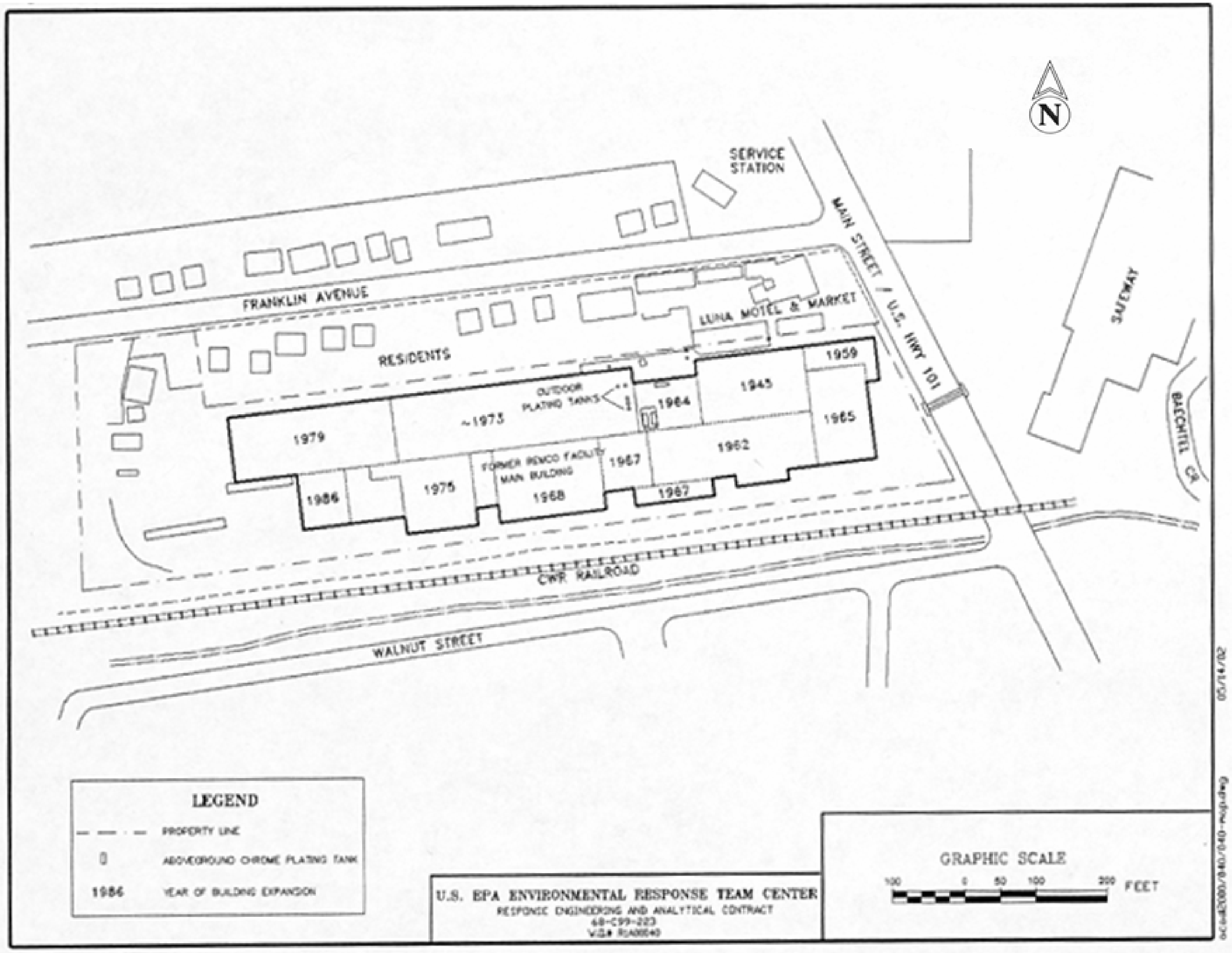


Figure 3. Annual Average Concentrations of Airborne Hexavalent Chromium (1968 – 1975), Abex/Remco Site, Willits, California

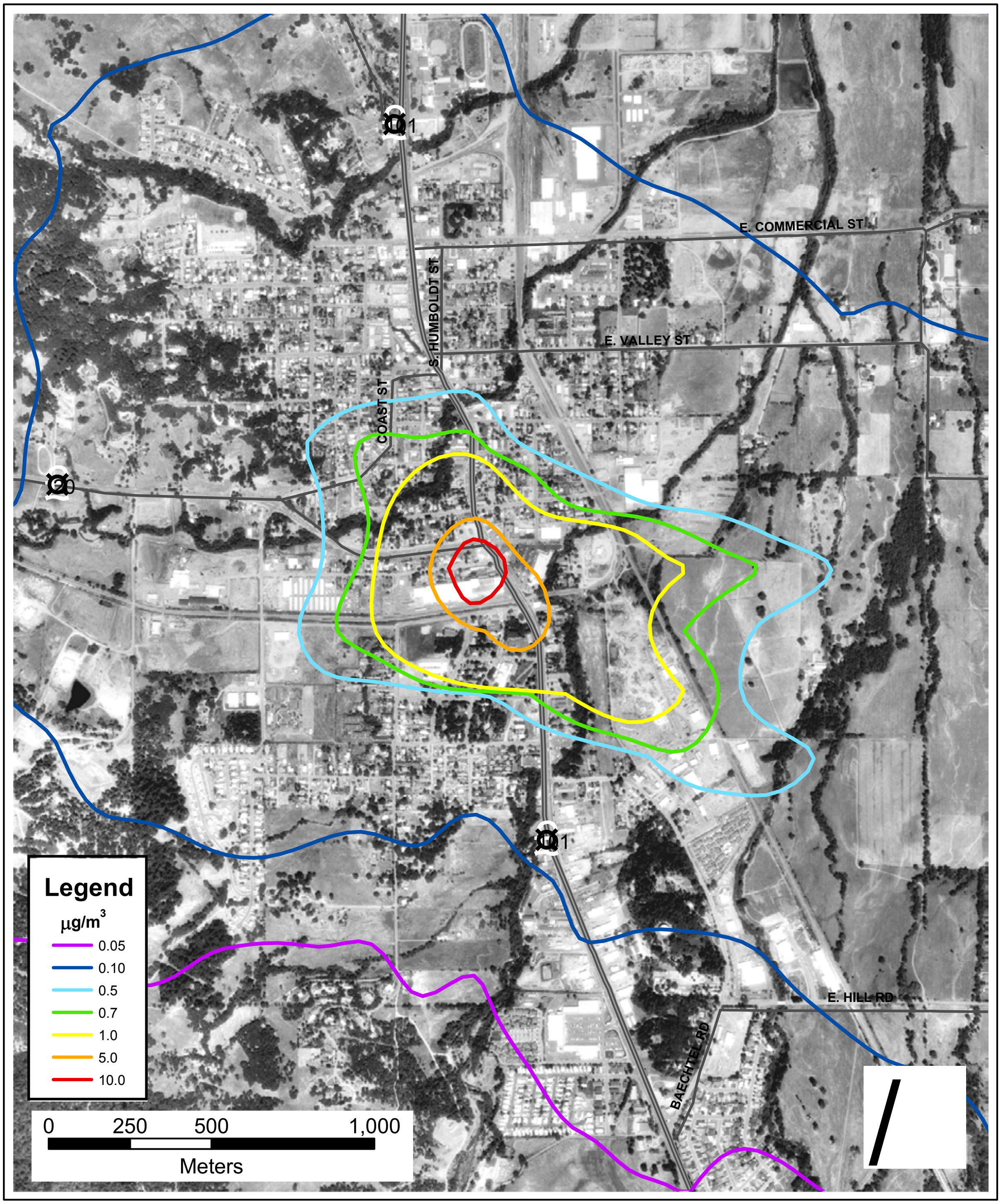


Figure 4. Annual Average Concentrations of Airborne Hexavalent Chromium (1976 – 1989), Abex/Remco Site, Willits, California

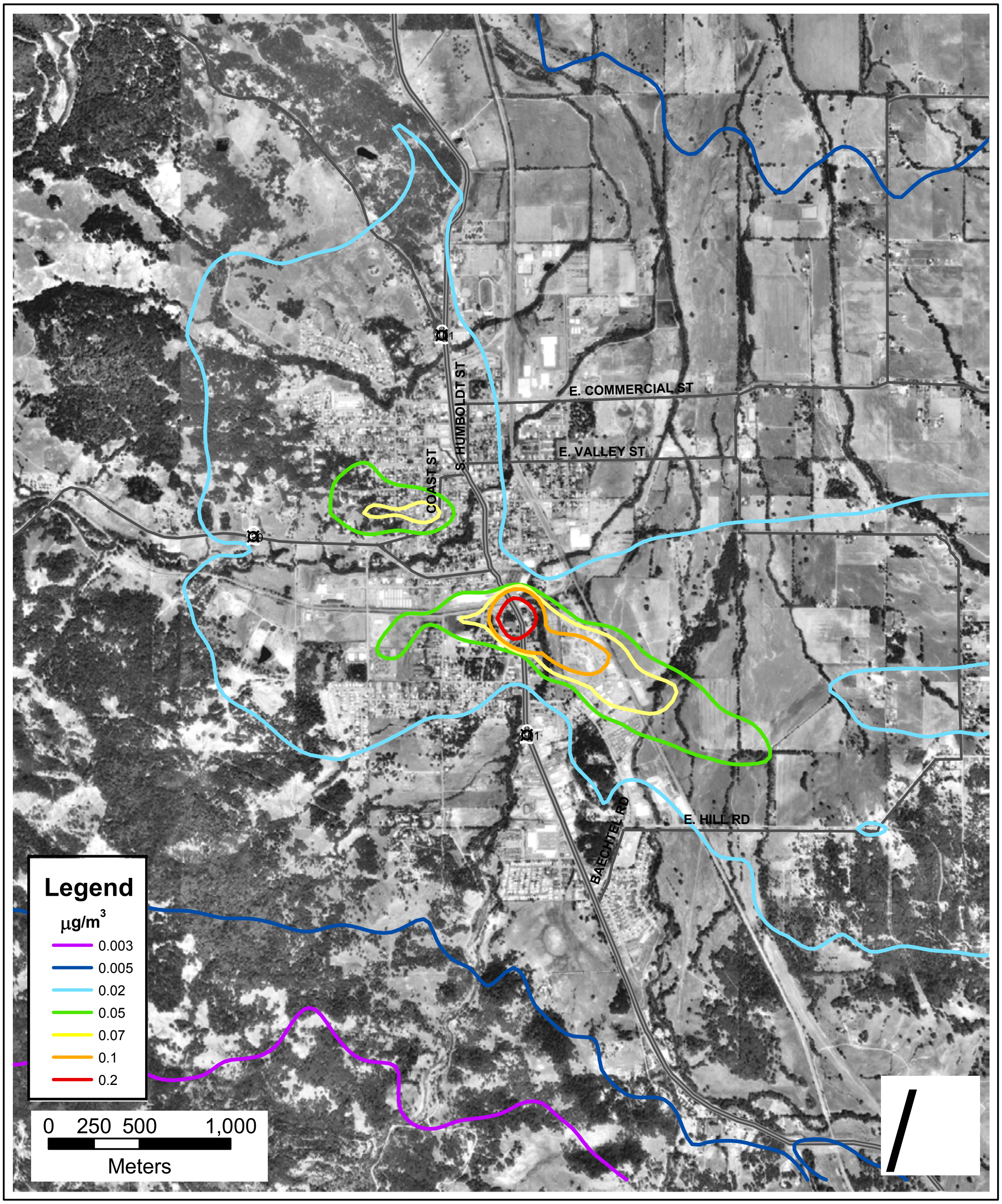
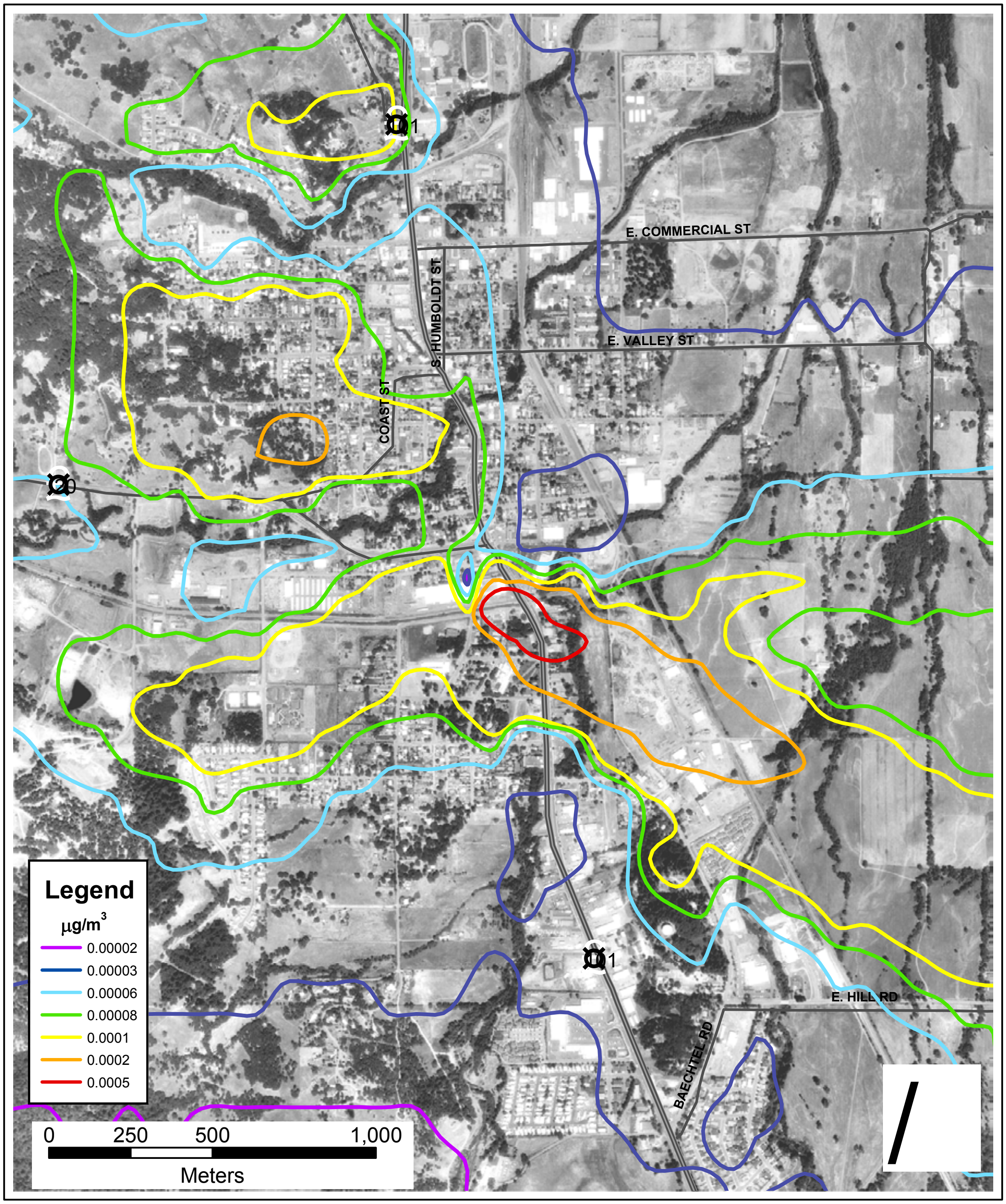


Figure 5. Annual Average Concentrations of Airborne Hexavalent Chromium (1990 – 1995), Abex/Remco Site, Willits, California



Appendix C—Tables

Table 3. Elements of Past Completed Exposure Pathway for Different Groups of People (1963 – 1995), Abex/Remco Site, Willits, California

Exposed Group	Primary Contaminants of Concern	Pathway Elements					
		Source	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time
Residents	Hexavalent chromium	Remco air releases	Air	Air	Inhalation	Adult and child residents	Past (1963 – 1995)
Staff and students at Baechtel Grove School	Hexavalent chromium	Remco air releases	Air	Air	Inhalation	Staff and students	Past (1963 – 1995)
Staff and students at Blosser Lane Elementary School*	Hexavalent chromium	Remco air releases	Air	Air	Inhalation	Staff and students	Past (1990 – 1995)
Workers in Willits	Hexavalent chromium	Remco air releases	Air	Air	Inhalation	Workers	Past (1963 – 1995)

*Blosser Lane Elementary School opened in 1990.

Table 8. Exposure Assumptions Used in Increased Cancer Risk Calculations, Abex/Remco Site, Willits, California

Exposed Group	Time Period	Inhalation Rate (m^3/day)	Body Weight (kg)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years of exposure)
Resident	1963 – 1975	20 (adult) 10.5 (child)	70 (adult) 36 (child)	24	350	12
	1976 – 1989			24	350	14
	1963 – 1995			24	350	32
Worker	1963 – 1975	9.6	70	8	250	12
	1976 – 1989			8	250	14
	1963 – 1995			8	250	32
Baechtel Grove staff	1963 – 1975	9.6	70	8	180	12
	1976 – 1989			8	180	14
	1963 – 1995			8	180	32

Residential exposure time and exposure frequency based on two factors: 1) Remco plating hours of operation (24 hr/day, 7 days/week) according to former workers (C. Nickerman, Remco employee [1984 – 1986], personal communication, November 11, 2003) (R. Wake, Remco employee [1972 – 1991], personal communication, November 19, 2003) (C Douglas, Remco employee [1974 – 1988], personal communication, November 20, 2003) (F. Vincent, Remco Worker [1967 – 1995], personal communication, January 6, 2004); 2) 13 hour atmospheric half life of hexavalent chromium (e.g. if plant shut-down after 16 hours, hexavalent chromium would still be present in the air). School staff exposure time and exposure frequency based on the number of days in the school year. Inhalation rate for workers and Baechtel Grove staff calculated at using an inhalation rate of 1.2 m^3/hour (57); resident (54). Child's body weight average of 6 months–19 years of age (57).

Table 9. Theoretical Increased Lifetime Cancer Risk Estimates for Different Exposed Populations, Abex/Remco Site, Willits, California

Exposed Population	Contour (color)	Increased Cancer Risk Estimates	
		1963 – 1975 (12-year exposure)	1976 –1989 (14-year exposure)
Willits residents (adults and children): Refer to contour maps for corresponding hexavalent chromium concentrations and colors (Appendix B) Figure 3: 1968 – 1975 Figure 4: 1976 – 1989	red	1 in 10 (adults); 1 in 10 (children)	6 in 1,000 (adults); 6 in 1,000 (children)
	orange	6 in 100 (adults); 6 in 100 (children)	3 in 1,000 (adults); 3 in 1,000 (children)
	yellow	1 in 100 (adults); 1 in 100 (children)	2 in 1,000 (adults); 2 in 1,000 (children)
	green	8 in 1,000 (adults); 8 in 1,000 (children)	2 in 1,000 (adults); 1 in 1,000 (children)
	light blue	6 in 1,000 (adults); 6 in 1,000 (children)	6 in 10,000 (adults); 6 in 10,000 (children)
	dark blue	1 in 1,000 (adults); 1 in 1,000 (children)	2 in 10,000 (adults); 1 in 10,000 (children)
	purple	6 in 10,000 (adults); 6 in 10,000 (children)	9 in 100,000 (adults); 9 in 100,000 (children)
Willits workers: Refer to contour maps for corresponding hexavalent chromium concentrations and colors (Appendix B) Figure 3: 1968 – 1975 Figure 4: 1976 – 1989	red	4 in 100	2 in 1,000
	orange	2 in 100	1 in 1,000
	yellow	4 in 1,000	7 in 10,000
	green	3 in 1,000	5 in 10,000
	light blue	2 in 1,000	2 in 10,000
	dark blue	4 in 10,000	5 in 100,000
	purple	2 in 10,000	3 in 100,000
Baechtel Grove Middle School staff: Refer to contour maps for corresponding hexavalent chromium concentrations and colors (Appendix B) Figure 3: 1963 – 1975 Figure 4: 1976 – 1989	yellow/green	3 in 1,000	5 in 10,000

Estimated concentrations from 1963 – 1967 are not shown on the contour map (Figure 3), but are reflected in the estimated cancer risks. Cancer risk estimates for the 1963 – 1975 time period reflect the number of years each tank operated per installation history. Nine years is the minimum exposure duration recommended for estimating cancer risks (4). Therefore, cancer risks were not estimated for Baechtel Grove Middle School students because attendance was for a 3-year period. Cancer risks were not estimated for Blosser Lane Elementary School students or staff because exposures were less than 9 years in duration (school opened in 1990 and Remco closed in 1995).

Table 10. Cumulative Theoretical Increased Lifetime Cancer Risk Estimates at Various Locations in Willits, Abex/Remco Site, California

Location (Figures 3-4)	**1963 – 1975 (Figure 3)** (estimated risk/contour color)	**1976 – 1989 (Figure 4)** (estimated risk/contour color)	**1963 – 1995** Cumulative increased cancer risk: 32-year exposure
Adult Resident			
Former Luna Apartments (directly behind/north of Remco)	1 in 10 – red	2 in 1,000 – green	1 in 10
S. Humboldt Street at E. Valley Street	1 in 1,000 – blue	6 in 10,000 – light blue	2 in 1,000
East Hill Road at Baechtel Road	6 in 10,000 – purple	2 in 10,000 – blue	8 in 10,000
Worker in Willits			
Luna Market (directly behind/north Remco)	4 in 100 – red	5 in 10,000 – green	4 in 100
Safeway (Hwy 101 across from Remco)	4 in 1,000 – yellow	5 in 10,000 – green	4 in 1,000
S. Humboldt Street. at E. Valley Street	4 in 10,000 – blue	2 in 10,000 – light blue	6 in 10,000
East Hill Road at Baechtel Road	2 in 10,000 – purple	5 in 100,000 – blue	2 in 10,000
Baechtel Grove Middle School Staff			
Baechtel Grove Middle School	3 in 1,000 – yellow/green	5 in 10,000– yellow/green	3 in 1,000

Table 12. Mendocino County Census Tract 0107000—Observed vs. Expected Cancer Incidence (Invasive Only) at Selected Sites, Both Sexes and All Races Combined, 1988 – 2000, Abex/Remco Site, Willits, California

Cancer Site	Time Period	Observed Cases	99% Confidence Range	Expected Cases
All Cancer Sites Combined				
	1988 – 1995	230	192.6 – 271.8	213.3
	1996 – 2000	133	105.0 – 165.5	156.6
	1988 – 2000	363	315.6 – 414.8	369.8
I. All respiratory cancers (including lung, nasal cavity, middle ear, accessory sinus, larynx, pleura, trachea, mediastinum, and other respiratory)				
	1988 – 1995	49	32.6 – 69.9	39.5
	1996 – 2000	28	16.0 – 44.5	26.1
	1988 – 2000	77	56.1 – 102.4	65.6
a. Lung				
	1988 – 1995	47	31.0 – 67.5	36.5
	1996 – 2000	26	14.5 – 42.0	24.3
	1988 – 2000	73	52.7 – 97.8	60.8
b. Nasal cavity/Middle ear/accessory sinus				
	1988 – 1995	0	-	<5
	1996 – 2000	0	-	<5
	1988 – 2000	0	-	<5
II. Prostate				
	1988 – 1995	20	10.1 – 34.5	26.7
	1996 – 2000	15	6.7 – 28.0	21.4
	1988 – 2000	35	21.4 – 53.1	48.1
III. Lymphomas (Hodgkin's Disease and non-Hogkin's lymphomas)				
	1988 – 1995	15	6.7 – 28.0	9.3
	1996 – 2000	7	1.8 – 16.9	6.8
	1988 – 2000	22	11.6 – 37.0	16.1
a. Hodgkin's Disease				
	1988 – 995	<5	-	<5
	1996 – 2000	<5	-	<5
	1988 – 2000	<5	-	<5
IV. Leukemia (all subtypes)				
	1988 – 1995	7	1.8 – 16.9	5.2
	1996 – 2000	0	-	<5
	1988 – 000	7	1.8 – 16.9	9.1
V. Bone				
	1988 – 1995	0	-	<5
	1996 – 2000	0	-	<5
	1988 – 2000	0	-	<5
VI. Stomach				
	1988 – 1995	<5	-	<5
	1996 – 2000	<5	-	<5
	1988 – 2000	5	0.9 – 14.0	5.84
VII. All Urinary Tract (includes urinary bladder, kidney, ureter, and other urinary)				
	1988 – 1995	19	9.4 – 33.2	11.8

Table 12. Mendocino County Census Tract 0107000—Observed vs. Expected Cancer Incidence (Invasive Only) at Selected Sites, Both Sexes and All Races Combined, 1988 – 2000, Abex/Remco Site, Willits, California

Cancer Site	Time Period	Observed Cases	99% Confidence Range	Expected Cases
	1996 – 2000	6	1.4 – 15.5	8.3
	1988 – 2000	25	13.8 – 40.8	20.1
a. Urinary bladder				
	1988 – 1995	14	6.0 – 26.6	7.1
	1996 – 2000	5	0.9 – 14.0	4.6
	1988 – 2000	19	9.4 – 33.2	11.7
b. Kidney				
	1988 – 1995	5	-	<5
	1996 – 2000	<5	-	<5
	1988 – 2000	6	1.4 – 15.5	7.8
VIII. Testes				
	1988 – 1995	0	-	<5
	1996 – 2000	<5	-	<5
	1988 – 2000	<5	-	<5
IX. Liver				
	1988 – 1995	<5	-	<5
	1996 – 2000	<5	-	<5
	1988 – 2000	<5	-	<5
VIII. Brain and nervous system				
	1988 – 1995	<5	–	<5
	1996 – 2000	<5	–	<5
	1988 – 2000	<5	–	5.97

Appendix D—Atmospheric Dispersion Modeling Report

Final Report

Atmospheric Dispersion Modeling

Chrome Plating Facility
Abex/Remco Hydraulics, Inc.

Willits, California

April 2004

U. S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Table of Contents

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) and the California Department of Health Services (CDHS) were asked by concerned citizens whether exposures to air emissions from the Remco Hydraulics Site in Willits (REMCO), Mendocino County, posed a public health hazard. Because no ambient air samples were available, ATSDR and CDHS collected available data emissions data to reconstruct the possible chemical release rates and determine their transport and fate into the community. This report summarizes the procedures used in determining the fate and transport of the most toxic of those chemicals, hexavalent chromium (Cr_6) and provides a public health perspective of the choices made when the data sets were in conflict.

The Atmospheric dispersion modeling was performed using the Industrial Source Complex Short Term (ISCST3) dispersion model in conjunction with representative surface and upper air meteorological data.

Objective

The objective of this modeling study is to determine the potential ground level Cr_6 concentrations resulting from uncontrolled, partially controlled, and mostly controlled (scrubber) chrome-plating operations at REMCO. Modeling results will represent the average facility operational stages from an emissions (or public health) perspective. This is done by separating the facility's history into three general time periods.

Site Background

The site's history is provided in the Background and Statement of Issue section of the public health assessment. The emissions data used were initially gathered through a Lockheed Martin contract with the Environmental Protection Agency's (USEPA) Response Engineering and Analytical Contract (REAC), and subsequently new information was provided through the "October 20, 2003 Comments of the Whitman Corporation" in their response to the draft public health assessment.

REMCO began manufacturing hydraulic cylinders at the site around 1959, with chrome plating of the cylinders commencing around 1963 and ceasing in 1995. Although varied plating operations occurred at the site, chromium plating was the primary operation. Seven chrome plating tanks were in use during peak periods. Tank locations are illustrated in Figure 1: History of Building Expansion and an aerial photograph of the facility and surrounding community is provided in Figure 2. The tank installation time line and emission control history is summarized in the table below:

Table 1. Tank Installation Timeline, Emission Control History and Efficiency

Tank No.	*Specification / Orientation*	*Installation Date*	*Emission Control*	*Control Efficiency %*
1	14' x 5' x 7' deep - 3500 gallon capacity / horizontal	~ 1963(4)	**1963(4)–1968**: surface tension reducer, foam	–80*
			1968–1975: vapor collection system (no filtration)	0
			1976–1990: demister	83*
			1991–1995: scrubber	99.991
2	4' x 6' x 4.5'deep - 800 gallon capacity / horizontal	~ 1963(4)	**1963(4)–1968**: surface tension reducer, foam	–80*
2 (replaced 800 gallon tank)	12' x 5.5' x 7' deep - 3200 gallon capacity / horizontal	~ 1967(8)	**1968–1975**: vapor collection system (no filtration)	0
			1976–1990: demister	83*
			1991-–1995: scrubber	99.991
3	3' diameter x 32' deep / vertical	1968	**1968–1975**: vapor collection system (no scrubbing/filtration)	0
			1976–1990: demister	83*
			1991–1995: scrubber	99.991
5	3' diameter x 20' 6" deep / vertical	1970	**1968–1975**: vapor collection system (no filtration)	0
			1976–1990: demister	83*
			1991–1995: scrubber	99.991
4	4' diameter x 38' deep / vertical	1973	**1973–1975**: vapor collection system (no filtration)	0
			1976–1990: demister	83*
			1991–1995: scrubber	99.991
6	4' diameter x 48'	1977	**1977–1990**: demister	83*

Tank No.	Specification / Orientation	Installation Date	Emission Control	Control Efficiency %
	8" deep / vertical		**1991–1995**: scrubber	99.91
7	4' diameter x 70' deep / vertical	1982	**1982–1990**: demister	83*
			1991–1995: scrubber	99.991

(*): USEPA Emission Factor Documentation for AP-42;
Efficiency of emission control estimates for time periods: 1968–1975 based on expert testimony and employee depositions: 1990–1995 based on source tests.

The Lockheed REAC modeling report scenarios differed. However, there is no data to show that the results reported by Lockheed are not possible during some of the time periods, with the exception of the displacement of the graphical depiction of the plume on the map (contours were off center due to mapping error). The current modeling/reconstruction effort includes much of the data provided by REMCO and its contractors after the initial public release of the Lockheed REAC report. Much of the data provided is low-biased, but the resultant concentrations are still too high, while including many of the lower values. The new data and its biases are described in the Methodology section.

Methodology

Meteorological data was collected, analyzed, and evaluated and a single year of meteorological data was derived to represent typical conditions. Then, emissions and operations data were collected analyzed and evaluated, and a single set of emissions data were developed. Finally, three scenarios were developed representing three different release characteristics from the site.

Sensitivity of the input selections was evaluated by rerunning the model with reasonable alternative data sets. Then the results of the alternate model runs were compared with those considered most likely (those used to estimate exposures—in some cases, the lowest likely exposures).

Meteorological Data

An ISCST3 modeling study requires weather observations at both the surface and aloft. Due to the rural location of the REMCO facility, no nearby hourly airport or twice-daily upper air weather observations commonly distributed by the National Weather Service (NWS) were available as input for dispersion modeling. Therefore, data was gathered from a variety of sources and locations in order to best represent the climate of Willits, CA.

Surface Data

A complete set of hourly temperature, wind speed, and wind direction data from 1997–2000 was provided by the Mendocino County Air Quality Management District (MCAQMD). The weather station providing this data was located on the roof of the Safeway Supermarket located across the street from the REMCO site at 845 South Main St., Willits, CA.

Data had to be collected so close to the city because it is important to account for the local effects when evaluating the likely transport for public health purposes. While local effects may interfere with regional policy decision making, local data is ideal to evaluate local transport.

Time-series analysis of this data suggests that the wind directions were reliable for fate and transport calculations and approximately 1.5 years of the wind speed was of good quality. The wind direction data was stable and repeatable throughout the period, with the exception of two continuous events that occurred in the beginning of 1997. The "typical" produced results similar to actual data through comparative model runs. Therefore, the concluding analysis will use the wind speed data from 1997. The winds after May 20, 1998 began to decline, and although the model runs using the wind speeds after May of 1998 show similar results to before then, the concluding analysis was limited to the best available data.

Upper Air Data - Twice daily data recorded at 0z and 12z was obtained via the internet from the Forecast Systems Laboratory (FSL) in Boulder, CO. This data includes wind speed, wind direction, air temperature, and dew point temperature from various heights above ground level. Geographically, upper air data is not as widely recorded as surface data. This is exemplified by the fact that there are only 12 such stations across the entire state of California. For this modeling study, Oakland, CA was chosen as the upper air station and data from 1997–2000 was obtained. The upper air data will have little effect on the dispersion at the surface, and there is little difference from one upper air station to the next.

Cloud Cover/Cloud Height Data

Complete NWS observations include air temperature, dew point temperature, barometric pressure, relative humidity, wind speed, wind direction, cloud height, and cloud cover. Since surface observations were obtained from a small weather station located in Willits, cloud information was unavailable. The closest NWS airport that could provide this data was Ukiah, CA. Hourly readings of cloud cover and cloud height for the years 1997–2000 were acquired electronically from the Western Regional Climate Center in Reno, NV. This data, like the upper air data will impact the regional transport more than the local transport because cloud cover is used to determine the highest altitude under which the air will mix.

Replacement of Missing and Incomplete Data

The EPA document entitled *Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models* (Atkinson & Lee 1992) was used as the guide for this modeling project. Hourly weather data provided by the MCAQMD was a complete set and did not need any substituted values. Nevertheless, both the NWS cloud cover and cloud height data and the FSL upper air data required substitute data to replace missing values. In all cases, the regulatory procedures were followed. The document is attached as Appendix A of this report.

Procedures for Developing a Complete Data Set

Estimates of hourly mixing heights are required in applications of the ISCST3 dispersion model. To produce these estimates, hourly wind speed and wind direction data from Willits, CA were combined with cloud height and cloud cover data from Ukiah, CA and placed in yearly files in Hourly United States Weather Observations (HUSWO) format. The complete HUSWO files were combined with upper air files from FSL and run through a mixing-height program. This program produced hourly mixing heights, which are required for a successful ISCST3 run. The procedures are outlined in *Computing Twice-Daily Mixing Heights From Upper Air Soundings and Hourly Temperatures.*

The final step in producing a viable data set for ISCST3 is to combine the hourly mixing height file with the HUSWO hourly data set. Procedures for this step are covered in *PCRAMMET User's Guide,* June 1999. This preprocessor generates data files that contain the correct parameters in the proper format to be read by the ISCST3 dispersion model. This is done for the model to run. But the actual temperature, mixing height, and upper air soundings have little or no impact on local dispersion. The dispersion equation for fate and transport has no temperature term. Still, the data needs to be complete for the model to run.

Source Characterization

After an hourly data set was completed, the REMCO site was characterized so that it could be used for input in ISCST3. Parameters used as input to the model included three scenarios using ISCST3:

1968–1975: Tanks 1 and 2 combined as a single uncontrolled point source vented out the facility roof with Tanks 3, 4 and 5 modeled as uncontrolled outdoor area sources with a release height of 12'. (Note: 1963−1967: Tanks 1 and 2 modeled as area sources controlled with surface tension reducers, with an estimated efficiency of 80%.)

1976–1989: Tanks 1 through 7 modeled as single point source vented out of the roof with mist eliminator operating at 83% efficiency.

1990–1995: Tanks 1 through 7 modeled as single point source vented out of roof with scrubber operating at 99.991% efficiency.

Other Considerations:

- Yearly concentration averaging periods were used together with shorter intervals of 8 and 24 hours.

- ISCST3 was run in the Elevated Terrain mode, which allows for the calculation of ground-level concentrations at locations higher than the source. Higher than source concentrations are completed using the COMPLEX1 algorithm within the ISCST3 model.

- The exact source location was acquired by importing an electronic United States Geological Survey (USGS) quadrangle map for the Willits area and importing the map file into the ArcView mapping program. The source location, in Universe Transverse

Mercator Unit (UTMs), was determined to be 469630N and 4361525E at an elevation of 423 meters. Modeling was done to mark the source locations to ensure that map and contour coordinates matched. The REMCO modeling completed by Lockheed Martin used NAD83, which placed the source and the resultant plots to the south. These plotting errors from Lockheed do not change the plume dispersion characteristics.

- A stack gas exit temperature of 295°K was used for all tanks in all scenarios.

- Exit velocities and stack diameters for each tank were calculated from data recorded in an October 1983 operating permit from the County of Mendocino Air Pollution Control District. Flow rates in cubic feet per minute (CFM) were recorded for each tank and this data was converted into units of meters/second (m/s) needed by the ISCST3 model. This information was also used for the earlier time periods. Area measurements for each tank in square feet (ft^2) shown in the operating permit were converted to stack diameters in units of meters (m) that could be used by the model. *Uncertainty:* this may low-bias the results because actual volumetric flow rates of air pollution control devices were shown to be lower than the design rates (USEPA 1992).

- Emissions were restricted to the hours of 7 AM through 11 PM 5 days per week. This operation schedule is noted in a March 1983 application permit to the County of Mendocino Air Pollution Control District. That said, however, data provided by the Whitman Corporation (October 20, 2003) indicates that emissions continued after the facility closed (the recorded loss is 0.7 oz/gal of scrubber chrome) [Latham & Watkins 2003 (MCI 021 1470)]. Assuming 1,000 gal of solution, 19,836 g of chrome was lost in 3 days (275.5 g/hr). Furthermore, REMCO has documented that it worked outside the permitted times –even during source testing periods. They allowed the tanks to operate overnight to meet demands (USEPA 1992).

- A Digital Elevation Model (DEM) file with 1 m resolution was obtained from the U.S. Geological Service. The DEM was imported into the ISC model and elevations were inserted for each source and receptor point.

- A discrete Cartesian grid centered on the source and extending outward 5 kilometers in all directions in conjunction with corresponding elevations was used in the modeling study. Ground-level concentrations in micrograms per cubic meters ($\mu g/m^3$) were generated for each discrete location. (electronic ISCST3 input files are provided on public institution copies or at the request of the individual.)

Modeling Scenarios

Three main scenarios were modeled using ISCST3: 1) Tanks 1 through 5 without a scrubber, 2) Tanks 1 through 7 with a mist eliminator/demister, and 3) Tanks 1 through 7 with a high-efficiency scrubber. Several variations of these scenarios were run to account for short-term operational changes or uncertainty.

Model Scenario 1 (1968–1975) : uncontrolled emissions:

Operating assumption (air district permit); **16 hrs/day, 5 days/week**

Selected Emission rate = **7,776 µg/amp-hour**

Power Usage:

Tank 1&2 = 19,000 amps (24,350 amps was reported in Latham & Watkins 2003 (MCI 021 0981–0990); 15,400–16,450 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 16,500–19,500 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507); and 7,800–8,000 amps is reported for Tank 2 only in the Galson Test). The value chosen (**19,000 amps)** is 22%

lower than the regulatory reporting value. There is evidence that the original Tank 2 required less power than the one that replaced it after 1972 or 1973. The exact power usage is unclear: 3,000-10,000 amps (The Galson test value is within this range).

Tank 3 = 7,900 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988) for Tanks 3–7 or 13,880 amps per tank; 7,800–8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1463); 7,800–8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1494-–1507); and 8,000 amps was reported in the Galson Test). The value chosen **(7,900 amps)** is 1.3% lower than the regulatory reporting value.

Tank 4 = 11,000 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988) for Tanks 3–7 or 13,880 amps per tank; 10,100–11,400 amps was reported in Latham & Watkins 2003 (MCI 021 1463-1469); 10,600–11,700 amps was reported in Latham & Watkins 2003 (MCI 021 1494-–1507); 10,000 amps was reported in the Galson Test). The value chosen **(11,000 amps)** is 31.3% lower than the regulatory reporting value.

Tank 5 = 8,000 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988) for Tanks 3–7 or 13,880 amps per tank; 8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 7,800–7,900 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507); 8,000 amps was reported in the Galson Test). The value chosen **(8,000 amps)** is the regulatory reporting value.

Justification

There are several possible ways methods to calculate emissions for the periods when there were no controls. The methods include:

using the USEPA AP42 (1996) chrome plating conversion factor of **7,776 µg/amp-hr** or the chromic acid conversion factor of **16,200 µg/amp-hr** emission factor;

using the California Air Resources Board (CARB) Bay Area Approved (1991) chrome plating conversion factor of **31,750,000 µg/amp-hr**; emission factor;

using the site-specific Duall study (Latham & Watkins 2003 - MCI 0211459) uncontrolled emission rate of (Test 2) **49,136 µg/amp-hr** or the study average of **24,892 µg/amp-hr**;

using the site-specific results of the Galson study 96 ug/amp-hr and convert it them to **6,857 µg/amp-hr** uncontrolled emission rate (assuming 98.6% efficiency);

using the site-specific results of the USEPA study 4.0 ug/amp-hr and convert it them to **44,444 µg/amp-hr** uncontrolled emission rate (using the 99.991% efficiency);

The original modeling chose the latter, which is 4,630 times less than the approved CARB approved method and over 72 times less than the results collected by Duall onsite.

USEPA's current emission factor (7,776 µg/amp-hr) was chosen for the uncontrolled scenario, because it was confirmed by using the Galson results. The results, however, may be low-biased by a factor of 3–6 if the Duall or the USEPA measurements (and efficiencies) are correct.

USEPA and CARB policy for estimating emissions is to use the permitted operation capacity (Latham & Watkins 2003).

Model Scenario 1 (~1963–1967) / subset of main scenario: 80% control:

Operating assumption (air district permit); **16 hrs/day, 5 days/week**

Selected Emission rate = **7,776 µg/amp-hour (Controlled to 1,555.2 µg/amp-hour)**

Power Usage:

Tank 1 = 9000 amps (8000–9000 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469) and 8,500–9,500 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507)

Tank 2 = 3,000 amps (7,800–8,000 amps was reported for Tank 2 only in the Galson Test.) There is evidence that the original Tank 2 required less power than the one that replaced it after 1972 or 1973. The exact power usage is unclear, 3,000–10,000 amps. This value is highly uncertain, but the lowest value within the range was chosen as the facility was in a growth mode when a facility's hours are sometimes longer and sometimes shorter than permitted.

Control Efficiency = 80% (USEPA AP42 references control efficiencies of early control devices 26-99%, with elaborate systems of fume suppressant and polypropylene balls achieving 94.7%). Anecdotal information on operational practices indicates that higher emissions were likely, as the actual control system did not operate inside a building.

Model Scenario 2 (1976—1989) : 83% control:

Operating assumption (air district permit): 16 hrs/day, 5 days/week

Selected Emission rate = **1,321 µg/amp-hour**

Power Usage:

Tanks 1&2 = 19,000 amps (24,350 amps was reported in Latham & Watkins 2003 (MCI 021 0981–0990)); 15,400-–16,450 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 16,500–19,500 amps was reported in [Latham & Watkins 2003 (MCI 021 1494-–1507); and 7,800–8,000 amps was reported for Tank 2 only in the Galson Test]. The value chosen (**19,000 amps)** is 22% lower than the regulatory reporting value.

Tank 3 = 7,900 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988)) for Tanks 3–7 or 13,880 amps per tank; 7,800–8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1463); 7,800–8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507); and 8,000 amps was reported in the Galson Test). The value chosen **(7,900 amps)** is 1.3% lower than the regulatory reporting value.

Tank 4 = 11,000 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988)) for Tanks 3–7 or 13,880 amps per tank; 10,100–11,400 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 10,600–11,700 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507)]; 10,000 amps was reported in the Galson Test). The value chosen **(11,000 amps)** is 31.3% lower than the regulatory reporting value.

Tank 5 = 8,000 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988)) for Tanks 3–7 or 13,880 amps per tank; 8,000 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 7,800–7,900 amps was reported in Latham & Watkins 2003 (MCI 021 1494–1507); 8,000 amps was reported in the Galson Test)). The value chosen **(8,000 amps)** is the regulatory reporting value.

Tank 6 = 11,000 amps (69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988)) for Tanks 3–7 or 13,880 amps per tank; 11,200–11,850 amps was reported in Latham & Watkins 2003 (MCI 021 1463–1469); 12,500–14,600 amps was reported in Latham & Watkins 2003 (MCI 021 1489–1515); 6,600–11,500 amps was reported in the Galson Test). The value chosen **(11,000 amps)** is 0.8% lower than the regulatory reporting value.

Tank 7 = 13,360 amps (The max amperage is 16,000; 69,400 amps was reported in Latham & Watkins 2003 (MCI 021 0988) for Tanks 3–7 or 13,880 amps per tank; 11,200–11,850;

EPA stack test reports that Tank 7 uses 21.4% more than Tank 6). The value chosen **(13,360 amps)** is 16.5% lower than the regulatory reporting value.

Justification

Pollution controls for varied creation a range of possible emissions from: **96 µg/amp-hour to 3110 µg/amp-hr** (associated with efficiencies of 98.6 and 40%). The average is **1,603 µg/amp-hour**. The extreme of all possible emissions quoted through literature and tests is >1 ug/amp-hour[6] to 31,750,000 ug/amp-hr (average = **15,875,000 µg/amp-hr**). An emission rate of **1,230 µg/amp-hr** was derived from the Galson data (below). A separately derived value of **1,321 µg/amp-hr,** representing an average 83% control efficiency of the EPA 1996 default emission value, was chosen for the modeling.

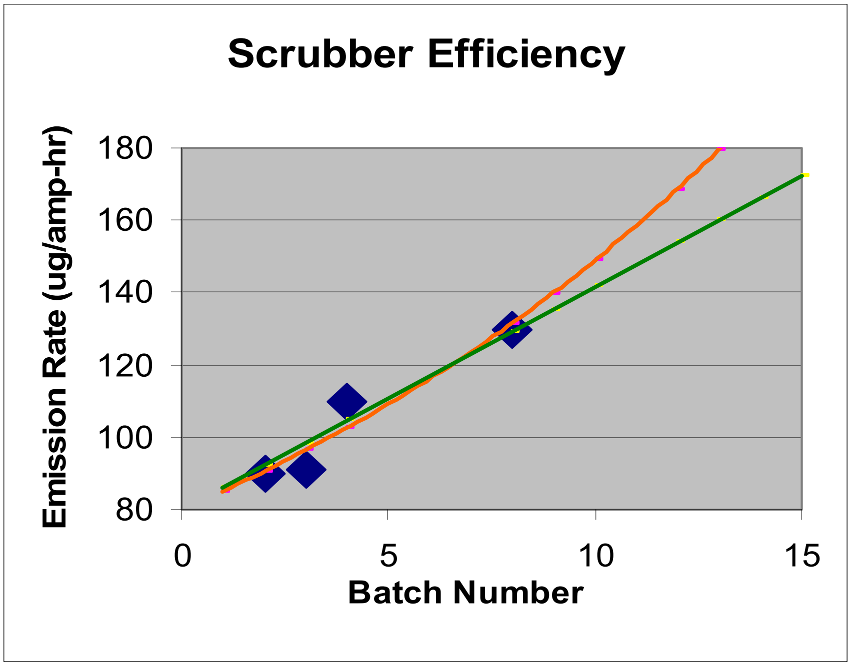
Emission Rate Data Background

The source emission rate varied throughout the life of Remco. Although a considerable amount of emission data exists,, because of the unreliability of that data there is little to estimate the actual or average control efficiency of any of the air pollution control devices. The best emission testing data was the Galson Test (a May 1989 report from Galson Technical Services, Inc. titled *Source Emission Testing of the Plating Tanks Scrubber Exhaust Stack at Remco Hydraulics, Inc* (Galson 1989). This test resulted in an average emission rate of 4.2 grams per hour (g/hr) or **96 µg/amp-hr.** But even this test was done under optimal conditions with the use of a new Scrubber and somewhat fresh water. Other tests were done, but the results varied widely, were poorly documented, and were done under non-typical operational conditions. Still, some of the data from these tests can be used.

The available evidence suggests that even with the most efficient air pollution control device, with each batch run scrubber effeciency drops rapidly. This creates higher emissions than those reported by Galson. The graph below illustrates the loss of efficiency with each test run (as the scrubber solution becomes chrome-laden).

[6] The lowest values were reported in the Duall study reported in MCI 021 1458 -69. However, the hexavalent chrome to total chrome ratios were extremely low in the effluent and at the source.

Graph 1: Scrubber Efficiency



The blue diamonds refer to the sampling results from the Galson report; the orange and green lines indicate the "best fit" and "linear regression". (µg = micrograms)

The average emission value (of **96 µg/amp-hr** of hexavalent chromium), calculated by averaging the first three tests, is much lower than expected after a few days' use (after five batches were run). Laboratory notes suggest that scrubber solution was left unchanged for periods of 5 days or more [Latham & Watkins 2003 (MCI 021 1470)]. Furthermore, the notes indicate that the scrubber solution gains 1 ounce/gal (or more) of chrome [Latham & Watkins 2003 (MCI 021 1470, 41, 81)]. Early operators were instructed to add water as needed (not instructed to change the water—approximately 0.3 gal/min of added fresh water for the 300 gal/min recycled water. Therefore, it is likely that the scrubber's efficiency was much less than reported by Galson. USEPA recommended changing the water.[7] Galson's data suggests that after each batch (2–3 hours time), 15–20 ounces/gal of water could have been added while 1 ounce/gal of chrome was added. The EPA report in May 1992, recommends draining and replacing 200 gal from the recirculation tank each day (1000 gal remains in the scrubber). Therefore, even if fresh water was were added (in 1991) the scrubber water would become chrome-laden and render the scrubber less efficient.

Continued uncertainty of emissions suggests the possibility of a low bias of emissions. The USEPA test that followed the Galson test indicated continued failure of the air pollution control system at REMCO: loss of fan pressure, pressure drop, low water flow, clogging of the mesh pad, insufficient drainage——all required constant attention toward

[7] The pre-testing conducted by USEPA in June 1991, indicated that the control system's flow rate was less than half of the design value, which results in higher fugitive emissions as well as loss of control efficiency. (USEPA May 1992).

all systems during testing. The need to attend to these items during testing suggests to achieve similar results, REMCO would need to be as diligent during normal operations.

Galson reports that the true emissions during the test conditions may be higher than those reported because some (possibly 17%) hexavalent chromium may have converted to trivalent chromium during the 12 days before the sample was analyzed. In considering these two low-biasing issues, the actual emissions may be **210 µg/amp-hr** after 13 batches (26–39 hours use)–even with the water added. After 1 month of two batches per day, the emission rate is approximately **351–1,230 µg/amp-hr**. According to EPA's AP42 emission rate calculation, the highest value (1230 ug/amp-hr) is equivalent to 84% control efficiency and is therefore not an unreasonable estimate for the time periods closer near to 1989.

Pre-testing in July of 1991 indicated several failures within the air pollution control system that would have rendered efficiencies below those of the test, including: excess system pressure drops, less than half of the proper utilization of the fan, insufficient drainage, and insufficient water flow rate. After a single run at the proper design rate, the control panel overheated and the fan rate dropped.

Model Scenario 3 (1990—1995) : 99.991% control:

Operating assumption (air district permit); 16 hrs/day, 5 days/week

Selected Emission rate = **4 µg/amp-hour**

Power Usage:

Tank 1&2 = 19,000 amps

Tank 3 = 7,900 amps

Tank 4 = 11,000 amps

Tank 5 = 8,000 amps

Tank 6 = 11,000 amps

Tank 7 = 13,360 amps

Operating assumption (air district permit); 16 hrs/day, 5 days/week.
Emission rates generated from USEPA source testing 1991 (0.004 mg/amp-hour)

Results

For each tank scenario, ISCST3 was run with the "typical year" of meteorological data. The uncertainty of these values became larger with each time period. The uncertainty was evaluated by running the scenarios while changing the input scenarios.

Model Scenario 1 (1963–1975): uncontrolled emissions:

For five tanks concentration contours predicted as uncontrolled (Tanks 1 and 2 combined as a single point source vented out the facility roof with Tanks 3, 4 and 5 as outdoor area sources with a release height of 12') are depicted in **Figure 3.** The average concentrations for the closest residents are above 10 $\mu g/m^3$. This value is 70,000 to 500,000 times higher than cancer risk - based comparison values

Uncertainty

This scenario has nearly an equal amount of upward and downward uncertainty. Higher concentrations would occur if peak usage, peak hours, or fugitive emissions were assumed in Tanks 1 and 2. Lower concentrations would result if the sources were enclosed and stacks were placed on all tanks or if the operations were less than half the permitted rate. A failure of the stack ventilation system and the inclusion of overnight and weekend operations would increase the concentrations by a factor of 3 to 8 (300–800%).

The brief period (1963−1967) when only two tanks operated with emissions controlled by 80%, were evaluated within this scenario. The resultant average predictions to the nearest residents were above 1 $\mu g/m^3$.

When considering the range of plausible scenarios, the resultant average ambient concentrations in the adjacent community would be between 1 and 50 $\mu g/m^3$ of hexavalent chrome.

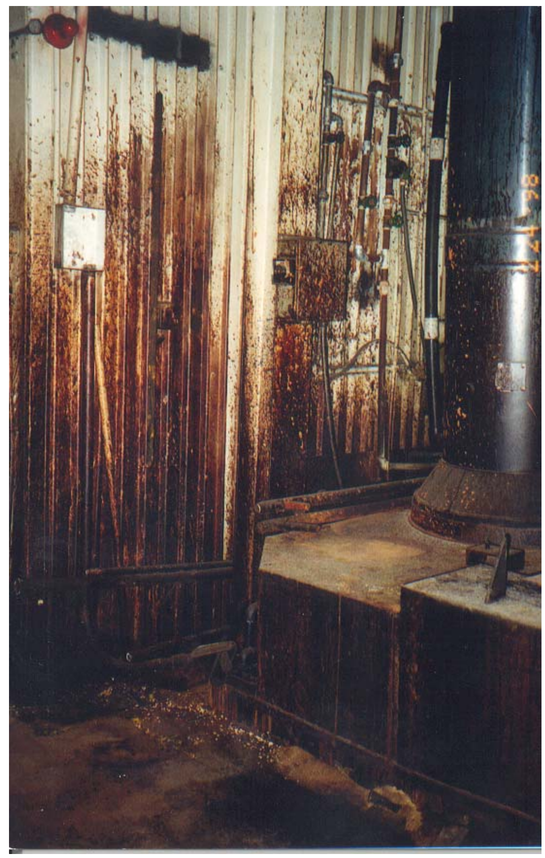
Model Scenario 2 (1976–1989) : 83% control:

Concentration contours predicted from the dispersion from seven tanks controlled at 83% and emitted through stacks (with fugitive emissions consistent with occupational exposures) are depicted in **Figure 4.** The average concentrations for the closest residents are above 0.2 $\mu g/m^3$. This value is 1400 to 10,000 times higher than cancer risk-based comparison values.

Uncertainty

Much more upward than downward uncertainty is present in this scenario. Higher concentrations would occur if peak usage, peak hours, or higher fugitive emissions were assumed. Lower concentrations would result if the operations were less than half the permitted rate. The same scenario was run excluding the existence of Tanks 6 and 7, and without redistributing the process burden to the other tanks. The results were only 60% lower (than the index case). The scenario was also run by redistributing part of the operations from

Tanks 6 and 7 to the other tanks. The outcome produced concentrations less than 23% lower than the index case. The scenario was also run while reducing the design flow rates to those values reported prior to the EPA-required testing in 1991 (reported in May 1992). The results of the reduced flow rates increased the maximum concentrations by over a factor of three (366%). The model was also adjusted to account for the loss of 0.7 oz/gal in the scrubber during the weekend following the Galson test, These emissions increased the ambient air concentrations by a factor of 3 as well. Had the air pollution control system been shut down or become inefficient, the resultant concentrations would be higher than those produced in Figure 3. The resultant range of average values in the community nearest to the facility for this scenario is 0.1 to >20 µg/m^3.



Model Scenario 3 (1990–1995) **<u>: 99.991% control:</u>**

Concentration contours predicted from the dispersion from 7 tanks controlled to 99.991% are depicted in **Figure 5.** These results indicate average annual concentrations in the closest neighborhood are approximately 0.0005 µg/m^3. In this case—where emissions met the legal requirements—the resultant concentrations are 7–50 times higher than the USEPA's risk-based values.

Uncertainty

Concentrations are more likely to be much higher than much lower. It is possible that ambient concentrations may have been thousands of times higher than those presented in the Figure 4. Higher concentrations would occur if we assumed peak usage, peak hours, longer hours, higher fugitive emissions, or efficiencies lower than those tested by Advanced Systems Technology [8] under ideal conditions. All of the above mentioned non-ideal situations have been documented at REMCO.

Should only one or a few of these conditions exist simultaneously, the emissions could be thousands of times higher than those measured during testing. For example, if the control efficiency were to drop to 98%, the emission rate would increase by a factor of 222 (as well as the downwind concentrations). With the scrubber shut down, the emissions would increase by a factor of over 11,000. Overnight operations could increase concentrations by 100%.

[8] The evaluation was provided for REMCO to meet EPA's standards. The evaluation includes procedural changes for REMCO in order improve emission controls.

Fugitive fugitive emissions were documented in REMCO's notes (Galson 1989) during the 1989 Galson test. Photographs from inside the plant in 1998 show the chrome plating out near the tanks, indicating that the fugitive emissions were high (example to the right).

Emissions were likely to be higher than the test values because the air pollution control system was operating far below design standards before testing. The following statements within the notes illustrate the operational and maintenance conditions of REMCO's scrubber in 1991, just prior to the last in a series of several stack tests.

> *"The measured exhaust rate was less than half of the design flow rate. Therefore, testing was delayed one day until modifications could be made... . . . consisting of increasing the fan speed, shutting down the recirculation sprays to the composite bed, and increasing the water flow rate to the packed bed section. ...Discontinuing the wash to the composite mesh pad reduced the pressure drop."*

This modification then made it necessary to have a "*periodic washdown [sic] to clean the pad."* Once these modifications were completed the system was set up to test the capability of the system to control under ideal situations. The first test

> "was interrupted for 15 minutes when the control panel on the fan overheated and caused the fan to loose power. Inspections were also "performed periodically during the test runs to ensure proper operation of the control system. Following the first test run, the composite mesh pad was washed . . . During this time, it was observed that the drainage system on the scrubber could not handle the increased water flow rate, and the scrubber water had backed up into the outlet transition zone of the scrubber. The scrubber was tuned off and [sic] rinsed with fresh water and drained through the drain holes [sic] until the drains ran clear. Following the second test run, the water flow rate [sic] was decreased and the composite mesh pad was washed down. During the washdown, however, the sump began to overfill with water [and] the scrubber was turned off…" . . .
>
> Further modifications to the system were made. Following the modifications
>
> "the scrubber was brought back on line at a lower ventilation rate. After [sic] 15 minutes, re-entrained water was observed escaping the second pad which, once again, contaminated the outlet transition zone with chromium. The scrubber was turned off and rinsed with fresh water and allowed to run overnight [while] parts were plated in the plating tanks overnight due to production demands."

Although the findings of the testing indicate that the scrubber operated at "*near optimum conditions during testing*," the findings are only limited to conditions that occurred during testing and not during the time of the modifications or when the newly proposed "*routine maintenance schedule*" is not maintained. Also the testing did not provide the control efficiency of the entire pollution control system—it was limited to evaluating the difference between what enters and what exits the scrubber. The ideal scenario was repeated with a reduction in the exhaust flow rate to resemble the pretest conditions. This change increased the maximum values by a factor of 19 (or 1900%).

On the issue of the possibility of the emissions being lower, lower concentrations may result if the operations were less than half the permitted rate. The facility, however even operated outside of the permitted times during the USEPA testing (overnight) due to "production demands." Also, if there were periods when production was lower, it does not mean emissions are lower; because the efficiency of the air pollution control system may not be as high when the loading is lower. For example, if the operations were cut in half and the control efficiency dropped to 99.982% the emissions and the resultant concentrations would be the same as periods with high throughput. This implies that if the control efficiency dropped during the most recent times, the downward air concentrations would be similar to the previous periods. An additional run was made while eliminating all contributions from Tank 7. The resultant concentrations were similar, with peak levels reduced by 25% and the extent of the 0.001 $\mu g/m^3$ contour reduced by 18% (or by 58 meters in length). Another run partially redistributed operations to the other tanks and resulted in an 8% reduction of the maximum. Therefore, the range of average maximum concentrations are from >0.001 to >11 $\mu g/m^3$ for the neighboring community.

Evidence provided in the REMCO test reports indicates that the control systems required a high level of maintenance to achieve sufficient control. Furthermore, the modifications to the air pollution control system during testing decreased REMCO's throughput so much that to meet production demands the facility operated overnight—outside their its permitted times—to meet production demands. Former workers have stated that REMCO frequently operated overnight. The model predictions assumed that the operations occurred at or below the permitted levels.

Because the only REMCO-specific values that were available for modeling came from testing during "optimized" conditions, ambient air concentrations could be much higher than those predicted by the models.

Summary of Uncertainty

Several scenarios were rerun using alternate inputs to determine the sensitivity of several of the input parameters. Those parameters most sensitive to the results are reported below.

Emissions Uncertainty

The emissions data varied widely due mostly to the varying control efficiencies throughout the period. Downwind concentrations are directly proportional to the emission rate. Therefore:

If REMCO released 50% of the emissions on one day, the resultant concentrations would be reduced by 50%;

If REMCO only operated 50% of the day, the resultant concentrations would be about 50% less;

If REMCO operated for a16-hr day and 8-hrs overnight, the resultant concentrations would be more than 50% higher (because air disperses less overnight);

If REMCO's venting rate was 50% of the recommended value (as shown in tests), the resultant concentrations would be 1961% higher (or ~20 times higher); and,

If REMCO's control efficiency rate was 96% instead of 99.991%, the resultant concentrations would be 44444% higher (or 444 times higher).

Meteorological Uncertainty

The meteorological data used in the Lockheed REAC modeling of REMCO was reviewed for its use to predict long-term dispersion. The wind directions were consistent for all but a portion of 1997. 1997 was not necessarily improper for long-term estimates, but the direction data was not used because it was inconsistent with the other years. The results of a direction change will only shift the area of maximum concentrations from one property to another. Wind speeds were found to drop during 1998 and through the remaining period. A 40% decrease in wind speed will increase the predicted maximum concentrations by 40% (in most cases). To minimize a potential high bias due to meteorology, the wind data was limited to 1997.

Dispersion Modeling Uncertainty

The ISCST Dispersion model has been shown to predict concentrations within a factor of 2.5, but a few publications indicate that values may be higher for untypical modeling scenarios (EPA 1995, 2003). The shortcomings of specific parameters used to predict concentrations create uncertainties on the order of approximately 20 to 25% (Pasquill 1976; Ellis 1980; API 1980; Bowne 1983; Benarie 1987). These errors or uncertainties are of the same order as the laboratories analytical uncertainty for chromium and for the measurement uncertainty in the collection methods used at REMCO.

The cumulative uncertainty of the dispersion modeling uncertainty, the analytical uncertainty, the measurement uncertainty, and the meteorological uncertainty are much lower than the uncertainty produced by the varying operations of the air pollution control systems used at REMCO.

Conclusions

- Ambient chromium concentrations near REMCO were likely to be above acceptable levels because the homes were close, the emissions were high, and pollution controls were below design requirements for years.

- REMCO's emissions, even under the best control conditions, produced ambient air concentrations of hexavalent chromium that might have been several times higher than USEPA's risk-based thresholds. Resultant concentrations from likely scenarios are thousands of times higher than these thresholds.

Authors, Technical Representatives

Author

Greg Zarus
Atmospheric Scientist/Geophysicist
Exposure Investigations and Consultations Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
National Centers for Environmental Health

Reviewers/Technical Assistance

Brian Kaplan
Environmental Engineer
Exposure Investigations and Consultations Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
National Centers for Environmental Health

Howard Schmidt
Meteorologist
Lockeed Martin, Response Engineering and Analytical Contract
Environmental Response Team
US Environmental Protection Agency

Tracy Bareau, R.E.H.S.
Environmental Scientist
Environmental Health Investigations Branch
California Department of Health Services

Tammie McRae, M.S.
Environmental Health Scientist
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
National Centers for Environmental Health

References

[API] American Petroleum Institute.1977 Gaussian dispersion models applicable to refinery emissions. API Publication 52.

[API] American Petroleum Institute. 1980. An evaluation of short-term air quality models using tracer study data. API Report No. 4333.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997: Record of Activity, ATSDR investigation of Kelly AFB source emissions. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1998. Draft health assessment, Kelly Air Force Base, San Antonio, Texas. Atlanta: US Department of Health and Human Services.

[ATSDR] 2000: Toxicological profile for chromium. Atlanta: US Department of Health and Human Services.

Benarie MM. 1987. Editorial: The limits of air pollution modeling. Atmos Environ 21:1–5.

Bowers, J.F., and A.J. Anderson, An Evaluation Study for the Industrial Source Complex (ISC) Dispersion Model, EPA-450/4-81-002, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1981.

Bowne NJ. 1983. Overview, results and conclusions for the EPRI plume model validation and development project: Plains site. Electric Power Research Institute. Final Report 1616-1 for Project EA-3704.

Briggs GA. 1969. Plume rise. USAEC Critical Review Series.

Briggs GA. 1971. Some recent analyses of plume rise observation. Proc. Second Internat'l. Clean Air Congress. New York: Academic Press.

Briggs, G.A., "Discussion: Chimney plumes in neutral and stable surroundings", Atmospheric Environment, 6:507–510, 1972

CARB 1992: AB2588, Risk Assessment under the Toxics Information and Assessment Act (on 1988), California Air Resources Board. 1992.

Cox WM, Moss GK. 1985a. Evaluation of rural air quality simulation models, addendum A: Muskingum River Data Base. Research Triangle Park, NC: US Environmental Protection Agency; EPA-450/83-003a.

Cox, 1985b: Cox, W.M., G.K. Moss, J.A. Tikvart, and K.W. Baldridge, Evaluation of Rural Air Quality Simulation models, AddendumB; Graphical Display of Model Performance Using the Clifty Creek Data Base, EPA Region III.*[]US Environmental Protection Agency. .s.,: EPA Region IX] US-450/83-003b, U.S. Environmental Protection Agency. .AP42: .. –, Research Triangle Park, NC, August 1985.

Cox 1986, Cox, W.M., H.W. Rorex, and G.K. Moss, Evaluation of Rural Air Quality Simulation models, Addendum C: Kincaid SO2 Data Base, EPA]-450/83-003c, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1986.

Cox, 1987a: Cox, W.M., H.W. Rorex, G.K. Moss, and K.W. Baldridge, Evaluation of Rural Air Quality Simulation models, Addendum D: Paradise SO2 Data Base, EPA-450/83-003d, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1987.

Cox 1987b, Cox, W.M., G.K. Moss, and J.A. Tikvart, Evaluation of Rural Air Quality Simulation models, Addendum E: Graphical Summary of the Performance of Rural Air Quality Models, EPA-450/83-003e, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1987.

Ellis, H.M. et al, "Comparison of predicted and measured concentrations for 58 alternative models of plume transport in complex terrain", JAPCA, June 1980

EPA 1992: Hexavalent Chromium Emissions Evaluation Remco Hydraulics, Willits, CA Advanced Systems Technology for the US Environmental Protection Agency. /Research Triangle Park. May 1992

EPA 1994:. Consideration of Washington, DC:Fugitive Emissions in Major Source Determinations. Office of Air Quality Planning and Standards, US Environmental Protection Agency. March 1994.

EPA 1995: Users Guide for the Industrial Source Complex Dispersion Models (ISC3), Office of Air Quality, Planning, and Standards, Emissions, Monitoring, and Analysis Division, US Environmental Protection Agency. Research Triangle Park, NC. September 1995.

EPA AP42 1996: Emission Factors for Chromium Electroplating, Metallurgical Industry, 12.20 pp 15-17, US Environmental Protection Agency. July 1996.

EPA 1998a: US Environmental Protection Agency Region III Risk-Based Cancer Value, Philadelphia, PA. 1998.

EPA 1998b: US Environmental Protection Agency .California Advanced Systems Technology, CA. Region X Risk-Based Cancer Value, Seattle WA 1998.

EPA 2003: US Environmental Protection Agency, *Guideline on Air Quality Models,* published as 40 CFR Part 51 (revised), April 15, 2003.

Galson Technical Services, Inc.1989.: Source Test Report: Source Emissions Testing of the Plating Tanks Scrubber Exhaust Stack at Remco Hydraulics, Inc., Willits, CA. May 1989.

Hanna, S.R. and Drivas, P.J., "Guidelines For The Use Of Vapor Cloud Dispersion Models", Center For Process Safety, American Institute of Chemical Engineers, 1987.

JAPCA, 1979: "Atmospheric dispersion modeling, a critical review", J. of Air Pollution Control Assoc., Sept. 1979.

Koontz, Zarus, Stunder, and Nagda.1991. . Presented at "Air Toxic Risk Assessment," 84th Annual Meeting of the Air & Waste Management Association, Vancouver, BC, June 1991.

Latham & Watkins. 2003: November 2002 and March 2003 comments to the revised final report: atmospheric dispersion modeling, Remco Hydraulics, Inc. site.

Lee RF, Mills MT, Stern RW. 1975. Validation of a single source dispersion model. Presented at: Proceedings of the Sixth TATO/CCMS International Technical Meeting on Air Pollution Modeling.

Lee RF, Irwin JS. 1995.Methodology for a comparative evaluation of two air quality models. Workshop on Operational Short-range Atmospheric Dispersion Models for Environmental Impact Assessment in Europe, Mol, Nov. 1994. published in Int J Environ Pollut 5;4-6.

Lee RF. 1993. Pilot Study: Evaluation of the ISCST2 Model. Proceedings of the Workshop: Intercomparison of Advanced Practical Short-Range Atmospheric Dispersion Models, August 30–September 3, 1993, Manno, Switzerland, pp. 33-42.

Londergan R, Minott D, Wackter D, Fizz R. 1983. Evaluation of urban air quality simulation models, EPA-450/4-83-020, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1983.

Londergan et al., 1982: Londergan, R.J., D.H. Minott, D.J. Wackter, and D. Bonitta, Evaluation of Rural Air Quality Simulation Models, EPA-450/4-83-003, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1982.

Montgomery, T.C. and Coleman, J.H., "Empirical relationship between time-averaged SO2 concentrations", Environmental Science & Technology, Oct. 1975

Latham & Watkins 2003.Whitman Corporation: Commentscomments of Whitman Corporation concerning there: Draft, Public Health Assessment Remco Hydraulics Facility, Willits, CA, Oct. 2003.

Pasquill, 1961: "The estimation of the dispersion of windborne material", Meteorology Magazine, Feb. 1961

Pasquill, 1975: "Atmospheric dispersion parameters in Gaussian plume modeling. Part II: Possible requirements for change in Turner Workbook values", U.S. EPA Publication 600/4-76-030b, June 1976

Turner, 1970: "Workbook of atmospheric dispersion estimates", U.S. EPA Publication AP-26, revised 1970.

Zarus G.1991a: The AB2588 Risk Assessment with Original Chromium Plating Tanks for Naval Air Station/Naval Aviation Depot, Alameda, CA, GEOMET February 1991. Atlanta: US Department of the Navy.

Zarus G.1991b: The AB2588 Risk Assessment with New Chromium Plating Tanks for Naval Air Station/Naval Aviation Depot, Alameda, CA, GEOMET.Atlanta: US Department of the Navy. April 1991.

Bibliography

Interviews and Investigation Sources:

A compilation of correspondences, permits, and test results relating to the site provided by ATSDR entitled *Abex/Remco Hydraulics Air Data*

A May 22–23, 2001 REAC field trip to the site from May 22–23, 2001 and conversations with Jan Goebel of the California Regional Water Quality Control Board and John Bird from (of Henshaw Associates).

A May 2001 ATSDR/CDHS site visit and public meeting.

Numerous telephone conversations with Tracy Barreau, CDHS, June 2000 through March 2004.

Figure 1. History of Building Expansion, Remco Hydraulics, Inc. Site, Willits, California

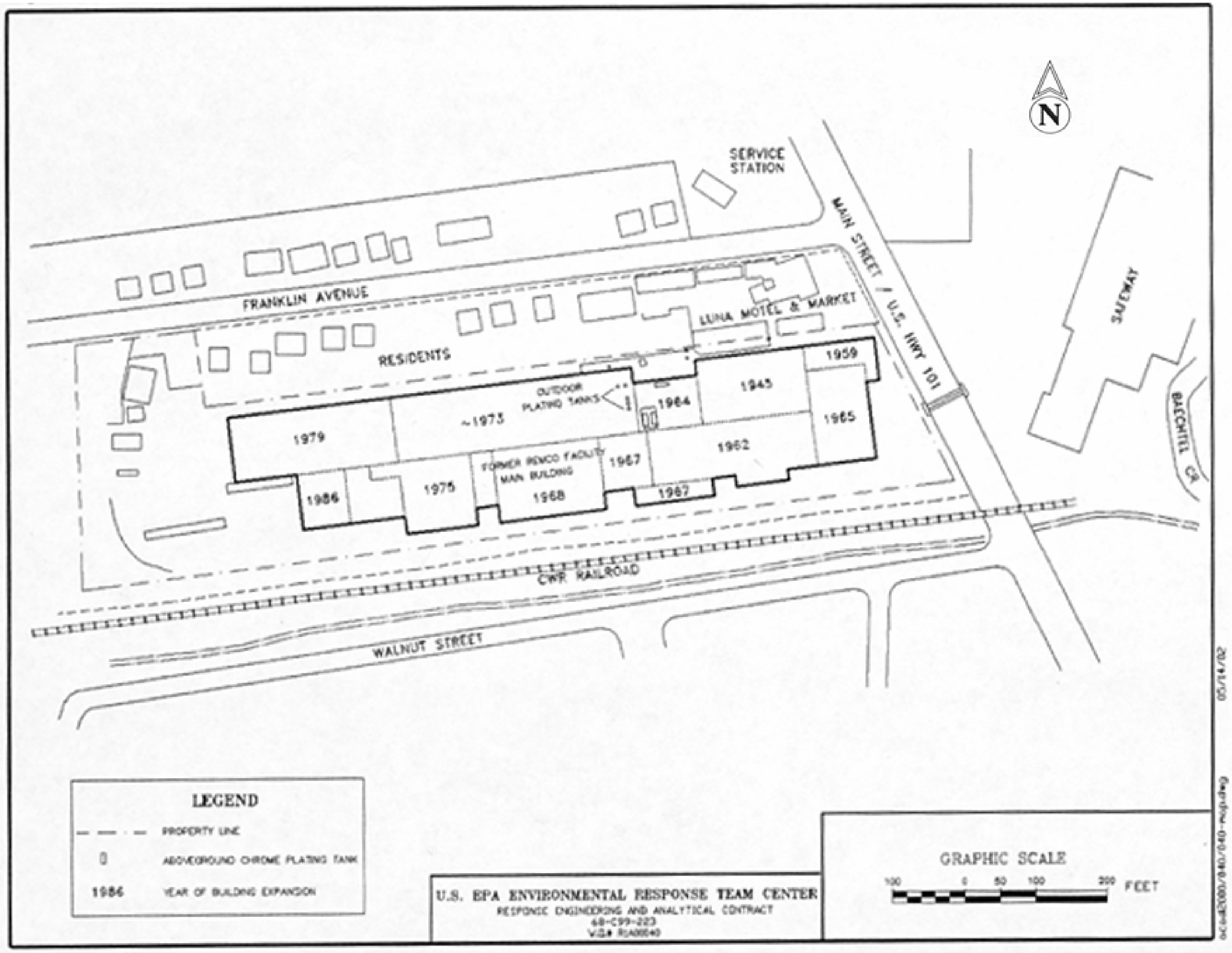


Figure 2. Location of Abex/Remco Site, Willits, California

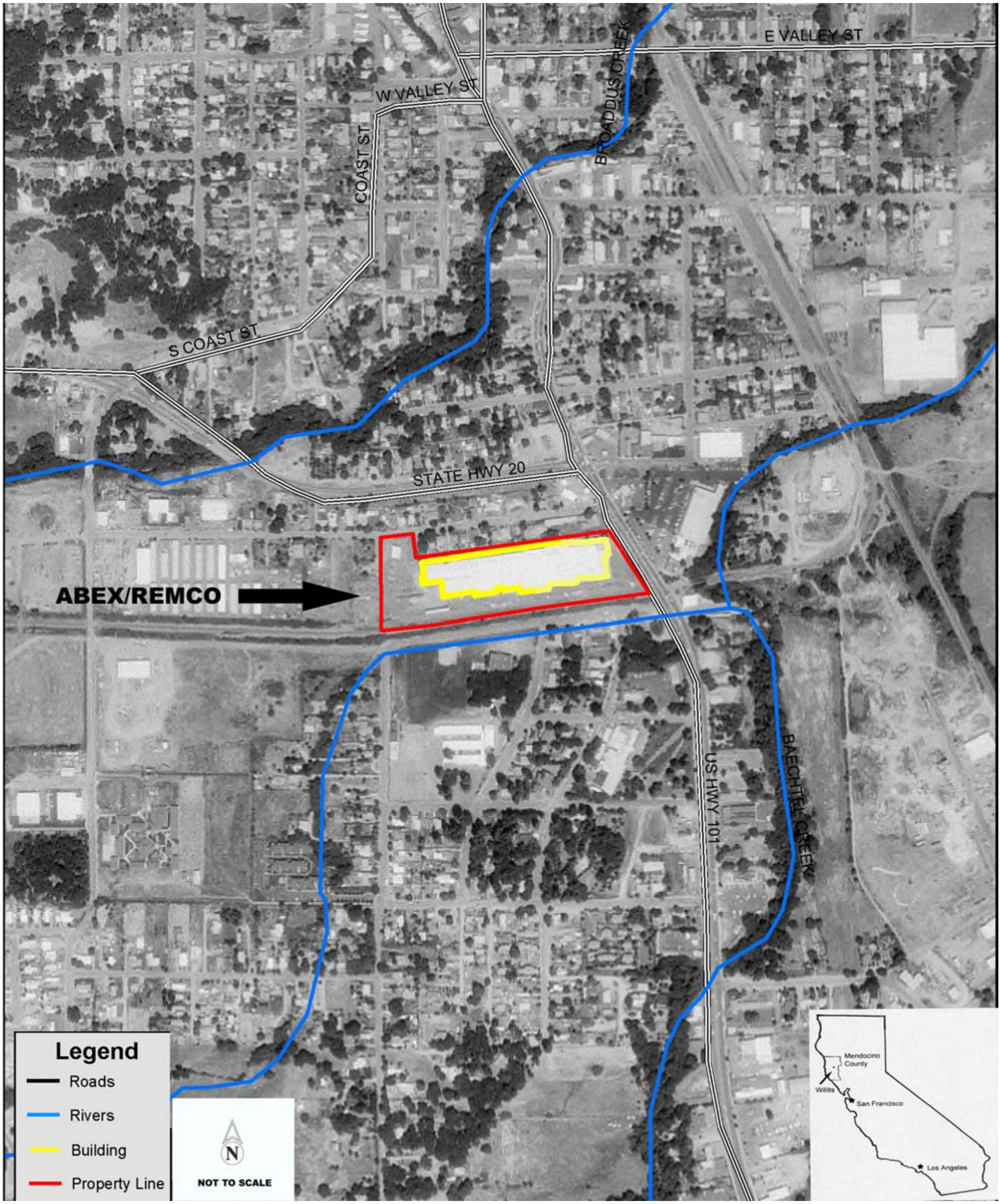


Figure 3: Model Results for Scenario 1 (estimate of the impact of emissions that occurred before 1976)

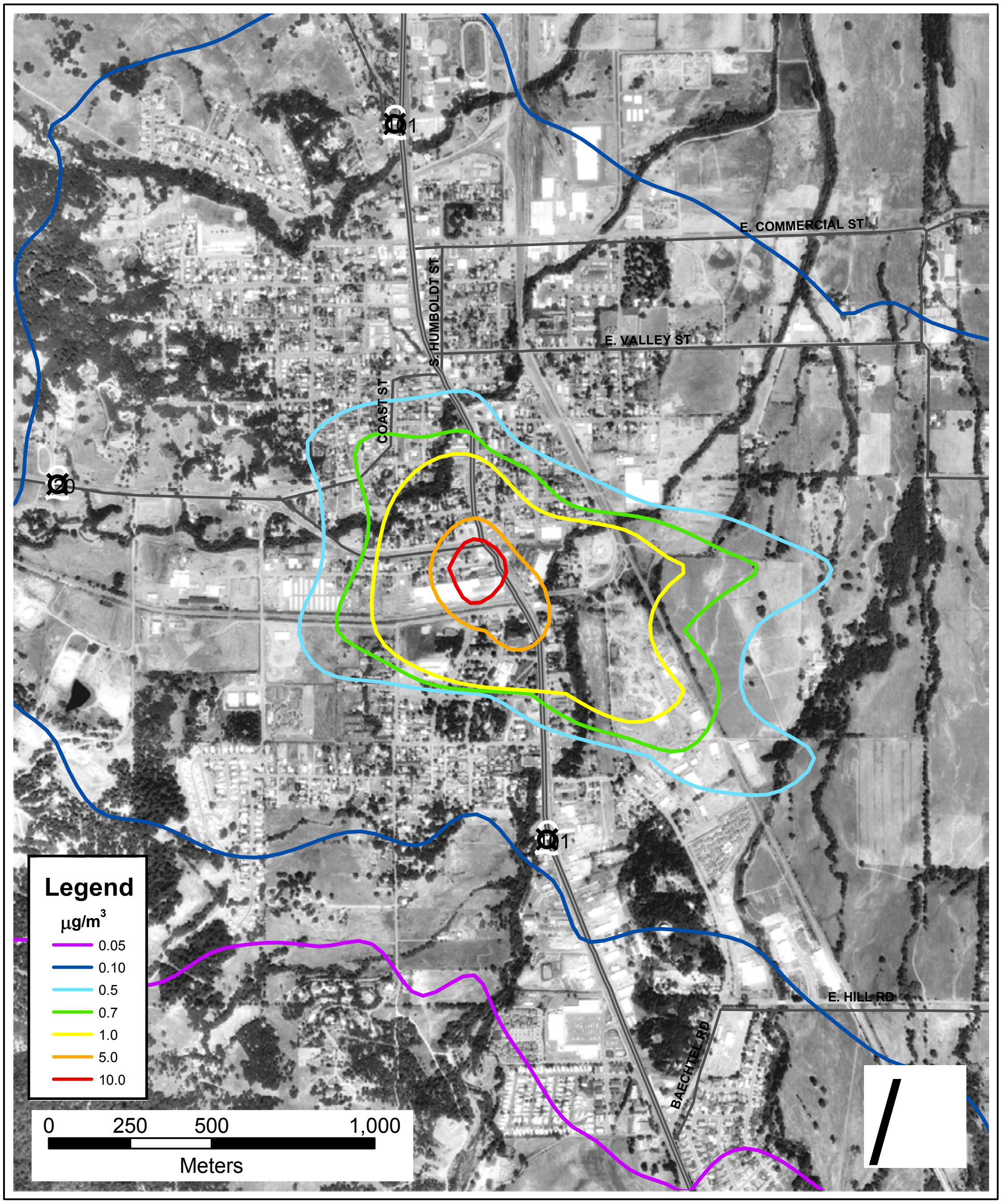


Figure 4: Model Results for Scenario 2 (estimate of the impact of the near ideal case emissions 1976–1989)

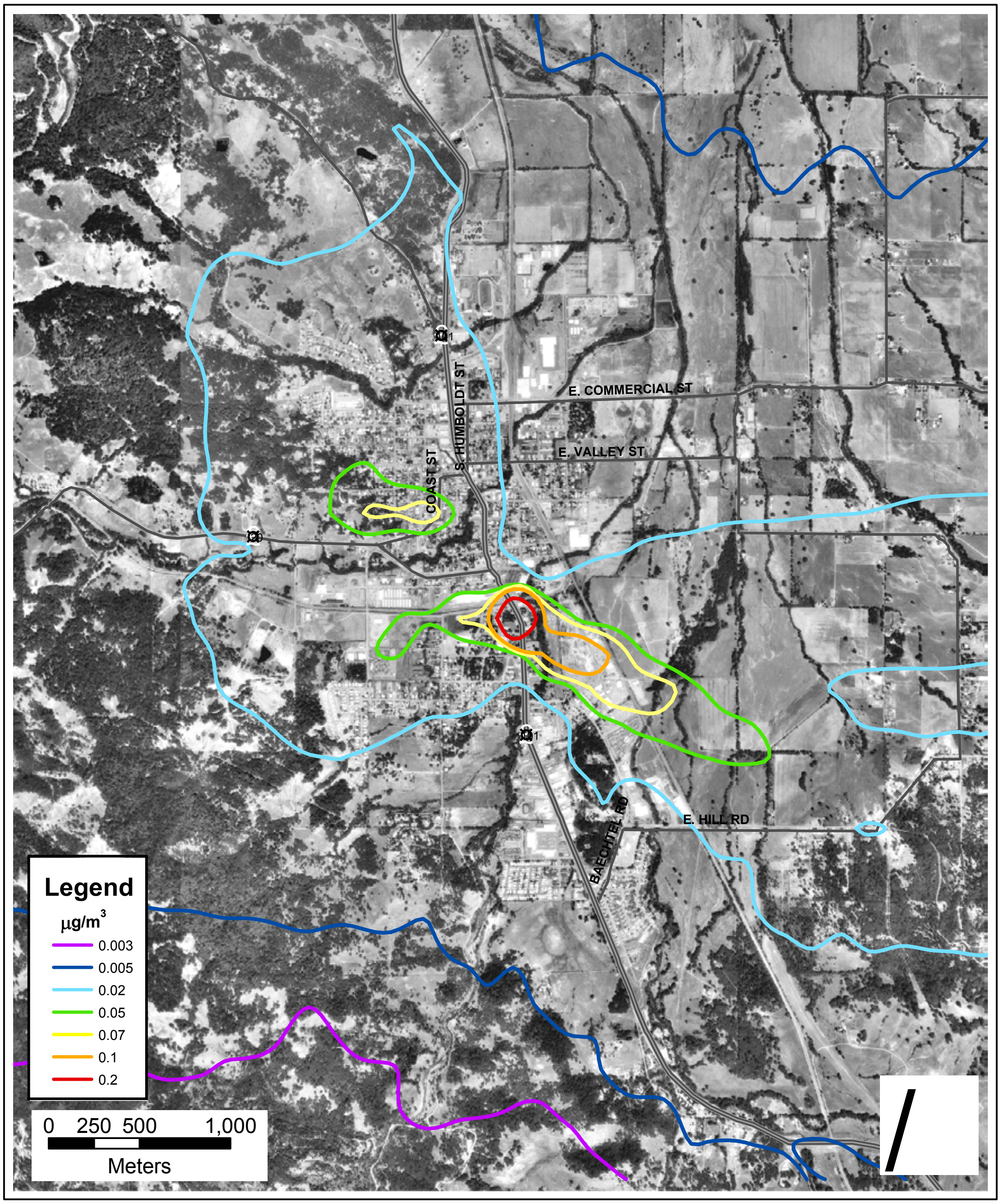
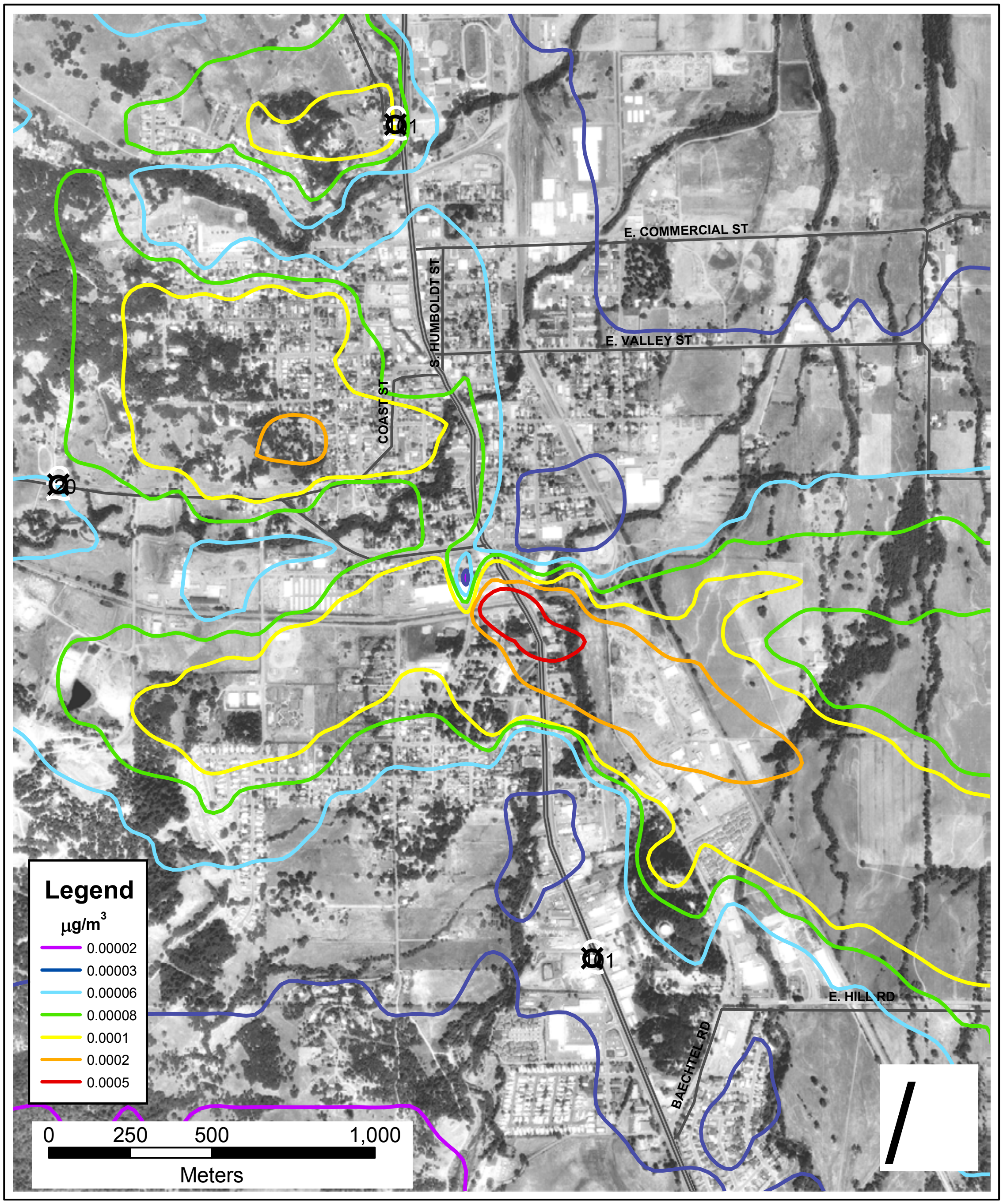


Figure 5: Model Results for Scenario 3 (estimate of the downwind impact of near ideal case emissions 1990–1991)



Appendix E—Toxicological Summary for Chromium

Noncancer Health Effects

Some of the potential adverse health effects of hexavalent chromium are well recognized, but there is still much information that is not known. This makes the interpretation of the past air releases from the Abex Remco site difficult. For example, hexavalent chromium is known to have caused an increase in lung cancers for workers in the chromium industry. It is not clear if this effect in workers is still occurring, considering the better working conditions. Also, it is not clear if other cancers could be associated with exposure to chromium in the workplace. It is unclear if exposures to residents living near a workplace that uses chromium are associated with increases in cancer. Additionally, occupational exposures to chromium have been associated with effects on the nose, kidney, and the gastrointestinal tract; respiratory problems like bronchitis and asthma; skin sensitization; and sperm quality and quantity; however, these are not well studied. The absence of information about the toxicity of chromium may not mean that there is an absence of toxicity, but rather an absence of adequate clinical and epidemiological investigation.

In this section, CDHS describes what is known in the medical and scientific literature about the noncancer health effects of hexavalent chromium exposure. Only studies showing positive findings are summarized.

How Chromium Can Affect the Body

Since chromium toxicity has not clearly been defined, examining the mechanism by which chromium causes its toxicity might help better explain the level of concern one might have for the gaps that exist in the knowledge. An analogy may be made to car that has a problem, and even though the mechanic checked several parts of the system, he/she has not found the source or root of the problem. It might be best at that point to have a specialist that really understands the way that your particular car is put together to suggest what might be going wrong.

Unfortunately, there is no one who precisely knows how the body works and thus how chromium may disturb the normal functioning of the body. Also, what is in fact known about how hexavalent chromium may act in the body is not a simple story to describe. When inhaled, hexavalent chromium can be changed into trivalent chromium by the fluid that lines the lung, or be taken up by the lung itself. Trivalent chromium is considered to be non-toxic, and is not taken up by the lung cells. The hexavalent chromium that is not changed by the fluid lining the lungs can be taken up by the lung cells. Once taken up by the lungs, it can move unchanged into the blood stream or be changed into trivalent chromium. Once in the blood stream, it can be changed into trivalent chromium, or be taken up by the cells in blood or in other parts of the body and then changed into trivalent chromium.

The change of hexavalent chromium to trivalent can occur with no damage, or it can result in damage to a cell. For example, there is some information to suggest that certain cells typically make the chromium change using an antioxidant system (ascorbate) that results in no toxicity to the cell. When this system is overwhelmed, a back-up system of enzymes, the glutathione S-transferases, makes the changes resulting in toxicity to the cell. The cell may or may not be able to correct or fix the toxic changes to the cell. The damage can be to the genetic material in the cell (the DNA), causing cancer or effects on reproduction or development, or to proteins in the cell, disrupting the functioning of the cell or the immune system (sensitizing).

Inhaling chromium can affect the function of the lungs. Other cells that readily take up hexavalent chromium from the blood stream may also be affected. Since the damage to the cell occurs after chromium is taken up into the cell, it is important to understand what types of cells take up chromium.

Hexavalent chromium can easily enter most cells because it resembles the structure of phosphate and sulfate, two elements needed for a cell's normal functioning. Thus, it seems that many cell types in the body could be affected by hexavalent chromium. For instance, there have been animal studies examining the distribution of chromium in the body after exposure. After a single exposure to sodium dichromate 3 days prior, the tissue distribution based on the relative concentrations was lung greater than kidney greater than gastrointestinal tract greater than erythrocytes greater than liver greater than serum greater than testis greater than skin (97).Twenty five days after the single exposure, the tissue distribution was lung greater than kidney greater than erythrocytes greater than testis greater than liver greater than serum greater than skin greater than gastrointestinal tract. All tissue concentrations of chromium declined to low or non-detectable levels in 140 days with the exception of tissue of the lungs and spleen. This study shows that many different organ systems take up and retain chromium for a short period of time after a single exposure.

For an understanding of what happens after long-term exposure, one can look to autopsy studies of chrome workers. One study found higher levels of chromium in the lymph node, lung, spleen, liver, kidney, and heart of Japanese and chrome-refining workers when compared with normal healthy males (98). Analysis of the chromium concentrations in organs and tissues at autopsy of a man who died of lung cancer 10 years after his retirement from working in a chromate-producing plant for 30 years revealed measurable levels in the brain, pharyngeal wall, lung, liver, aorta, kidney, abdominal rectal muscle, suprarenal gland, sternal bone marrow, and abdominal skin (99). Similarly, a man who died of lung cancer after being retired for 18 years had levels of chromium in all tissues except the neural tissues (95).

Effects in humans exposed by inhalation occupationally to high levels of chromium or its compounds—primarily hexavalent chromium—may include nasal septum ulceration and perforation, and other irritating respiratory effects; possible cardiovascular effects; kidney and liver effects; gastrointestinal and hematological effects; effects on the male reproductive system; and increased risks of death from lung cancer. In addition, chromium exposure can be associated with allergic responses (e.g., asthma and dermatitis) in sensitized individuals. Inhalation studies in animals with chromium compounds generally support respiratory and immunological findings in humans.

Chromium can be taken up by the skin can lead to an allergic response (dermatitis) of the skin if the individual is sensitized to chromium. It can lead to ulcerations of the skin if the amount of chromium that contacts with the skin is high.

The information about each of these effects of chromium on the body will be described briefly.

Known Toxicity of Chromium

Nasal Septum Ulceration and Perforation

The nose may be the first part of the affected by chromium in the air. Chromium is corrosive and can produce ulceration, scar formation, and perforation of the nose. Less severe symptoms can include rhinorrhea (runny nose), nasal itching, soreness, sneezing, and nose bleeds. These effects have been found at fairly low levels—4 $\mu g/m^3$ for an average of 7.5 years (28), 0.1 $\mu g/m^3$ to 7 $\mu g/m^3$ for an average of 26.9 months (29), and 90 $\mu g/m^3$ to 730 $\mu g/m^3$ for less than 12 months (39).

Many of these symptoms would cease after exposure ends and if the nose has had time to recover. If enough damage has occurred, then the change becomes permanent. There also is some evidence to suggest that ulcerations that do not have time to heal can lead to nasal cancer.

Irritating and Allergic Responses of Other Parts of the Respiratory Tract

Chromium can also be toxic to other parts of the respiratory tract including the lungs. Sometimes this is due to chromium irritation and sometimes it is due to an allergic reaction. The irritating effects may result in bronchitis and decreased pulmonary function. In some people, inhalation of hexavalent chromium may result in asthma. The development of asthma could occur via an irritating or an allergic response from the immune system.

Three studies have shown chromium exposure to workers can result in an increased risk of death due to noncancer respiratory disease (82, 100, 101). The exact nature of the diseases was not described in two studies, but another study described an increased risk of death from chronic obstructive airway disease. Chronic obstructive airway disease involves a narrowing of the air tubes leading to the lung and can be caused by several conditions including emphysema, bronchitis, and asthma. Smoking is a leading cause of emphysema and bronchitis (102, 103). Chromium exposure has been linked with chronic bronchitis. Several worker studies have shown decreases in pulmonary function (e.g., forced expiratory flow) after testing to diagnose obstructive pulmonary disease (35, 40, 41). One study found these lung function effects to be associated with exposure to levels of chromium at 2 $\mu g/m^3$ or higher (31).

As will be described in the next section, workers who are exposed to chromium often develop an allergic reaction of the skin. On the other hand, there are just a few cases of chromium causing an allergic reaction (asthma) in the lungs (32-34, 104-106). In several of these cases, the workers also were exposed to nickel. In many of the cases the workers smoked. An investigator found that the air levels ranged from 0.5 $\mu g/m^3$ to 50 $\mu g/m^3$ chromium and 0.5 $\mu g/m^3$ to 9.3 $\mu g/m^3$ nickel for seven workers who developed asthma (32). In all the cases, the workers were sensitive to a medical test where they were asked to breathe a chromium-containing solution. Some of them reacted immediately, while others took longer to react. Some of the cases reacted to a skin test for chromium. This suggests that the mechanism that induces lung sensitivity may be different from the mechanism that causes skin sensitivity. This could explain why there are not as many cases of lung sensitivity as skin sensitivity.

It is important to note that workers who ended their exposure to chromium 1 to 5 years previously no longer experienced asthmatic symptoms and had normal lung function (34, 107). One worker continued to have airway hyper-responsiveness and asthmatic symptoms, even though the exposure ended (33).

Irritating and Allergic Responses of the Skin

Chromium can be corrosive to the skin. Skin ulcers develop slowly in exposed areas of the body following exposure to hexavalent chromium, particularly in areas where there is a loss of integrity of the outer layer of the skin. These ulcerations and other irritations of the skin are usually associated with direct contact with chromium in solution, but can also occur after exposure from airborne chromium. Sores from chromium will heal if exposure is discontinued, leaving a scar. These effects have been found at fairly low levels—5 $\mu g/m^3$ to 170 $\mu g/m^3$ (50), 6 $\mu g/m^3$ to 289 $\mu g/m^3$ (27), 90 $\mu g/m^3$ to 100 $\mu g/m^3$ for less than 12 months (49).

Individuals can become sensitive to hexavalent and trivalent chromium exposure and can develop rashes or erythema. This effect on the skin is an allergic response from the immune system. This effect is thought to be mediated via a cell-mediated process. Chromium is the industrial agent that leads to the most allergic skin reactions. Direct contact and airborne chromium can cause skin problems in those who are sensitive. Patch tests can detect sensitivity. However, there is no information about the levels in the air that can result in skin problems for sensitized individuals.

Possible Immunological Effects Other than Allergic Reactions

The function of the immune system is to protect the person from foreign matter by distinguishing the foreign matter and neutralizing or eliminating it. The immune system is immensely complex and not contained within a single organ system but is present in lymph tissue throughout the body, the spleen, bone marrow, thymus and the blood stream. Failure of the immune system can result from the following: (1) an enhanced immune response that produces more damage than it prevents; (2) failure of self-recognition leading to autoimmunity; and (3) failure of adequate protection from an immune response (immunodeficiency).

In previous sections there are discussions of allergic responses of the lungs and skin that may occur after exposure to chromium. A few contentious reports have suggested that exposure to chromium compounds may result in the formation of anti-DNA antibodies (108, 109). However, the relationship between the formation of these antibodies and autoimmune disease is unknown. In this section, CDHS describes changes in immune system components that have been found to relate to chromium exposure, primarily related to immunodeficiency. The changes include increases or decreases to 1) cells of the immune system (e.g., CD4, total lymphocytes) (110-113), 2) functionality of the cells of the immune system as measured by chemicals released by the immune system cells (e.g., Interleukin 6 and 8) (114, 115), and 3) responsiveness of the immune systems (lymphocyte activation after exposure to a known mitogen) (116, 117).

These changes have not always been consistent from study to study. Inconsistencies could be due to the difficulties of the assays and/or variation in the population. These assays are not typically run when a person sees their physician. Because they are research tests and not standard medical tests, interpretation is difficult. It is not clear how these changes relate to toxicity. For example, there has been some indication that children with decreased levels of some immune system components experience a increased number of infections per year (111). These changes may be part of the body's adaptive response to the chromium and not necessarily a toxicological response. On the other hand, a change in immune function caused by chromium, especially in already-compromised individuals, could result in an inability of that person's body to adequately respond to exposure to another substance or infectious agent.

Kidney Effects

Effects on the kidney are often cited as the primary systemic, noncancer adverse health effect of chromium. However, chronic renal disease due to occupational or environmental exposure to chromium has not been well documented. There was one reported case study of a plasma-cutting stainless steel worker who developed renal disease (chronic interstitial nephropathy) (118). Chronic renal disease can result in failure of the kidney(s) and the need for kidney transplantation. One study found that 272 individuals with chronic renal failure compared to an equal number of matched controls had a significantly elevated risk for renal failure based on exposure to a number of environmental agents, including chromium (119).

It has been shown that massive exposure (15 mg/kg body weight) to potassium chromate can cause acute tubular necrosis (ATN) in animals (120). This disease, if recognized early enough, can be treated with dialysis and result in full recovery of the individual.

Many occupational studies and several community studies have examined markers of kidney effects of chromium by studying changes in components in the urine. It is not clear what correlation exists between changes in these kidney effect markers and relevant damage to the kidney(s). For example, some studies of chrome platers, chromate production workers, and stainless steel welders have found excessive urinary excretion of proteins indicating that the proximal tubule part of the kidney has been affected (N-acetyl-β-gluosaminidase, β-glucuronidase, β2-microglobulin and brush border protein) (43-46, 121). Some studies have found changes in the kidney effect markers in current workers but not in ex-chrome workers (30, 46). These studies found effects as low as 4 $\mu g/m^3$ with a 5.3-year average work time, 4.2 $\mu g/m^3$ mean concentration (range 0.4 to 18.2 $\mu g/m^3$) with a 5.8-year average exposure, and 50 $\mu g/m^3$ to 1,000 $\mu g/m^3$ with a seven-year average exposure (30, 43, 46).

Still, other studies have not found these or other changes in the urine of workers (122, 123). There are many reasons that all these studies did not find the same effects, some these reasons include: 1) some of these kidney damage markers are not well validated; 2) some of the effects may be reversible; 3) some of the markers return to normal levels within a few days of the exposure despite renal damage; and 4) many markers have large inter-individual variation, making changes in the levels due to chromium harder to detect.

Examination of the urine of people who were lifetime residents of a contaminated area near chromium landfills, where environmental exposures to chromium dust occurred, did not reveal evidence of tubular proteinurea or signs of pre-clinical kidney disease (120). Urinalysis results revealed no difference between housewives who lived near a chromium slag construction site and the control population (124).

It is likely that occupational or higher levels of exposure to hexavalent chromium could result in kidney effects. However, the extent of renal injury from this exposure is not known. These effects may be reversible after exposure ceases, though this is not well studied. Chronic renal failure is not known to be associated with chromium exposure.

Liver Effects

After exposure, chromium is found in the liver, which indicates that it could have a toxic effect depending upon the ability of the liver to convert hexavalent chromium to trivalent chromium by a mechanism that does not result in damage to the cell. There are two studies showing effects of occupational exposure to chromium and effects on the liver. The levels of exposure associated with these toxic effects were not reported in these two studies:

- Hexavalent chromium has been reported to cause alterations in cell structure, increased cell death followed by an immune response (lymphocytic and histiocytic infiltration and increases in Kupffer cells) in four of five workers in the chrome plating industry. Several liver function tests (sulfobromophthalein retention, gamma globulin, icterus, cephalin cholesterol flocculation and thymol turbidity) were altered (48).
- Increased deaths from cirrhosis of the liver compared with national rates were seen in 4,227 workers involved in stainless steel production from 1968 to 1984. Stainless steel workers are typically exposed to hexavalent chromium particulate. Cirrhosis is irreversible alteration of liver structure such that fibrous tissue has been laid down after continuous insults. Individuals with cirrhosis have a poor prognosis for survival (125).

Gastrointestinal Effects

Gastrointestinal effects have been noted in workers when exposure was similar to that at Remco (mist form) and at facilities where hexavalent chromium was present in the air in particulate form (like a dust particle). These effects on the gastrointestinal system are probably due to chromium being swallowed after some of it was breathed in through the mouth or cleared from the respiratory/lung system and swallowed.

Effects in hexavalent chromium workers have included stomach pain, stomach cramps, frequent indigestion, and ulcers. The workers experiencing these effects were exposed to mean concentrations of 4 $\mu g/m^3$ for an average of 7.5 years (28). Workers exposed to particulate hexavalent chromium as particulate have reported ulcers, hypertrophic gastritis, and colitis (103, 126, 127).

If workers in the hexavalent chromium industry are more likely to have gastrointestinal effects, these effects do not seem to contribute to their death. A lower than expected incidence of death from diseases of the digestive tract was found among a cohort of 2,101 employees who had worked for at least 90 days during the years 1945-1959 in a chromium production plant in Baltimore, Maryland. These workers were followed until 1977 (128).

Reproductive Effects

After exposure, chromium has been found in male reproductive organs. There are questions about its toxicity to these organs and in particular its effect on reproductivity. There is limited information regarding chromium effects on female reproductivity, while the studies on male reproductivity suggest an effect.

Two Russian studies found effects of chromium exposure on complications during pregnancy (toxicosis) and childbirth (post-natal hemorrhage) in women who worked in factories where chromate was made (129, 130). These studies are not of good quality and are poorly reported. There are no other studies of effects on women's reproductive function.

Several studies of stainless steel welders that assessed chromium effects on male reproductivity have been conducted in Holland. Stainless steel welders are exposed to hexavalent chromium particulate, nickel, and manganese. No exposure levels were reported. Stainless steel welding has reported in other literature to have levels of chromium near 50–400 $\mu g/m^3$ in the early 80s and more recently median levels of 4 $\mu g/m^3$ to 10 $\mu g/m^3$ with a maximum level of 80 $\mu g/m^3$.

- A study of more than 10,000 male metal workers in Denmark during 1973 to 1986 found an increased risk of self-reported spontaneous abortions for spouses of stainless steel workers (1.9, 1.1-3.2), but not for those of mild steel workers. Mild steel workers are not exposed to hexavalent chromium. The occurrence of reduced birth weight, preterm delivery, infant mortality and congenital malformation was not increased among children at risk from paternal welding exposure. The overall incidence of childhood malignancies was similar to national rates (26).
- Spontaneous abortion risk among 2,520 pregnancies of 1715 spouses of metal workers from 1977 through 1987 did not increase. This study, unlike the previously mentioned self-reported study, examined hospital registry data. Thus this study did not account for early pregnancy spontaneous abortions that would not have necessarily required a hospital visit (131).
- Increased risk (3.5 RR, 1.3-9.1) of biochemical and clinically recognized spontaneous abortions occurred to spouses of stainless steel welders (chromium exposure) but not to spouses of other kinds of welders (132). These same workers did not have differences in sperm density, motility, morphology (shape and structure of the sperm) or hormone levels (133). Study participants included in this perspective study were first time pregnancy planners without prior reproductive experience. The risk of pregnancy loss increased as the number of years of stainless steel welding increased.
- Sperm parameters (quantity, motility, shape) and hormone levels were not statistically different in 30 stainless steel workers, 30 mild steel workers, and 47 non-welding workers (134).
- Semen analysis of 55 men in the welding industry found a higher risk (2.0, 1.16-3.45) of poor sperm quality compared with metalworkers not in the welding industry and unexposed workers. Poor sperm quality was defined as sperm concentration less than 20 million/milliliter; less than 50% of the sperm cells motile; or less than 50% of the sperm cells with a normal morphological appearance (47).

In a recent Chinese report, investigators examined 21 workers exposed to hexavalent chromium in an electroplating factory and 22 workers from the same factory who were not exposed to chromium (135). They found a statistically significant decrease in sperm counts and sperm motility, a deficiency of several components of seminal fluid (zinc, lactate dehydrogenase, and lactate dehydrogenase C4 isoenzyme), and a decrease of blood hormone important in spermatogenesis. On the other hand, there were no significant differences seen in another hormone in the blood, in semen volume, semen liquefaction time, or in the amount of chromium in serum or seminal fluid.

Chromium inhalation exposures in rats have not resulted in abnormal changes in the structure or cells of the male and female reproductive organs (8, 136). However, a number of mice and rat studies have shown alterations in reproductive function when the chromium was given orally. These effects include reduced sperm count, alterations in sexual behavior (less sexually active males), less numbers of follicles (pre-eggs), and increases in pre-implantation losses, and resorptions (spontaneous abortions).

On this basis, inhalation of hexavalent chromium may have an effect on male reproductivity. There is not enough information about effects on female reproductivity from inhaling chromium. It has not been well studied.

Effects that Have Been Studied and Do not Seem To Be Associated with Chromium Exposure

Possible Cardiovascular Effects

There have been a few investigations of various sorts of cardiovascular effects and chromium exposure (50, 84, 103, 125). Most have not found an association of hexavalent chromium exposure with cardiovascular effects. One study reported that workers with respiratory effects and gastrointestinal effects had changes in the bioelectric and mechanical activity of the heart muscle. The study concluded that these changes could be secondary to an effect on the respiratory system or could be from a direct effect on the heart (137). In one animal study there were no lesions found in the hearts of rats exposed chronically to chromium (136).

If workers in the hexavalent chromium industry are more likely to have cardiovascular effects, these effects do not seem to contribute to their death. A lower than expected incidence of death from diseases of the cardiovascular system were found among a cohort of 2,101 employees who had worked for at least 90 days during the years 1945-1959 in a chromium production plant in Baltimore, Maryland. These workers were followed until 1977 (128)

Hematological Effects

The blood is responsible for transporting material and carrying oxygen throughout the body. The blood contains cells that are involved in the immune system (see section about immune effects of chromium) and cells that protect the body from loss of blood if injury occurs. The blood system includes bone marrow, red blood cells, white blood cells called monocytes/macrophages, platelets, and granulocytes.

There has been one study showing an effect on the non-immune aspects of the blood. A study of 97 workers employed at a chromate plant found leukocytosis in 14% of the workers and leukopenia in 19.6% of the workers. Decreases in hemoglobin concentrations and slight increases in bleeding time were also reported (126). However, several other studies of workers have not shown effects on red or white blood cell counts and hemoglobin (50, 103, 122).

Cancer Health Effects

There is a vast amount of evidence from scientific studies that show chromium inhalation exposure can cause lung cancer. More than 30 scientific studies were located which noted excesses in lung or respiratory system cancers among people who work with chromium. Seven additional studies were located in which an excess of lung or respiratory cancer was not found, although some of these included workers who had shorter exposure periods. Some studies involved only exposure to trivalent chromium, but not hexavalent chromium (76-79). The increases in cancer seen among these workers covered a broad range. Although some the studies did not find an elevation or the elevation was not statistically significant, many were able to detect significant elevations when the amount of lung cancer was about 2 times as high as expected. One study had an unusually high incidence of lung cancer among chromium pigment workers: 44 times more lung cancer than expected (Langard & Vigander 1983).

In many of the occupational studies that found elevated lung cancer to be associated with chromium exposure, other cancers were also evaluated, but lung cancer was the only cancer that was found to be elevated. The International Agency for Research on Cancer (IARC) has evaluated chromium and concluded that “There is sufficient evidence in humans for the carcinogenicity of chromium[VI] compounds as encountered in the chromate production, chromate pigment production and chromium plating industries.” (138). Within its evaluation of epidemiological studies at the time of publication (1989) it stated that, "for cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds.” In 1988, the World Health Organization similarly did not find enough evidence to classify chromium as a causative agent of cancers other than lung (139).

However, although inconsistent, some studies have found elevations of cancers other than lung, nasal and sinus cavity. Besides respiratory cancer, ATSDR identifies oral cavity cancer and stomach cancer to be potentially related to chromium inhalation exposure (36). A high number of precancerous oral cavity lesions were found among a group of Czech chromium platers (36). Stomach cancer has been found to be significantly elevated in some studies of platers (Sorahan, Franchini) and other chromium-exposed workers (44, 82-85). An early study of chromate production workers at five plants in the U.S. found rates of cancer of the digestive tract to vary from 0 to 3.04/1,000 compared to 0.59/1,000 for controls (Machle & Gregorius 1948, reported in WHO document 1988) (139). Also, several studies have found a significant association between chromium and bladder cancer (Rosenman, Becker), including a case-control study of bladder cancer and occupation that identified this relationship (Kunze), which adds strength to the validity of this potential association (84, 86, 87). Two studies found liver cancer mortality to be significantly elevated among chromium exposed workers (82, 88). Additional data on other cancer sites would be helpful in understanding these questions.

The author (Max Costa) of one review article identified studies of cancer in which chromium exposure was present. These types of cancer included prostate, lymphoma, leukemia, bone, stomach, genital, urinary tract, renal, bladder, and testicular, and Hodgkin's disease (91). Without additional evidence, many of these findings would typically not be considered meaningful for a number of reasons. In many of these studies, there were only a few cases, so it is hard to say if chromium exposure was related to those few individuals in the study who got cancer. One study had two cases of prostate cancer but only 1.04 cases expected (140). It is possible to estimate the number of cancers expected in a study on the basis of how many people are being studied and other factors. This is discussed in more detail in the following section. Typically, results that are based on very few events and could easily have occurred by chance are not considered significant findings. However, if such a result were seen over time in many studies, it would be considered worthy of further investigation. In other studies, workers also had also been exposed to other hazardous chemicals, so it was not possible to know if chromium exposure caused the cancer.

In another study, an elevation was noted in prostate cancer, but the elevation occurred similarly both among people who worked in the chromium department, and among non-chromium exposed people who worked in other departments (35). In this study, there was a significant increase in lung cancer among those in the chromium department (as might be expected), and no lung cancer cases were found among the non-chromium workers. Although prostate cancer may have been elevated in the study, the overall evidence did not suggest that the cancers were related to the chromium exposure received by only a portion of the workers.

There are a few studies of residents near chromium facilities, but these few studies did not find that residents had worse health. A Swedish study of 810 lung cancer deaths found no association with residence near local ferrochromium alloy industries (141). Studies in the People's Republic of China did not find consistent associations between cancer and exposures from an alloy plant that smelted chromium (142).

<u>Occupational Studies with Chromium Exposure Measurements</u>

A few studies reported estimates of the chromium levels to which workers had been exposed. One study estimated worker hexavalent chromium exposure levels to be 413 $\mu g/m^3$ during the years 1945–1949 (25). The study included 1,803 male chromium chemical production workers employed during those years, whose vital status and cause of death was then ascertained as of 1977. The exposure estimates were based on historical measurements made by the Baltimore City Health Department. Another estimate of 218 $\mu g/m^3$ was made for the years 1950–1959 and was based on measurements made during an industrial hygiene survey. An increase in the number of deaths from lung cancer was found among different groups of exposed workers for both exposure situations (413 $\mu g/m^3$ and 218 $\mu g/m^3$). A Standardized Mortality Ratio (SMR) is often used to assess the number of observed deaths to determine if they are more than or less than the number of expected deaths. The number of expected deaths for a particular worksite is based on the death rates in a comparison population. This study also found that the SMR also depended on how long the workers had been exposed. Short-term workers (those who worked between 90 days and 3 years) had a SMR of 1.75 for lung cancer during the earlier, high-exposure period. This means that the number of lung cancer deaths was 75% higher among this group when compared with the general population. Long-term workers (more than 3 years) had an SMR of 3.04 for lung cancer. This exposure group experienced about 3 times as many deaths as expected; 4.3 deaths were expected but 13 occurred.

Exposures were often categorized by levels such as low, moderate, and high to determine if the number of cancers increased at higher exposures. In one study by Dr. Thomas Mancuso, records of employees who had worked from 1931–1937 at a chromate plant were followed up in 1974 to observe how many persons had died from lung cancer (52). There were 332 employees in the original group, and 174 had died by 1974. As no environmental study of chromium exposures had been done during the early years of operation of the plant, weighted average exposures for the year 1949 were used to estimate the exposure levels for that time period. The number of deaths from lung cancer increased with each level of increase in chromium, both for insoluble and soluble chromium (most insoluble was probably trivalent chromium, and most soluble was probably hexavalent chromium). With each increase in chromium exposure level, the rate of deaths compared with the number of people who were studied increased steadily.

In another study, exposure levels were estimated to be between 500 $\mu g/m^3$ to 1500 $\mu g/m^3$ for the nine individuals who developed bronchial cancer, although the sampled levels in the facility were generally lower (60).

Appendix F—Evaluation of Community Health Concerns

The following section summarizes community health concerns expressed to CDHS and provides general information about these health concerns. The health concerns that follow either have not been studied for their association or are not considered to be associated with exposure to chromium.

Cancer Concerns

Cervical Cancer

The cervix is the lower, narrow part of the uterus (womb). Approximately 15,000 women in the United States are diagnosed with cervical cancer each year. Symptoms usually do not appear until abnormal cervical cells become cancerous and invade nearby tissue. Abnormal bleeding (during or between menstrual cycles) is the most common symptom. Increased vaginal discharge is another symptom. Risk factors for cervical cancer include: having sexual intercourse before age 18 or having many sexual partners (increased risk of exposure to sexually transmitted viruses); smoking; being a women whose mother was given the drug diethylstilbestrol (DES) during pregnancy; being a women whose immune systems is weakened; and being a women who used oral contraceptives (although this is not always the case). Environmental tobacco smoke may also contribute to the development of cervical cancer (90).

Testicular Cancer

Testicular cancer is a disease in which cells become malignant (cancerous) in one or both testicles. This cancer can be broadly classified into two types: seminoma and non-seminoma. Seminomas make up about 30% of all testicular cancers. Non-seminomas are a group of cancers that include choriocarcinoma, embryonal carcinoma, teratoma and yolk sac tumors. Testicular cancer can be a combination of both types. An estimated 7,400 men in the United States were diagnosed with testicular cancer in 1999. Although testicular cancer accounts for only 1% of all cancers in men, it is the most common form of cancer in men between 15 and 35 years of age. Any man can have testicular cancer, but it is more common in white men than in African American men (143).

Symptoms include: a painless lump or swelling in either testicle; any enlargement of a testicle or change in the way it feels; a feeling of heaviness in the scrotum; a dull ache in the lower abdomen or groin; a sudden collection of fluid in the scrotum; pain or discomfort in a testicle or in the scrotum (143).

The causes of testicular cancer are not known. However, studies show that several factors increase a man's chance of developing testicular cancer: undescended testicle; abnormal testicular development; Klinefelter's Syndrome (a sex chromosome disorder characterized by low levels of male hormones, sterility, breast enlargement and small testes); and family history of testicular cancer (143).

Colon and Rectal (Colorectal) Cancer

The colon and rectum are parts of the body's digestive system that remove nutrients from food and stores waste until it passes from the body. Together, the colon and rectum form a long, muscular tube called the large intestine. Cancers affecting either of these organs may also be called *colorectal* cancer. Together, cancers of the colon and rectum are among the most common cancers in the United States. They occur in both men and women and are most often found among people who are more than 50 years old. Common symptoms of colorectal cancer include: a change in bowel habits; diarrhea, constipation or feeling that the bowel does not empty completely; blood in the stool; stools that are narrower than usual; general abdominal discomfort; weight loss with no known reason; constant tiredness; and vomiting. Risk factors associated with colorectal cancer are: age (more likely to occur as people get older); diets that are high in fat and calories and low in fiber; polyps (benign growths on the inner wall of the colon and rectum); personal or family history of colorectal cancer; and ulcerative colitis, a condition in which the lining of the colon becomes inflamed (90).

Breast Cancer

After skin cancer, breast cancer is the most common type of cancer among women in the United States. More than 180,000 women are diagnosed with breast cancer each year. Breast cancer affects more than 1,000 men in the United States each year. The exact causes of breast cancer are not known, but studies show that the risk of breast cancer increases, as a woman gets older. This disease is very uncommon in women under the age of 35. Also, breast cancer occurs more often in white women than African American or Asian women. Risk factors include: previous personal or family history of breast cancer; certain breast changes; genetic alterations; overexposure to estrogen or DES (a synthetic form of estrogen that was used between the early 1940s and 1971); late childbearing; breast density (breasts that have a high proportion of lobular and ductal tissue, not fatty tissue); radiation therapy; and alcohol. Scientists are examining at whether the risk of breast cancer might be affected by environmental factors. Other breast cancer studies are examining miscarriages and abortions; genetic mutations; and lifestyle factors, such as exercise and diet (90).

Brain Tumors

Tumors that begin in brain tissue are known as primary brain tumors. The most common brain tumors are gliomas that begin in the glial (supportive) tissue. Cancer that begins in other parts of the body may spread to the brain and cause secondary tumors, which are not the same as primary brain tumors. Although brain tumors can occur at any age, studies show that they are most common in two age groups: children 3 to 12 years old and adults 40 to 70 years old. The causes of brain tumors are not known (144).

The most frequent symptoms of brain tumors include headaches that tend to be worse in the morning and ease during the day; *seizures* (convulsions); nausea or vomiting; weakness or loss of feeling in the arms or legs; stumbling or lack of coordination in walking; abnormal eye movements or changes in vision; drowsiness; changes in personality or memory; and changes in speech. Obviously, these symptoms can be caused by something other than a brain tumor. Therefore, patients with a brain tumor have no clear risk factors. The disease is probably the result of several factors acting together. Some types of brain tumors are more frequent among workers in certain industries such as oil refining, rubber manufacturing and drug manufacturing. Other studies have shown that chemists and embalmers have a higher incidence of brain tumors. Researchers are also examining exposure to viruses as a possible cause. Because brain tumors sometimes occur in several members of the same family, researchers are studying families with a history of brain tumors to see whether heredity is a cause. At this time, scientists do not believe that head injuries cause brain tumors (144).

Leukemia

There are several types of leukemia. They are grouped in two ways: 1) how quickly the disease develops and gets worse; and 2) the type of blood cell that is affected. Leukemia can arise in either of the two main types of white blood cells referred to as lymphoid cells or myeloid cells. The most common types of leukemia are listed below:

- Acute lymphocytic leukemia (ALL) is the most common type of leukemia in young children. This disease also affects adults, especially those 65 years of age and older (145);
- Acute myeloid leukemia (AML) occurs in both adults and children. This type of leukemia is sometimes called acute nonlymphocytic leukemia (ANLL) (145);
- Chronic lymphocytic leukemia (CLL) most often affects adults older than 55 years of age. It infrequently occurs in younger adults, but it almost never affects children (145);
- Chronic myeloid leukemia (CML) occurs mainly in adults. A very small number of children also develop this disease (145).

Common symptoms of leukemia include: fever, chills and other flu-like symptoms; weakness and fatigue; frequent infections; loss of appetite and/or weight; swollen or tender lymph nodes, liver or spleen; easy bleeding or bruising; tiny red spots (called petechiae) under the skin; swollen or bleeding gums; sweating, especially at night; and/or bone or joint pain. Scientists know that leukemia occurs in males more often than in females and in Caucasians more often than in African Americans. Exposure to large amounts of high-energy radiation increases the risk of getting leukemia. Some research suggests that exposure to electromagnetic fields is a possible risk factor for leukemia. (Electromagnetic fields are a type of low-energy radiation that comes from power lines and electric appliances.) However, this link is not yet proven. Certain genetic conditions can increase the risk for leukemia. One such condition is Down's syndrome; children born with this syndrome are more likely to get leukemia than other children. Workers exposed over a long period of time to certain chemicals, such as benzene, are at higher risk for leukemia (145).

Noncancer Health Concerns

Reproductive Health Concerns

Female residents were concerned about reproductive health problems they were experiencing, including endometriosis. Other residents were concerned about birth and developmental effects.

Endometriosis

Endometriosis occurs when the endometrium—the tissue lining the inside of the uterus—grows outside of the uterus, usually on surfaces of organs in the pelvic and abdominal areas. The most common symptom of endometriosis is abdominal, lower back and pelvic pain. Other symptoms may include: extremely painful menstrual cramps; chronic pelvic pain; pain during or after sex;

intestinal pain; painful bowel movements or painful urination during menstrual periods; heavy menstrual periods; premenstrual spotting or bleeding between periods; and infertility. The cause of endometriosis is not known; however, current research projects are being conducted on genetic, endocrine (hormonal), and immune system links. Other research focuses on determining if there are environmental causes of endometriosis. Current research does not show an association between endometriosis and endometrial, cervical, uterine or ovarian cancers and environmental factors (90).

Irregular and Painful Menstrual Cycles

Menstruation is the cyclical discharge of blood and tissue from the lining of the uterus. In general, a menstrual cycle occurs every 28 days on average and lasts 2 to 7 days. Almost every woman will experience some menstrual irregularity during her lifetime. An occasional abnormal cycle does not indicate a persistent problem. Some causes of irregular or painful menstrual cycles are stress, bulimia (eating disorder), infectious sexually transmitted diseases, and strenuous exercise. Less common causes of menstrual irregularity are glandular problems, such as pituitary adenoma, thyroid disease and diseases of the adrenal glands; polycystic ovarian syndrome; inherited bleeding disorders; autoimmune thrombocytopenia; and leukemia (146).

Polycystic Ovary Syndrome

Polycystic Ovary Syndrome (PCOS) results from abnormal levels of certain hormones. It is generally considered a syndrome because it manifests itself through a group of signs and symptoms that can occur in combination, rather than having one known cause or presentation. PCOS affects an estimated 5 to 10% of women of childbearing age, and is a leading cause of infertility. It is the most common endocrine disorder among reproductive age women, affecting as many as 30% of all women. In some women with PCOS, hormone changes may begin as early as the very first menstrual cycle. In others, changes occur over time. Other signs and symptoms may include excess hair on the face and body; acne; skin darkening and texture change; obesity; vaginal yeast infections and hair loss. The exact cause of PCOS is unknown. Studies are underway to see if there may be a genetic link. Many current studies are focusing on the body's ability to process insulin. A growing collection of data suggests that elevated insulin levels are unhealthy and contribute to increased androgen production, worsening PCOS symptoms, and eventually increasing the risk of certain cancers, diabetes, and heart disease (90).

Birth Defects

About 150,000 children are born each year with birth defects. A birth defect is an abnormality of structure, function or metabolism present at birth that results in physical or mental disability or death. Several thousand different birth defects have been identified. Birth defects are the leading cause of death in the first year of life (90).

Birth defects are generally grouped into three major categories: a) structural/metabolic, such as missing or malformed limbs, spina bifida and urinary tract disorders; b) congenital infections, such as rubella, cytomegalovirus and sexually transmitted diseases; and c) other conditions, such as fetal alcohol syndrome, Rh disease, and cocaine use (90).

Both genetic and environmental factors can cause birth defects. However, the causes of about 60 to 70% of birth defects are currently unknown. A single abnormal gene inherited from parents can cause a birth defect. Abnormalities in the number or structure of chromosomes can also cause numerous birth defects including infertility, growth abnormalities, and behavioral and learning problems. Birth defects also may result from environmental factors such as drug or alcohol abuse, infections or exposure to certain medications or other chemicals. Many birth defects appear to be caused by a combination of one or more genes and environmental factors (90).

Developmental Disabilities

About 17% of children in the United States under age 18 have a developmental disability. Developmental disabilities are a diverse group of physical, cognitive, psychological, sensory, and speech impairments that begin anytime during development up to age 18. In most instances, the cause of the disability is not known. Approximately 2% of school-aged children in the United States have a serious developmental disability such as mental retardation or cerebral palsy, and need special education services or supportive care. Developmental disabilities that appear during childhood include attention deficit and hyperactivity disorder, autism spectrum disorder, cerebral palsy (which can also be classified as a birth defect), hearing loss, mental retardation, vision impairment, and epilepsy. The causes of many developmental disabilities are mostly unknown. Current research is focusing on genetic and environmental factors. However, certain causes of mental retardation are known and can be prevented (90).

Chronic Fatigue Syndrome

Chronic fatigue syndrome (CFS) is a complicated disorder characterized by profound fatigue that doesn't improve with bed rest and may worsen with physical or mental activity. CFS is an influenza-like condition that can drain your energy and sometimes last for years. It has no clear cause. CFS may occur after such infections such as colds, bronchitis, mononucleosis, hepatitis or intestinal illness. It can start during or shortly after a period of high stress or come on gradually without any clear starting point and any obvious cause. CFS is diagnosed more commonly in women than in men. An estimated 500,000 people in the United States have a CFS-like condition. Although CFS is most common in people 25 to 45 years old, it can affect people of all ages (89).

Unlike influenza (flu) symptoms, which usually subside in a few days or weeks, the signs and symptoms of CFS can last for months or years. They may come and go frequently with no identifiable pattern. In addition to persistent fatigue not caused by other known medical conditions, CFS has eight possible primary symptoms: loss of memory or concentration; sore throat; painful and mildly enlarged lymph nodes in the neck or armpits; unexplained muscle soreness; pain that moves from one joint to another without swelling or redness; headache of a new type, pattern or severity; sleep disturbance and extreme exhaustion after normal exercise or exertion. According to the Centers for Disease Control and Prevention, a person meets the diagnostic criteria of CFS when unexplained persistent fatigue occurs for 6 months or more with at least four of the eight primary symptoms also present. Other symptoms may include: abdominal pain; alcohol intolerance; bloating; chest pain; chronic cough; diarrhea or constipation; dizziness; dry eyes and mouth; earache; irregular heartbeat; jaw pain; morning stiffness; nausea; night sweats; shortness of breath; tingling sensations; weight loss and;

psychological problems such as depression, irritability, anxiety disorders and panic attacks. People with CFS usually experience the most severe symptoms within the first 1 to 2 months of illness. After that, a small number of those affected recover completely while a small percentage of others become incapacitated by their symptoms. For most people a gradual improvement occurs, although those affected by CFS often don't regain their normal level of energy. Doctors don't know the cause of CFS. Several possible causes have been proposed, including: iron deficiency anemia; low blood sugar (hypoglycemia); allergies to environmental elements; body-wide infections such as mononucleosis; dysfunction in the immune system; changes in the levels of hormones produced in the hypothalamus, pituitary glands or adrenal glands; and mild, chronic low blood pressure (89).

Diabetes

Diabetes affects more than 16 million Americans. It is a life-long disease marked by elevated levels of sugar in the blood. It can be caused by too little insulin, resistance to insulin or both. The three major types of diabetes are: type 1 diabetes, a condition diagnosed at birth that requires daily injections of insulin; type 2 diabetes, usually diagnosed in adults and caused by obesity and lack of exercise; and gestational diabetes, a condition that occurs during pregnancy in a woman who does not have diabetes. Symptoms include frequent urination, excessive thirst, hunger, fatigue, weight loss and blurry vision. An estimated 40% of type 2 diabetics have no symptoms of the condition. There are many risk factors for diabetes that include a family history of diabetes (parent or sibling), obesity, age greater than 45 years, being a person of certain ethnic groups (particularly African Americans and Hispanic Americans), gestational diabetes or delivering a baby weighing more than 9 pounds, high blood pressure, high blood levels of triglycerides, and a high blood cholesterol level (90).

Appendix G—Public Comments and CDHS/ATSDR Responses

Public Comments and Responses From the California Department of Health Services

On July 21, 2003, this Public Health Assessment (PHA) for the Remco site was released in draft for public comment. The comment period was scheduled to end October 6, 2003, but at the request of the City of Willits and Latham & Watkins (representing the responsible parties – Whitman Corporation/Pepsi America), the California Department of Health Services (CDHS) extended the public comment period to October 21, 2003.

As part of the release of this PHA, CDHS prepared a fact sheet that provides a summary of the PHA. This fact sheet was mailed to approximately 3,000 addresses in the Willits area. The PHA was placed in the local libraries for public review and comment. The PHA was mailed to more than 200 addresses from the CDHS mailing list for the Remco site. This list contains residents and former residents of the nearby neighborhood, other community stakeholders, civic and political interested parties, and government agencies. The PHA and fact sheet are available on the CDHS web site at www.ehib.org.

CDHS received comments from each of the following groups: Willits Citizens Advisory Committee, a former community member, Willits Citizens for Environmental Justice, North Coast Regional Water Quality Control Board (RWQCB), Technical Outreach Services for Communities (TOSC), County of Mendocino Department of Public Health, Erler & Kalinowski, Inc. (EKI) (representing the City of Willits), Latham &Watkins (representing the responsible parties), and the Willits Environmental Remediation Trust (WERT). The comments are provided in the following pages. Comments about typographical errors are excluded. When appropriate, a response from CDHS is provided in ***bold italics***.

Comments From Willits Citizens Advisory Committee

On page 2 you state "other chemicals such as cadmium, nickel, zinc and lead were released. The health problems that can be caused by exposure to these chemicals needs to be addressed as well. Computer air modeling did not factor in the toxic burner in back of the Remco plant. Ex-employees in depositions and at public meetings told of the use of this burner to reduce and evaporate liquid waste from all areas of the plant-paint, VOC's etc."

1) CDHS Response**:** ***CDHS recognizes and documents in the PHA that exposure from burning wastes may have occurred in the past. The air modeling conducted uses emission information collected during plating operations, which includes electricity usage, measurements of hexavalent chromium taken at the stack exhaust, temperature, exit velocity, and meteorological information. The type of activity (burning wastes) could not be factored in to the air modeling that was conducted. It is possible to model contaminants released as smoke plumes as a result of burning activities, however, information about the waste make-up, quantities, air measurements, and frequency of burning would be needed. While some of this information is known, key pieces are not. Thus, we cannot quantify or estimate exposures from these activities with any degree of confidence.***

On page 2 you state "exposure to hexavalent chromium is not the only cause of these noncancer and cancer health effects." Your health assessment is not complete until you address all the VOC's present and the health effects they cause.

2) <u>CDHS Response</u>: Similar to the response above, there was not enough information to estimate exposure to VOCs in the air from Remco activities. CDHS acknowledges in the PHA that residents could have been exposed to VOCs in the air.

On page 3 you state "Due to data limitations with these type of data, the cancer review is not an effective tool for studying and characterizing how exposure to hexavalent chromium increased the risk of cancer in the Willits area." The presence of VOC's has to be addressed. These chemicals cause different types of cancer than the ones listed in your report. The people of Willits need to be informed of these facts.

3) <u>CDHS Response</u>: The same limitations of the cancer review (particularly that it is a relatively small population in terms of the effectiveness of this type of statistical method) would apply to VOCs as well as chromium, but we would be at an even greater disadvantage in our ability to detect an increase in cancer. Due to the nature of VOCs (volatilize rapidly to the atmosphere) we would not expect very many, if any, community members to have received VOC exposure at levels of health concern. With chromium, we estimate that a substantial portion of the community had a completed exposure pathway from chromium, which we do not know existed for VOCs.

If you wish to collect data that is a more comprehensive picture of what occurred in Willits use the ex-students at Baechtel Grove school- do it right!!!!

4) <u>CDHS Response</u>: Your comment that suggests we track former students of Baechtel Grove school to evaluate their health status, applying epidemiological methods in a scientific study. CDHS staff has considered various health study options for the Willits community, including tracking former students who attended Baechtel Grove School. This type of study option was presented during the November 2003 a public meeting that CDHS held to discuss health study options with the community. At that time, it seemed that most of the audience was in favor of focusing on obtaining medical monitoring services for the Willits community, recognizing the limitations of an epidemiological study. The limitations/potential problems with such a study include: 1) the chromium exposures to students may not have been high enough to cause illness; 2) depending on whether we are studying cancer, due to the fairly long latency period of cancer, cancers might occur in the future and not be included in a study conducted in the present; 3) there may not be enough students to detect a change in cancer rates (from a statistical perspective); 4) illnesses found among students might be caused by other factors, not chromium; 5) the study might not find illnesses are higher or unusual among Baechtel Grove students, which might negate legitimate health concerns or not be believable; 6) the study results could be inaccurate due to incomplete information available on former students; 7) it may be difficult to get the names of students, and to accurately identify them as adults as they have moved and changed names; and 8) substantial funding would have to be located for such a study, requiring competing with other institutions and agencies for scarce dollars.

On page 4 you address the remedial activities at the Remco site. We wish to state that we want no work done till all residents on Franklin Street be relocated and no work be done during school hours when children are present.

5) <u>CDHS Response</u>: As work is proposed for the site, the RWQCB and CDHS will review the health and safety concerns for the nearby neighbors.

On page 5-"This public health assessment will focus on exposure to air releases of hexavalent chromium" you then state "CDHS will prepare a second comprehensive public health assessment." This report needs to and must address all VOC's present at the site or it will not be complete.

6) <u>CDHS Response</u>**: **The comprehensive PHA will evaluate potential exposure to all site-related contaminants in all media (soil, water, and air). However, the air pathway, for the most part, was evaluated in this PHA. As stated earlier, VOCs released to the air could not be estimated because a lack of data. We will address this pathway in the second PHA, to the extent possible.

On page 7 You state "CDHS has been conducting public health activities in the Willits community"-We have requested repeatedly that all chemicals of concern be addressed-You are not using all available data if you do not address the VOC's present.

7) <u>CDHS Response</u>**: **CDHS used all available data, but these data are not adequate to quantify the VOCs release from the site. (Please refer to CDHS response #6 above)

On page 9, Current/Future Inhalation Pathway, You state a potential pathway to hexavalent chromium and lead may become a problem with future remediation at the site" once again we want no further remediation till all Franklin street residents are relocated and none during school hours when children are present. Page 11.

8) <u>CDHS Response</u>**: **CDHS recognizes there is a great deal of concern about the safety of remedial activities at the site. CDHS staff reviewed work plans relating to remedial work conducted at the site during the summer 2003. As a result, additional monitoring was conducted to ensure identification and mitigation of any exposures of health concern, to the surrounding community. CDHS reviewed the air monitoring results; neither chromium nor lead were detected in any of the air samples. We will continue to work with the RWQCB staff to ensure adequate measures are in place to protect the community while remedial work is being conducted at the site.

There is insufficient data to estimate releases of other plating contaminants such as lead, cadmium, nickel and zinc. Why if you use computer models for hexavalent chromium, can you not do the same with these contaminants as well? Why can't you address health problems caused by these contaminants? We need to know the whole picture of what we were exposed to.

9) <u>CDHS Response</u>**: **In order to model the other plating contaminant released, emission rate and source test data would be needed. These data were never collected for contaminants other than hexavalent chromium. Like hexavalent chromium, lung cancer is the primary cancer associated with inhalation of cadmium and nickel. We will include information on health effects associated with other site-related contaminants in the comprehensive PHA and in future physician outreach activities.

You state the model may over estimate exposure concentrations- How can this be when all exposures are not being addressed?

10) <u>CDHS Response</u>*: *The statement refers to the air model estimates of hexavalent chromium.

On page 12 Galson Technical Services, Inc. noted that source tests sample results might have been biased on the low side due to long holding times before the lab analysis was conducted- Why were these not redone?

11) <u>CDHS Response</u>*: *CDHS has no information on decisions made with regards to the source testing in 1989. While it is not ideal that the samples exceeded their holding times, it does not invalidate the test. Remco did not pass emission requirements based on this source test, even though the samples may have been biased on the low end. As a result of the failed test, Remco added a filter to the scrubber and was retested in 1991. When new regulations are implemented, facilities are generally given a grace period to get their operations into compliance. CDHS recognizes that these lengthy time periods can be frustrating for the communities living near such facilities.

On page 11 How Contaminants Were Released Into The Air- The building was not air tight and the doors were left open for various reasons. Men have stated that during emergencies the doors were open to allow contaminants out.

12) <u>CDHS Response</u>*: *The comment is correct, in that contaminants can be released through cracks and open doors in buildings. The initial air modeling considered the predominant way hexavalent chromium was released to the air. The revised air model took into account releases from the building (fugitive emissions). As stated earlier, we were not able to estimate how much VOCs were released to the air, which likely occurred through openings in the building.

On page 17 You talk about toxicological evaluation- you mention the other contaminants to which they may be exposed. We want a health survey that addresses all chemicals we have been exposed to.

13) <u>CDHS Response</u>*: *While the PHAs include an evaluation of exposure levels that were present in the community and an assessment using exposure guidelines of whether those levels could have caused possible health effects, a "health survey" suggests that the community would be surveyed about health problems they are having, and that this information be related to the other chemicals that the community may have been exposed to. We are aware that this is of interest to at least some members of the community, and we have considered the feasibility of a number of health studies of this type.

Unfortunately, the same problems faced in the PHA about the lack of information on VOC data—and other chemicals—would also affect the usefulness of a health study. If we don't have accurate information on community exposure to VOCs (for example), then we are not able to understand what its health effects would be in the community. In particular, VOCs are very short-lived in the air; once they are released, they quickly disperse, and there is no way to measure what someone's exposure has been afterwards. If a study is performed and there is no specific information on exposures, then we have to make assumptions about presumed exposure based on location/proximity to the facility during various exposure periods. If the assumptions are incorrect, exposures will be misclassified, which could result in a false conclusion that there was no effect, when there may have been an effect.

Your Cancer and Noncancer Health Effects Evaluation seems to be misleading because you do not tell health effects that are caused by VOC's and a combination of hexavalent chromium and VOC's. The people of Willits deserve to be told the whole picture-not just the parts you want us to know.

14) <u>CDHS Response</u>*: *CDHS evaluates health effects of exposure for which adequate data is available. We were able to estimate exposure from inhalation of hexavalent chromium but unfortunately not VOCs, so we do not know what VOC exposure the community may have experienced. Our next PHA on other contaminants and pathways will discuss what is known about potential health effects of VOCs.

Exposure to chemical mixtures is not well studied. Synergism occurs when the combined toxic effects of two or more chemicals are greater than each chemical alone. This issue has not been studied for VOCs and chromium, and it is uncertain if there is a synergistic effect between them. Antagonistic effects occur when two chemicals interfere with each other's actions, leading to a less toxic compound. It is not known if chromium and VOCs produce an antagonistic effect.

There has been very limited toxicological study of the effects of chromium in combination with other chemicals. Most of the knowledge on health effects from hexavalent chromium exposure comes from studies of workers. These studies are typically based on workers in a particular facility. Although such workers often have more than one chemical exposure, the studies generally address the main exposure thought to be responsible for any health effects found, although the authors may note the possibility for another workplace contaminant to be contributing to any effect seen.

In animal studies on the other hand, the researcher can control the animal's environment and better isolate the exposure. In one study, for example, the effects of trivalent chromium and hexavalent chromium (sodium chromate VI) on liver toxicity from exposure to carbon tetrachloride (not a Remco related VOC) were studied by pretreating cultures of mouse hepatocytes (36). Results showed pretreatment of hexavalent chromium significantly reduced cell toxicity and lipid peroxidation caused by carbon tetrachloride exposure. Pretreatment with trivalent chromium did not have any effect on cell toxicity (36).

This is discussed in the community concerns section of the document, as it was raised as a concern by a number of community members.

On page 24 You talk about Baechtel Grove Middle School Staff. What about the students who went to school there and were exposed to Remco contamination?

15) <u>CDHS Response</u>*: *Baechtel Grove students are included and discussed in the Health Effects Evaluation.

Your cancer review on page 27 is not complete till it addresses the whole picture of contamination-We want to know what to expect from our over-all exposure to Remco contaminants.

16) <u>CDHS Response</u>*: *While the cancer review looked specifically at cancers potentially associated with exposure to hexavalent chromium, the review also looked at all cancer types combined. The number of observed cancer cases (363) was similar to the number expected (370).

Page 29 You talk about a small group of people being difficult to review. Take into account all the ex-students that went to Baechtel Grove school from the 1960's to the 1990's. That greatly increases your numbers.

17) <u>CDHS Response</u>*: *We will note your comment that suggests we track former students of Baechtel Grove school to evaluate their health status, applying epidemiological methods in a scientific study. CDHS staff has considered various health study options for the Willits community, including tracking former students who attended Baechtel Grove School. This type of study option was presented during the November 2003 public meeting that CDHS held to discuss health study options with the community. At that time, it seemed that most of the audience was in favor of focusing on obtaining medical monitoring services for the Willits community, recognizing the limitations of an epidemiological study.

The limitations or potential problems with such a study include:

- ***The exposures to students may not have been high enough or lasted long enough to cause illness.***
- ***Cancer takes a long time to develop. If any cases of cancer were caused by chromium exposure at the school, it may still be too early for it to have developed.***
- ***There may not be enough students to distinguish a change in cancer or (other illness) rates from random variation (this is a statistical problem).***
- ***Illnesses in students may be caused by other problems not chromium.***
- ***We may not be able to get complete enough information on former students, which can make the overall study results inaccurate.***

On page 36 You talk about cancer studies that involved only exposure to trivalent chromium. Why is the Willits Environmental Remediation Trust turning all hexavalent chromium into trivalent chromium if it causes cancer or other health effects as well?

18) <u>CDHS Response</u>*: *CDHS believes the comment refers to the remedial activities underway that will reduce hexavalent chromium to trivalent chromium in groundwater. The cancer studies involving trivalent chromium are related to inhalation exposure during chrome plating. The presence of trivalent chromium in the subsurface does not present an inhalation health risk because people are not coming into contact with contaminated water or soils.

On page 36 In your Noncancerous Health Effects (All Other Health Effect Besides Cancer) You list various illnesses that can result from exposure to hexavalent chromium. These illnesses and more besides can be caused from exposure to VOC’s as well. We want to know what we can experience health-wise from VOC’s and the other heavy metals present at the site.

19) <u>CDHS Response</u>*: *The comprehensive PHA will evaluate potential exposure to all site-related contaminants in all media (soil, water, and air). However, the air pathway, for the most part, was evaluated in this PHA. As stated earlier, VOCs released to the air could not be estimated because a lack of data. We will address this pathway in the second PHA, to the extent possible. CDHS will provide health education information to the community regarding potential health effects from VOCs used at Remco. In Spring 2004, CDHS conducted a physician training, which include toxicological information on VOCs.

On page 41 your section on Household Dust in Willits. What about the Franklin Street residents?

20) <u>CDHS Response</u>*: *The discussion in the PHA on limitation of sampling household dust and suggested housecleaning techniques pertains to Franklin Street residents as well.

On page 43 CDHS/ATSDR recommend the feasibility of medical monitoring/ clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to air releases of hexavalent chromium from Remco, between 1964-1995 to be considered." We want that to address all exposures including other heavy metals present and VOC's. We also want a health clinic established, paid for by the polluters and all health care to affected people be provided at no cost to them. We want this clinic staffed with competent medical personnel with expertise in toxicology and chemical exposure.

20) <u>CDHS Response</u>*: *Comment noted.

In conclusion we ask that you do a comprehensive health assessment that includes all chemicals (VOC's) and all heavy metals that the people of Willits have been exposed to in the past as well as in the present.

You were able to do a computer air-modeling report based on incomplete data and we feel you could do the same with the knowledge you possess at this time. You know the VOC's and heavy metals present on site and you could give us an approximation of what we can expect health-wise from these exposures. We feel extreme frustration that no one will address these issues. They are not going to go away. You need to address the other sites of pollution as well. The gun plant on San Francisco Street, Shell Lane, Page Pitts, etc. People in Willits have been exposed to hazardous Remco contaminants at more than the Remco site on Main Street. Please make this a known fact. The people of our town deserve to know the truth.

[Letter signed by the co-chairperson of the Willits Citizen's Advisory Committee (WCAC)]

Comments From a Former Willits Community Member

I recently examined a document titled *Final Report: Atmospheric Dispersion Modeling, Remco Hydraulics, Inc. Site, Willits, CA September 2002.* The report was prepared by Lockheed Martin, Inc. for the US EPA under contract 68-C99-223. I shall refer to this as the "Lockheed Report".

The conclusion of the report is incorrect because it assumes that the scrubbers were working. In fact, the filters were operating inefficiently. I have attached copies of three documents documenting that fact.

Exhibit A is a telephone message record form from Mendocino County Air Pollution Control. Notice the bottom entry for 11-5-90, which says that the scrubber will need further modifications to keep the air flow from going around the filters.

Exhibits B and C are copies of comments (and responses) that Janice Goebel of the California Water Resources Control Board (North Coast Region) made concerning the Remedial Investigation prepared by the Willits Environmental Remediation Trust concerning the Remco facility. These confirm that the scrubber system was not functioning properly.

Furthermore, although I do not have copies available at this time, former Remco employees have stated in depositions that the filters were not changed according to schedule.

The Lockheed Report seems to be based on sound methodology, but it lacks controls. As shown by the attached documents, the assumption that the scrubber system was operating at design efficiency is incorrect. Furthermore, the Lockheed Report lacks the controls that were promised at a Remco Site Team meeting.

At the Site Team meeting, a representative of the Center for Disease Control spoke about modeling the atmospheric dispersion of particles from the Remco facility. He was asked how a model of events that occurred up to 30 years or more in the past could be verified. He replied that the amount of plating, and consequent original source discharge, could be estimated from the electrical consumption of the facility. He also said that the records of filter replacement would provide another control. Neither of these controls are discussed in the Lockheed Report. If control information were provided, it might be possible to estimate the degree of efficiency of the scrubber system.

1) <u>CDHS Response</u>**: **The comments regarding filter replacement seems to refer to the period post 1989, when Remco installed an actual scrubber. Prior to 1989, Remco used demisters as a method of emission control, which did not contain filters. In 1989, the efficiency of the new scrubber was rated at ~98.5%, based on source testing at the facility. This did not meet emission control regulations (page 12, public comment draft PHA). As a result, in November 1990, Remco acquired additional equipment (filter) to improve the scrubber's efficiency. In 1991, source testing indicated an average scrubber efficiency of 99.991% (page 12, public comment draft PHA). CDHS is not aware of any records discussing the filter replacement schedule. However, if the filters were not maintained between 1991 (source test documentation of efficiency) and 1995 (facility closed) then the efficiency of the system would have been less than what Lockheed modeled.

As part of the public comment period of the PHA, CDHS was provided with limited electrical consumption records (amperage data) from 1990 and 1992. This information was collected when the facility was required to reduce emissions and does not provided an adequate representation of time periods prior to emission control regulations. It is worth noting that Remco's workload began to decrease in 1991, which further limits the usefulness of electrical consumption data collected during 1992, for estimating emissions during the earlier time periods (R. Wake, Remco employee [1971 – 1991], personal communication November 19, 2003). Lockheed and ATSDR considered all available data in conducting the air modeling for the Remco site.

Figures 3, 4, and 5 graphically display the model results. In view of the attached documents. Figures 4 and 5 underestimate the degree of contamination. Without other information to estimate the degree of efficiency, Figure 3 represents a conservative conclusion for the entire period 1966 through 1995. Figures 4 and 5 cannot be relied on.

2) <u>CDHS Response</u>*: *Since the public comment release of the PHA, CDHS was has acquired additional information relative to operations and emission control equipment used at Remco. It appears that the control efficiency (98%) assumed for Scenario 2 (1975 – 1990); Figure 4 of Lockheed report) may have been an overestimation of control. As a result, this time period has been remodeled to reflect more accurate information.

Attachments: Pages 142-144

MENDOCINO COUNTY AIR POLLUTION CONTROL
PHONE MESSAGE RECORD FORM

COPY

COMPANY NAME: Duall / Chemco
DATE: 3-26-90
ADDRESS:
PHONE #: (517) 725-8184
PERSON CONTACTED: Rob Tiech / Dan Stat[illegible]
POSITION:

MESSAGE

Did not pass - 2-23-90 test - Range of 0.035 to 0.027 mg/amp hr
New Pad
Increase air flow
fix drain -
Shut of 2 spray bars

2-3 wks - parts ready ≈ 4-15-90
installation End of April

7-20-90 telecon Ron Buddish - Scrubber did not pass 5-23-90 S-Test
Duall is ~~[illegible]~~ studying problem and preparing modifications - Ron does not have copy of S-Test results

11-5-90 Office conf. Ron Buddish & Ron Wake
Wet Scrubber - reps from Duall & Dupont out week of 10-15-90 to investigate - scrubber will need further mods - reinforcing to keep air flow from going around filters.

Ex.

The Willits Trust's responses to your comments are provided below. For convenience, your comments have been reproduced in italics preceding each response.

Comment 1: *The Executive Summary should be a stand alone document with enough information for the reader to follow without having to refer to the many tables, lab data sheets and appendices.*

Response 1: The Willits Trust agrees that the Executive Summary should be essentially a stand alone document. However, due to the large amount of data collected and summarized in the RI Report, it is obviously not possible to include all the data within the Executive Summary. Instead, the Willits Trust included figures which summarized the conclusions of the remedial investigation in the Draft RI Report. The Willits Trust intends to modify the Executive Summary in the Final RI Report by including additional figures that illustrate the Site Conceptual Model, as discussed in Section 6 of the Draft RI Report.

Comment 2: *Section 2.3.1.3.4 Chromic Acid Air Emissions, first paragraph includes the statement that the chrome tanks always had a scrubber system. The scrubber systems should be described in more detail in the RI report. It should also be noted that during an inspection of April 11, 1988, Regional Water Board staff noted that the vapor hoods over the "small chrome vats" did not capture all vapors from the area.*

Response 2: The existence and use of scrubbers at the Remco Facility is based on information the Willits Trust obtained from former Remco employee testimony. Section 2.3.1.3.4 of the Final RI Report will be revised to more completely reflect this testimony. Specifically, the following information will be added to the Final RI Report:

1) Reportedly, there were scrubbers installed on the horizontal chrome tanks at least as early as 1963 (Figg Hoblyn, 1997).
2) Prior to Building 1973 being constructed, the scrubber was reported located within Building 1964 (Wake, 1996). This original scrubber reportedly vented through the roof of Building 1964 (Wake, 1996).
3) Prior to construction of Building 1973, there was reportedly no scrubbers installed on the outside vertical tanks. (Wisdom, 2002)
4) A new scrubber system was reportedly installed in approximately 1976 within Building 1973 (Wake, 1996; Wisdom, 2002).
5) In the mid- to late-1980s a new scrubber was installed, which is referred to as a "mist eliminator". (Wake, 1996; Wisdom, 1997; Kaser, 1996). This

system was installed in the southeast corner of Building 1973 (Kaser, 1996).

Comment 3: *[Section 2.3.1.3.4] It should also be noted in this section of the report that the ventilation systems and/or scrubber systems did result in the discharge of chromium outside the building. Regional Water Board file record indicates that during storm events chromium from the roofed area was a source of chromium contamination in stormwater runoff. Chromium contamination from the roof drains is documented until the early 1990s.*

Response 3: The Draft RI Report does note that there were reported discharges of chromium to the roof from the scrubber. The Willits Trust would appreciate receiving any additional information the RWQCB has regarding documented discharges which was not previously made available to the Willits Trust as part of past information requests.

Comment 4: *Section 2.3.1.4, first paragraph states that the operational records are in the possession of Remco's last owner and are unavailable. An explanation of why the records are unavailable should be provided.*

Response 4: The Willits Trust has reviewed the operational records available to it. In the Final RI Report, the Willits Trust will clarify the efforts made to obtain the records and a brief summary of the operational records available to it.

Comment 5: *[Section 2.3.1.4] First paragraph contains a citation of an incident which resulted in a release of chromic acid. A large steel part punctured the inside liner of the tank, but the structural integrity of the tank was maintained. Please clarify how the structural integrity of the tank was maintained.*

Response 5: The Final RI Report will include a more detailed description regarding the incident in which a part was reportedly dropped and damaged one of the chrome plating tanks. The information the Willits Trust has regarding this event is from the deposition testimony of former employees and the testimony is not consistent regarding the extent of damage to the tank.

Comment 6: *[Section 2.3.1.4] Second paragraph: Regional Water Board staff recollect that a drain was present outside, near the vertical chrome plating tanks. The drain discharged to the chrome sump on the north side of the building. The sump would overflow during rainfall events due to the contribution of stormwater into the system.*

APPENDIX 3-2

APPENDIX 2-1

APPENDIX 3-1

Comments From the Willits Citizens for Environmental Justice

Thank you for sending us your Public Health Assessment (PHA) for evaluation of exposure to Historic Air Releases at Abex/Remco Hydraulics Facility, 934 South Main Street, in the City of Willits, Mendocino County, California, prepared by the California Department of Health Services (CDHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

This public health assessment addresses the public health implications from exposure to historic (1964-1995) air releases of hexavalent chromium from the Abex/Remco Hydraulics Facility. The California Department of Health Services (CDHS) has conducted a number of community outreach activities in the effort to collect and understand health concerns that our community members have expressed. We as Willits Citizens are grateful to have this health assessment process of evaluation of existing environmental concerns addressed. We feel that we need further assistance from CDHS and ATSDR to further evaluate the possible extra air emissions such as Volatile Organic Compounds etc. that we have read about in documents and heard in discussions with former Abex/Remco employees.

We agree that most, if not all, of the Willits Community was exposed to a lot more of these air emissions throughout all the years while Remco was in business.

Reasons are:

1. Remco employees would burn mixed chemicals out in back of Remco in barrels to vaporize chemicals. Former Remco employee Bob Frey, who made comments at different meetings, worked for Remco in the 1980s.

2. Mr. Wilson Paige would haul the Remco waste to Paige Pits and also burn the Remco chemicals in the pits on his property, which caused the wind drifts to float throughout the town of Willits in the 1970s.

3. Remco had a pit that was 36 inches deep where Remco employees would burn mixed chemicals in 24 hours a day, seven days a week. Then the resin from this burn pit had to be jack hammered out of this pit — before agencies came to inspect the Remco Facility.

4. We Citizens have dug in our soil; planted trees, and replaced sewer lines, where even now we are still being exposed to the contamination of Remco chemicals.

5. Records at the Mendocino County Air Quality Management District show that Remco had air emissions for only 16 hours a day, when Remco sometimes worked 24 hours a day **and** 7 days a week. When the employees were not working, the Remco facility would always keep the chromium tanks hot because it would take up to 3 days to heat them up to the degrees that it took to chrome the parts.

Documents:

California Regional Water Quality Control Board (CRWQCB) 10-26-90
Mr. Paul La Courreye

Subject: Site Inspection Reassessment for Remco Hydraulics Division, Willits, Mendocino County, California

June 14, 1982 Boiler blow down water containing chromium from fumes vented and generated from a caustic cleaning bath. Venting system was not rerouted to air scrubbing system. Contaminated water in the storm drain and catch sump was pumped out *and* hauled off site for disposal.

The summary states that our agency has observed that chromium dusts from on-site operations were found in several locations at the site. According to RWQCB, the dust could be airborne and carried by vehicles to off-site residents' areas surrounding the site. The sources of contamination are unknown at this time, but we suspect two sources may be from ventilation (inadequate air scrubbing facilities and contaminated dust).

4-27-83 Air Pollution Control District

4 Chrome plating tanks vent. The attached article explains this situation exactly as we saw it, chromic acid fallout on the roof. To permit or not to permit seems to be a local option. I have called the BAAPCD but their expert Herb Johnson is on vacation until May 2. It sounds like more a local nuisance problem than as air pollution problem. Ever had any complaints or indications that chromic acid splatter is leaving the property limit. Perhaps it should be watched closely in light of recent Toxics concerns. We probably would not issue a permit, but it could go either way.

3-26-90 Duall/Remco

Message: Scrubbers did not pass 2-23-90 7-20-90 Telecom Ron
Buddish. Scrubber did not pass

5-23-90 S-test Duall is studying problem and preparing modifications. Ron does not have copy of S-test results.

11-5-90 Office conf Ron Buddish & Ron Wake Wet Scrubber-reps from Duall and Dupont out week of 10-15-90 to investigate- scrubber will need further mods- reinforcing to keep air-flow from going around filters.

Summary

(Draft PHA p. 2) "From 1976 -1990 all tanks were connected to a pollution control device (scrubber); the scrubber used between 1976 and 1990, had an approximate efficiency of 98%, the scrubber used between 1991-1995 had an approximate efficiency of 99.991%."

1. Can the CDHS and ATSDR explain to us Citizens how your agencies could come up with these percentages of releases, when a number of former Remco employees have said that most of the time they did not use filters on the scrubbers?

1) <u>CDHS Response</u>*: *Prior to 1989, Remco used demisters as a method of emission control, which did not contain filters. These systems were reportedly maintained by being rinsed out with water (R. Wake, Remco employee [1972 – 1991], personal communication November 19, 2003). There was no site-specific technical documentation available on the efficiency of the

demisters used at Remco. In the absence of site-specific documentation, we used information contained in the USEPA Emission Factors Documentation for AP-42, which cites ranges of efficiency for different types of emission control equipment used in electroplating. We then contacted the Mendocino County Air Quality Management District (MCAQMD) to verify whether the estimated efficiency of 98% was reasonable, based on the limited information available about Remco operations and the USEPA report.

In 1989, Remco installed a scrubber, which was rated at ~98.5% efficient, based on source testing conducted at Remco. The results of this source test did not meet emission control regulations (page 12, public comment draft PHA). As a result, in November 1990, Remco acquired additional equipment (filter) to improve the scrubber's efficiency. In 1991, source testing indicated an average scrubber efficiency of 99.991% (page 12, public comment draft PHA. CDHS is not aware of any records discussing the filter replacement schedule. However, if the filters were not maintained between 1991 (source test documentation of efficiency) and 1995 (facility closed) then the efficiency of the system may have been less than the 99.991% modeled.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco. This has resulted in better understanding of past operations at Remco, which has allowed the opportunity to provide a more accurate depiction of past releases. This resulted in revisions to both the early and mid time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated to reflect revised meteorological data. ATSDR determined that levels of hexavalent chromium during the middle (1975 – 1989) and latest (1990 – 1995) time period could have been orders of magnitude higher than estimated by the model, depending on operational practices at Remco (Appendix D). The information (source testing) used in the air model is conducted under optimal conditions (best case). Even during the source testing, Remco had trouble getting the emission control equipment to operate properly (Appendix D).

"Since there were no actual measurements/samplings of hexavalent chromium in the air around the facility, or in Willits, and CDHS used a computer modeling to estimate exposures to hexavalent chromium."

2. How did the CDHS come up with certain numbers, when some employees said that Remco did not use filters—only when agencies would come to the Remco site for inspections?

2) <u>CDHS Response</u>: Please refer to CDHS response #1 above.

There is insufficient data to model releases of other plating contaminants.

3. Why is there insufficient data for other contaminants, when there was not enough data for the hexavalent chromium to prove that we were exposed to some levels?
4. Can't the CDHS and ATSDR use another computer model also for cadmium, lead, nickel, zinc, and all Volatile Organic Compounds (VOCs)?

5. Can CDHS and ATSDR look at Remco data and figure out how many chemicals. and in what quantities, were brought into the facility, how much was used in production, and subtract what could have been released into our environment?

3) <u>CDHS Response</u>*: *In order to conduct modeling on the other contaminants, source test information, emission rates, the frequency and duration of plating activity would be needed. There were no source tests or measurements conducted for the other plating activities at the site. Information describing the frequency of other types of plating is also unknown. Chrome plating was the primary type of plating operation conducted at the site and would account for the majority of exposures related to the plating operations.

It is possible to model VOCs, though it would be a very complex process requiring many assumptions. For example, a complete record of the amount of VOCs purchased, when, where, and how they were used, amount of waste generated, and ideally some air measurements, are just a portion of what would be required. These data are not available. The complexity of the modeling and the number of assumptions that would have to be made would undermine the scientific credibility and defensibility of such an exercise.

"While we are not able to quantify inhalation exposures to other plating contaminants and VOCs, we have provided health information about these other contaminants to local physicians.

In general, hexavalent chromium levels decreased the farther away they were from the site."

6. How can the CDHS and ATSDR know about this statement when, fog or air drifts could cause levels of hexavalent chromium to float at different levels in any direction?

4) <u>CDHS Response</u>*: *The air model provided an annual average concentration of hexavalent chromium at different locations in the community, based on weather data collected near the site and in other places in California. These data provide a weather pattern for an entire year. While it is not possible to know what the exact weather conditions were for the 32 years Remco conducted plating operations, average weather patterns in an area are relatively consistent from year to year. The comment is correct in that generally, as a contaminant is released in the air, it becomes more diluted the further away from the source.

An individual's theoretical increased cancer risk would be less if she/he did not live in Willits for the entire time period evaluated (1964-1975).

7. Can people who breathe in hexavalent chromium for a day have enough hexavalent chromium in their bodies to cause cancer at the levels emitted from Remco during the time frame while Remco was in business?

8. How much hexavalent chromium does it take for a person to get cancer?

9. What if some people have low immune systems, such as children, or elderly are they at higher risk for cancer?

5) <u>CDHS Response</u>*: *Cancer is a common disease that can be attributed to many factors. We do not know the amount of hexavalent chromium that would be required to show a cause and effect relationship. In worker studies, hexavalent chromium has been shown to increase the

number of lung cancers in workers. The levels these workers were exposed to were much higher than what has been estimated in the Willits community (refer to Table 6 for examples of hexavalent chromium levels seen worker populations). Further, not every worker developed lung cancer. We can only provide a theoretical increased risk from exposure that is averaged over a lifetime. There is no scientific approach to quantify theoretical increased cancer risks for a one-time exposure. The calculations used to estimate theoretical increased cancer risk take into account sensitive populations, such as children, the elderly, and immune compromised individuals.

"Between 1976 and 1990, estimated exposures to airborne hexavalent chromium were much lower than in previous years, 1964 – 1975."

10. How can the CDHS and ATSDR know about these levels, when men had burned mixtures of all chemicals for years, especially in the 80's and 90s?

6) <u>CDHS Response</u>: CDHS acknowledges and states in the PHA that other exposures occurred in the past. Due to a lack of data, these exposures cannot be quantified.

"Between 1991 and 1995, estimated exposure to airborne hexavalent chromium could have resulted in noncancer health effects for children in areas closest to the site."

11. How could the CDHS and ATSDR know of noncancer effects, when agencies do not know when, where, or how humans can get cancer?

7) CDHS Response: The evaluation of noncancer health effects assumes there is a threshold level where these effects are possible, based on studies of either humans (mostly workers) or animals. In contrast, when evaluating cancer health effects it is assumed there is no threshold level from exposure to carcinogens (exposure at any level poses an increased risk). Please refer to the Noncancer Health Effects Evaluation section in the PHA for a detailed discussion on how noncancer health effects are evaluated.

12. Do any agencies know how, when and where humans could get cancer?

8) <u>CDHS Response</u>: Cancer is a common disease with many known risk factors. With regard to hexavalent chromium (focus of the PHA), we do not know the amount of hexavalent chromium that would be required to show a cause and effect relationship. In worker studies, hexavalent chromium has been shown to increase the number of lung cancers in workers. The levels these workers were exposed to were much higher than what has been estimated in the Willits community (refer to Table 6 for examples of hexavalent chromium levels seen worker populations). Further, not every worker developed lung cancer. We can only provide a theoretical increased risk from exposure that is averaged over a lifetime. The calculations used to estimate theoretical increased cancer risk take into account sensitive populations, such as children, the elderly and immune compromised individuals.

"Since 1988 the Cancer Registry has collected information on the number of people who get cancer."

13. Does the Cancer Registry have a direct connection, where we Willits Citizens can go to be examined by doctors in other areas, and they tell us if we have cancer?

9) <u>CDHS Response</u>*: *The Cancer Registry collects information on the cancer cases diagnosed in California; it does not provide health services.

"CDHS concludes that releases of hexavalent chromium posed a public health hazard in the past (1964-1995). There is an indeterminate health hazard both currently and in the future from exposure to hexavalent chromium and lead in dust that may be generated during site/building remediation of demolition activities."

All of us Willits Citizens commemorate both your agencies for proving our current *and* future exposure to hexavalent chromium from the Remco Facility.

"CDHS is currently consulting with in-house experts (physicians) to determine the types of medical tests that would be beneficial for the community."

14. Why are the physicians that told us there was nothing wrong here gets to decide what tests we are to receive?

10) <u>CDHS Response</u>*: *CDHS has recommended a process to develop a protocol for medical monitoring to be initiated. We have consulted with physicians with in the CDHS to help outline some tests that might be beneficial. At this time, nobody has been given the authority to decide what tests the Willits community should receive, as the comment suggests.

"The Willits Trust implement adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. This should be conducted in conjunction with air monitoring, using detection limits adequate to protect public health."

15. We Willits Citizens don't trust the WERT to adequately measure of mitigate any resuspension of hexavalent chromium-contaminated dust or soils since we already have her contractors releasing dust in other activities at and near the Remco site. When she did air monitoring for the Pilot Study for Calcium Poly Sulfide in the year 2000 she released H2S gas and poisoned us before so why should we trust the WERT again?

***11) <u>CDHS Response</u>*: *Comment noted*.**

Demographics

"In 1995, 33% of the total population was under the age of 19: and 13% was over the age of 65, 14% is Hispanic or Latino."

16. How come this Public Health Assessment is not wrote in Spanish? Are the CDHS and ATSDR trying to be raciest? If not we suggest that this PHA be wrote in Spanish and commented on in the future for ALL Americans?

12) <u>CDHS Response</u>*: *CDHS developed a fact sheet summarizing the PHA, which was translated into Spanish and mailed directly to the Latino community. We have conducted outreach in the Latino community and have staff available to discuss the PHA with Spanish-speaking citizens who may wish to comment on the PHA. To date, we have not received any inquiries.

17. So why won't the CDHS /ATSDR look at these age group instead of just adults?

13) <u>CDHS Response</u>: CDHS considered all age groups in the evaluation.

"Population data for the Willits area could not be located for the 1960s and 1970s (A.Falleri, City of Willits, personal communication, June 13,2002)."

18. Can Willits Citizens for Environmental Justice (WCEJ) have a copy of these documents (A.Falleri, City of Willits, personal communication. May 29, 2002) (3)?

14) <u>CDHS Response</u>: CDHS files are open to the public for review. The substance of the communication cited is provided in the PHA.

"CDHS and ATSDR also gathered information about Beachtel Grove Middle School and Blosser Lane Elementary because of their proximity to the Remco site."

19. Can WCEJ get the information that the CDHS and ATSDR collected for the proximity of both Beachtel Grove Middle School and Blosser Lane School? And can WCEJ get any-other data that was collected for the schools for this PHA?

15) CDHS Response: CDHS files are available to the public for review. The information gathered about Baechtel Grove and Blosser Lane Schools relates to the student population and is provided in the PHA.

History of Chrome-Plating Operations and Pollution Control at Remco

"CDHS investigated the timing of the installation of the vertical tanks because this information is an important factor in characterizing exposures to the community. To date, the Willits Trust has not provided CDHS with information about these discrepancies. CDHS conducted a limited review of employee depositions, and found information that supports the ERM-West construction timeline (3,6). Therefore, CDHS is assuming that tanks Nos, 3-5 were installed between 1964-1966."

20. Why do the CDHS and ATSDR allow the Willits Trust to get away with all these discrepancies?

16) <u>CDHS Response</u>: CDHS does not have any authority to dictate how the Willits Trust documents data. However, since the public comment draft of the PHA, Whitman Corporation/Pepsi America's lawyers have made additional documents available to CDHS relating to the tank installation timeline. Based on a March 13, 2002, letter from the Willits Trust, to the RWQCB, and cited in the Final Remedial Investigation Report (footnote 9, page 2-16), these documents were apparently not available to the Willits Trust. (The above referenced letter can be found in the Final RI, Appendix 1-1, "Response to Draft RI Comments.")

"Limited information indicates that the new scrubber operated at 98% efficiently (it removed 98% of hexavalent chromium from the air before discharging to the outside). An air scrubber is a pollution control device that reduces the amount of contaminates in the air)."

Yes, we feel that a scrubber will work to keep air clean to a certain level, only if it is used properly. We have read documents that say Remco had a lot of problems with the scrubbers and they were broke down a lot sometimes as long as two months.

21. Could these vertical and horizontal tanks be run without any kind of scrubbers on them?

22. And at anytime, while Remco was in business were these vertical and horizontal tanks run without scrubbers or filters in them?

23. Why did the CDHS only use limited information on the scrubbers?

17) <u>CDHS Response</u>*: *The use of air pollution control equipment at Remco changed over the years. During early operations (1964 – 1975), the type of equipment used consisted of vapor collection systems that would pull the vapors form the tanks and discharge them into the air. This type of system does not remove the hexavalent chromium from the air. In 1976, Remco installed equipment known as demisters that removed a portion of the hexavalent chromium before discharging it to the outside air. In 1989, a true scrubber was installed at Remco, capable of removing (scrubbing) ~98.5% of the hexavalent chromium before discharging to the outside air (please refer to CDHS response #1). CDHS considered all the information available at the time in writing the draft PHA. Since the public comment draft, we have obtained additional information that has been incorporated in the final PHA.

"In 1989, a new scrubber (a wet collector) was installed in response to new State of California regulations that requires facilities to reduce hexavalent chromium emissions."

24. So did the State of California know in 1989 that hexavalent chromium was dangerous to human health that was omitted in the Willits air? Why were we not told by the State of California or any agency about Remco was poisoning us in 1989? Or not told before or after 1989?

25. Since CDHS and ATSDR does not know how much-hexavalent chromium was released into our air at anytime because they don't know for sure that Remco even **used** filters all the times. How can the CDHS and ASTDR tell us that we were only contaminated "a little, and not a lot" at anytime?

18) <u>CDHS Response</u>*: *The regulations adopted by the State of California requiring facilities to reduce emissions of hexavalent chromium were developed to protect public health. In 1991, source testing at Remco indicated that they had reduced emissions and were in compliance with regulations. The Mendocino County Air Quality Management District (MCAQMD) was the oversight agency (responsible for regulating air releases) during that time. Prior to 1989, there were no laws requiring facilities to reduce emissions; therefore, there was no mechanism (agency, staff, mandate) for the "State of California" to evaluate releases from facilities or notify communities.

Current/Future Inhalation Exposure Pathway

"CDHS has identified a potential exposed pathway to hexavalent chromium and lead from resuspension of contaminated soils or dust residue on building surfaces that may become entrained in the air during remedial and other activities at the site."

26. When WERT took the side of the building down for the excavation of soils could the Remco contaminates been in our air again?

27. Could the excavation exposure pathway been a problem for Willits Citizens, **or** anyone living or traveling around Remco during the remediation process of excavation even at low levels?

19) <u>CDHS Response</u>*: *CDHS reviewed all the air monitoring data collected during the preparation of and excavation of VOC-contaminated soils during the summer of 2003. Hexavalent chromium and lead were not detected in any of the dust samples collected around the perimeter of the site. Therefore, citizens would not have been exposed to these to contaminants during the remediation process. There were sporadic detections of a few VOCs; all were below levels of health concern.

Characterization of Exposure

"Computer air modeling is a mathematical way to estimate how much hexavalent chromium was released from Remco facility in the past, and also what the concentrations of hexavalent chromium were in different areas of the Willits community."

28. Did CDHS use any information for this PHA on what amounts of chemicals were brought by Remco or any MSDS reports from Remco used through out the years while Remco was in business?

20) <u>CDHS Response</u>*: *The estimated releases of hexavalent chromium were based on computer air modeling that utilized source test data and operational information. CDHS did not review information on the amounts of chemicals purchased by Remco or MSDS (material safety data sheets). While this information may help in understanding the types of chemicals used at the site, it does not provide a measure of exposure. The PHA process uses environmental data to evaluate exposure.

Overview of Computer Air Modeling

"There is insufficient data to estimate releases of from plating contaminants such as lead (anode), cadmium, nickel, and zinc."

29. How come CDHS can't use the estimates like the computer modeling for hexavalent chromium for lead (anode), cadmium, nickel, and zinc?

30. Could of the CDHS use the billing or receiving records for the computer modeling for lead (anode), cadmium, nickel, and zinc?

21) <u>CDHS Response</u>: In order to conduct modeling on the other contaminants, source test information, emission rates, the frequency and duration of plating activity would be needed. There were no source tests or measurements conducted for the other plating activities at the site. Information describing the frequency of other types of plating is also unknown. Chrome plating was the primary type of plating operation conducted at the site and would account for the majority of exposures related to the plating operations.

"REAC used the following information to construct an air model of historical levels of hexavalent chromium: 1) the types of activities carried out at the facilities; 2) the types of emission control equipment used; 3) source test information; 4) how contaminants were released into the air; and 5) meteorological (weather) data."

31. Did the CDHS discover that the Remco building was not airtight, and could get a lot of contaminates out of the building especially when the doors were open and holes in the roof?

22) <u>CDHS Response</u>: CDHS staff have been inside the Remco building on a number of occasions and observed that it is not airtight, as suggested by the comment. While it is true that contaminants can be released through cracks and openings in buildings, the majority of the hexavalent chromium released to the air would have been from the areas where the chrome tanks were vented, as estimated by the air model. ATSDR considered fugitive emissions in the revised air model, which did not affect the results in a significant manner.

32. Could residue left inside and on top of Remco building be the reason to show that the scrubber emission control equipment was not working properly?

23) <u>CDHS Response</u>: Since the release of the public comment draft of the PHA, CDHS has obtained information written by the Abex Corporation indicating the emission control equipment used at Remco (prior to 1989) was not working effectively, based on chrome staining and residue on the roof. Test results of chromium in runoff water provide added confirmation to the Abex Corporation's evaluation of Remco's emission control equipment. The air model has been rerun to account for this information.

33. Who source test information did the CDHS used to construct this air model?

24) <u>CDHS Response</u>: Galson Technical Services, Inc., as referenced in the PHA.

34. How much contaminates was released into our air during Remco activities?

25) <u>CDHS Response</u>: Please refer to the PHA for discussion on estimated levels of hexavalent chromium released to the air from Remco.

35. How is the metrological (weather) data figured out for Remco/Willits?

26) <u>CDHS Response</u>: The MCAQMD has a monitoring station on the roof of Safeway, across the street from Remco. The monitoring station measures hourly temperature, wind speed, and wind direction. Other weather data used to represent the upper atmosphere (thousands of feet up) was obtained from the closest station, located in Oakland. Cloud cover and cloud height information was collected from the airport in Ukiah.

Source test at Remco

"In 1989, Galson Technical Services, Inc., with oversight by Mendocino County Air Management District staff, conducted source testing at Remco to determine the amount of hexavalent chromium emissions in the scrubber exhaust."

36. How many times did the Galson Technical Services, Inc., and/or the Mendocino County Air Management District staff conduct source testing for scrubbers from Remco?

37. How many times a year was the testing of hexavalent chromium emissions done?

38. And did the hexavalent chromium show that all the tests were at levels that did not harm human health?

27) <u>CDHS Response</u>*: *There were only three source tests conducted at Remco. Galson Technical Services conducted one source test in 1989. There were two additional source test conducted, one in 1990 by a contractor for Remco, and another in 1991 for the USEPA. The source tests alone cannot be used to interpret public health implications. Source test information, MET data, and operational information can be used to estimate exposure through modeling, which was done for this PHA.

"Galson Technical Services, Inc. noted that these sample results might have been biased on the low side due to long holding times before the lab analysis was conducted. Because emissions were above the maximum scrubber exhaust limits (0.006 mg/amp-hr), Remco needed to improve its emission control (13)."

39. How can the Galson Technical Services even use these samples when they were being held to long?

40. If Galson Technical Services would of did the test for the air emissions and the test would of came out high like they expected would of the Remco Facility been shut down for releasing contaminates in the air or got a large fine?

41. Why wasn't the test re-done for safety reasons?

28) <u>CDHS Response</u>*: *While it is not ideal that the samples exceeded their holding times, it does not invalidate the test. Remco did not pass emission requirements based the Galson source, even though the samples may have been biased low. As a result of the failed test, Remco added a filter to the scrubber and was retested in 1991. When new regulations are implemented, facilities are generally given a grace period to get their operations into compliance. CDHS recognizes that these lengthy time periods can be frustrating for the communities living near such facilities.

"In 1991, Advanced Systems Technology, Inc., USEPA contractor, conducted source tests for hexavalent chromium to evaluate the efficiency of a coalescing mesh pad (a type of filter) that had been added to the scrubber."

42. Was this state of the art filter always used 24 hours a day 352 days a year at Remco?

29) <u>CDHS Response</u>: CDHS is not aware of the maintenance schedule for the scrubber filter. We have heard anecdotal reports that the filters were not maintained and removed because they restricted the airflow. This would have occurred between 1991 and 1995. The uncertainty of not changing the filters and/or malfunctioning equipment has been addressed in the uncertainty section of the ATSDR air modeling report (Appendix D) and in the Limitations of Evaluation Section of the PHA.

43. Could the scrubber system be used without a filter?

30) <u>CDHS Response</u>: The scrubber operated without the filter from 1989 – 1991, with an estimated efficiency of ~98.5%, based on the Galson source test. The filter was added to improve the efficiency of the scrubber in order to meet emission control regulations.

44. Can we get a copy of all evaluations of and how many times any companies or agencies came out to test Remco scrubbers?

31) <u>CDHS Response</u>: CDHS sent you copies of the source tests, per your request.

How Contaminates Were Released into the Air

"Contaminants released from area sources tend to have higher concentrations in the near field (the area closest to the source or tank) and do not disperse as far into the air."

45. If levels of hexavalent chromium are considered high for the Point source area how can the CDHS know that these concentrations will not disperse if released into the atmosphere or nearby areas at high concentrations?

32) <u>CDHS Response</u>: The air model provided an annual average concentration of hexavalent chromium at different locations in the community, based on weather data collected near the site and in other places in California. These data provide a weather pattern for an entire year. While it is not possible to know what the exact weather conditions were for the 32 years Remco conducted plating operations, average weather patterns in an area are relatively consistent from year to year. The comment is correct, in the sense that the air model cannot predict very accurately in areas close to the source, due to micrometeorological events caused by the building, trees and other obstructions. In general, as a contaminant is released in the air, it becomes more diluted the further away from the source.

Metrological Data

46. Where did the hexavalent chromium land when released from Remco when the wind was not blowing at different years?

33) <u>CDHS Response</u>: Hexavalent chromium converts to trivalent chromium in the presence of organic matter. The amount of total chromium in soil as a result of deposition is a complex issue that cannot be answered by a casual look at the data. Chromium is found naturally in soil with a great deal of variation. Surface soil collected in Willits has shown to contain total chromium concentrations ranging from 13.2 – 132 ppm. It is not possible to know how much of this is a result of deposition from Remco plating operations, versus natural background. Background can vary greatly: one study by the US Geologic Survey found an average value of

total chromium of 41 ppm for the Western United States, but the upper end of the range would be greater than this. In order to determine deposition impacts from airborne emissions, a study of chromium fate and transport in soil, additional soil sampling, modeling, and statistical analyses would be required. The total chromium levels detected in off-site soil are not at a level of health concern to children or adults.

Air Modeling of Hexavalent Chromium Concentrations, 1964-1995

Table 2. Source Test Data Used for Air Modeling

"Emission rates from source tests conducted in 1989, by Galson Technical Services, Inc., were used because these tests appear to be reflective of the historical time period, which was prior to regulations for reducing hexavalent chromium releases."

47. How could the 1989 source test be thoughtful/meditative when the Galson Technical Services, Inc. explained that the samples were held to long and could have been a higher reading for hexavalent chromium?

34) <u>CDHS Response</u>: Based on the available information, the Galson Technical Services report provided the most representative data reflective of the earlier time periods.

** Emission rates from the Advanced Systems Technology source tests conducted in 1991 were used to estimate hexavalent chromium releases from 1991-1995, when the facility closed.

48. Were their any other tests throughout the 1991-1995 years done by Advanced Systems Technology? Who paid for these test with Advanced Systems Technology?

35) <u>CDHS Response</u>: Advance Systems Technology was contracted by the USEPA and conducted source testing at Remco on one occasion.

There is an added degree of uncertainty in the modeled concentrations for homes directly adjacent to the facility due to the occurrence of micro-meteorological events (influences caused by buildings, trees or other localized obstructions). Concentrations in these areas could have been higher or lower depending on location and circumstances on any given day.

49. With the blocking of the Remco building and other obstructions such as trees, homes, etc. could Willits residents been higher contaminated with the hexavalent chromium than the Public Health Assessment explains if they were in the vicinity of the Remco pollution?

36) <u>CDHS Response</u>: Concentrations in these areas could have been higher or lower depending on location and circumstances on any given day, due to micrometeorological events caused by buildings, trees, or other localized obstructions.

Estimated Hexavalent Chromium Concentration, 1964-1975

"On the basis of the modeling results, the annual average concentrations of hexavalent chromium for 1966-1975 ranged between 0.05 $\mu g/m^3$ to 20 $\mu g/m^3$ (micrograms per cubic meter of air), depending on the location in the community (Appendix B, Figure 3)."

50. If a person that was visiting in Willits from 1966-1975 and the concentrations of hexavalent chromium was at 0.05 $\mu g/m^3$-20 $\mu g/m^3$ (microgram per cubic meter of air), and they were standing at the specific spot where the hexavalent chromium was being released from/Remco could of this person been contaminated by Remco?

51. And what are the chances of these visitors getting cancer or other known health effects?

37) <u>CDHS Response</u>*: *The air model produces an annual average concentration. This means depending on the weather, there are times and locations where hexavalent chromium may be in the air at some level (high or low) or may not be in the air at all. Thus, a visitor may or may not have been exposed to hexavalent chromium from Remco, depending on the day and location. It is very difficult to determine whether noncancer health effects could have occurred to someone visiting Willits. There is no scientific approach to quantify theoretical increased cancer risks for a one-time exposure.

Estimated Concentrations of Hexavalent Chromium from (1976-1990)

52. In 1976 did the Remco employees always use filters on the scrubbers and did the scrubbers always breakdown?

38) <u>CDHS Response</u>*: *Prior to 1989, Remco used demisters as a method of emission control, which did not contain filters. These systems were reportedly maintained by being rinsed out with water. There was no site-specific technical documentation available on the efficiency of the demisters used at Remco. In the absence of site-specific documentation, we used information contained in the USEPA Emission Factors Documentation for AP-42, which cites ranges of efficiency for different types of emission control equipment used in electroplating. We then contacted the Mendocino County Air Quality Management District (MCAQMD) to verify whether the estimated efficiency of 98% was reasonable, based on the limited information available about Remco operations and the USEPA report.

In 1989, Remco installed a scrubber, which was rated at ~98.5% efficient, based on source testing conducted at Remco. The results of this source test did not meet emission control regulations (page 12, public comment draft PHA). As a result, in November 1990, Remco acquired additional equipment (filter) to improve the scrubber's efficiency. In 1991, source testing indicated an average scrubber efficiency of 99.991% (page 12, public comment draft PHA. CDHS is not aware of any records discussing the filter replacement schedule. However, if the filters were not maintained between 1991 (source test documentation of efficiency) and 1995 (facility closed) then the efficiency of the system would have been less than the 99.991% modeled. ATSDR determined that operational issues identified during the source test suggest the system may not have achieved this level of efficiency under normal operating conditions and acknowledge that there would have be a great deal of variation in the amount of hexavalent chromium released if the equipment was not maintained properly (please refer to Appendix D for a detailed discussion of uncertainty associated with the air model and the Limitations of Evaluation Section of the PHA).

52. What are the levels of trivalent chromium that cause cancer?

39) <u>CDHS Response</u>*: *Trivalent chromium is not considered carcinogenic.

53. Was the tests on the scrubbers for the years 1976-1990 consistent for the whole year or were the scrubbers only tested once for the whole year?

40) CDHS Response: ***There were only three source tests conducted at Remco. Galson Technical Services conducted one source test in 1989. There were two additional source test conducted, one in 1990 by a contractor for Remco, and another in 1991 for the USEPA. The source tests alone cannot be used to interpret public health implications. Source test information, MET data, and operational information can be used to estimate exposure through modeling, which was done for this PHA.***

54. Where was the test for the range of 0.02 $\mu g/m^3$ to 1.0 $\mu g/m^3$ taken at for the years 1976-1990?

41) CDHS Response*: *The concentration range referred to by the comment is an estimation produced by the air model, not a measured concentration.

55. Were their any tests done off the Remco site or for the surrounding area for hexavalent chromium?

42) CDHS Response*: *As stated in the PHA, no air measurements were collected in the Willits community during Remco operations.

56. Is there any volume of records that explain how many filters were brought for the Remco site for the scrubbers in 1976-1990?

43) CDHS Response*: *Between 1976 and 1990, demisters that did not contain filters were used at Remco.

57. If the scrubbers were working right, why was all the hexavalent chromium on the roof and in drains?

44) CDHS Response*: *Since the release of the public comment draft of the PHA, CDHS has obtained information written by the Abex Corporation indicating the emission control equipment used at Remco (prior to 1989) was not working effectively, based on chrome staining and residue on the roof. Test results of chromium in runoff water provide added confirmation to the Abex Corporation's evaluation of Remco's emission control equipment. The air model has been rerun to account for this information.

Estimated Concentrations of Hexavalent Chromium from Air Model (1991-1995)

58. At what location was the highest level for hexavalent chromium in 1991-1995?

45) CDHS Response*: *Please refer to the contour map (Figure 5) in the PHA.

59. How do CDHS and ATSDR know that the levels for hexavalent chromium at all times during 1991-1995 were at the levels that were reported? When formers Remco employees have said they burned mixtures of Remco chemicals and did not use filters all the time?

46) <u>CDHS Response</u>*: *CDHS recognizes and documents in the PHA that exposure from burning wastes may have occurred in the past. The air modeling conducted uses emission information collected during plating operations, which includes electricity usage, measurements of hexavalent chromium taken at the stack exhaust, temperature, exit velocity, and meteorological information. The type of activity (burning wastes) could not be factored in to the air modeling that was conducted. It is possible to model contaminants released smoke plumes as a result of burning activities, however information about the waste make-up, quantities, air measurements, and frequency of burning would be needed. While some of this information is known, key pieces are not. Thus, we cannot quantify or estimate exposures from these activities with any degree of confidence. The Limitations of Evaluation Section of the PHA acknowledges these issues.

Estimation of the Size of the Populations within Different Exposure Contours

"Because the more detailed census information was only readily available for the 2000 census, we created an estimate based on this information by applying the percentage change in the Willits city population to estimate roughly the percentage that would have been present in previous decades."

60. Did CDHS use the populations of the surrounding area of Willits, or just the City of Willits for the populations of Willits?

61. Did the CDHS use the populations of all the citizens because in the 60's-80s the Willits Schools population would be a great source to study and seemed to be larger than it is now?

47) <u>CDHS Response</u>*: *We estimated the size of the populations living within each of the hexavalent chromium contours for the years Remco conducted plating operations (1964 – 1995), which included areas beyond the city limits.

We will note your comment that suggests we study students of Baechtel Grove School. CDHS staff has considered various health study options for the Willits community, including tracking former students who attended Baechtel Grove School. This type of study option was presented during the November 2003 public meeting that CDHS held to discuss health study options with the community. At that time, it seemed that most of the audience was in favor of focusing on obtaining medical monitoring services for the Willits community, recognizing the limitations of an epidemiological study.

Health Effects of Hexavalent Chromium

Inhalation of hexavalent chromium has also been associated with nasal and stomach cancer; however, these cancer effects have not been well studied?

62. Has any studies been done with hexavalent chromium and other chemicals related to Remco?

48) <u>CDHS Response</u>*: *ATSDR has a draft interaction toxicological profile, which discusses adverse health effects information for mixtures containing arsenic, cadmium, chromium, and lead. We are not aware of chemical mixture studies of hexavalent chromium and other Remco related chemicals, such as VOCs.

63. Since Willits residents were exposed to hexavalent chromium, is the CDHS and ATSDR going to use our exposure to help other areas for future studies?

49) <u>CDHS Response</u>*: *It has been our experience that residents often benefit from the experiences and lessons learned in other communities dealing with environmental exposure issues. CDHS hopes that the experience of the Willits community will be helpful to others in the future.

64. Are these scientific studies that are a current understanding that are linked to other health conditions on a healthy populations or does the linked to health also use a populations that has low immune systems, young children or elderly?

50) <u>CDHS Response</u>*: *The majority of studies of hexavalent chromium are of worker populations, which are generally considered healthy. When evaluating potential impact to a community, safety factors are incorporated to account for sensitive populations, such as immune compromised, children, and the elderly.

65. How much hexavalent chromium does it take to show different health effects?

51) <u>CDHS Response</u>*: *Table 6 in the final PHA provides different levels at which health effects have been seen. It is important to recognize that not all workers experienced health effects or developed cancer at the levels shown in the table. Additional information is provided in Appendix E, Toxicological Summary of Hexavalent Chromium.

66. In table 5 (draft PHA), "Health Effects Seen in Workers at Different Levels of Hexavalent Chromium", the first four explains that at least 90 days to three years has an increased lung cancer and more than expected deaths. Why is it expected in the first place? We thought with the levels that our government allowed no one was supposed to die. Or get sick. Or are they?

52) CDHS Response*: *The term "more than expected" refers to the amount of cancer that is typical or expected. As stated earlier, cancer is a common disease caused by many factors. One in four people will get cancer in their lifetime. Table 6 shows levels of hexavalent chromium to which workers were exposed and the health effects that were seen. The government (Occupational Safety and Health Organization – OSHA) allows workers to be exposed at much higher levels than the general population. For example, current federal standards allow workers to be exposed to 10 $\mu g/m^3$ of hexavalent chromium per day in the work place. There were probably no OSHA standards during the time the workers that are referenced in the studies in Table 6 were conducting chrome plating.

67. If the levels of hexavalent chromium were down to 0.02 would all these health effects hurt people or cause cancer in any populations?

53) <u>CDHS Response</u>: Based on current knowledge, levels below 0.02 µg/m^3 would not be expected to cause health effects in any population, including children, immune compromised, and the elderly.

Toxicological Evaluation

68. So does the CDHS and ATSDR believe that most of Willits Citizens were exposed to harmful contaminates from Remco enough to cause any health effects?

54) <u>CDHS Response</u>: The time periods, locations, and populations where health effects could have occurred are discussed in the Toxicological Evaluation section in the PHA and shown in Table 7.

69. Can the CDHS and ATSDR ask Judge Illston to allow our town and the surrounding area of Willits for all Citizens pasted and present to have full toxicology evaluations in health care and medical prescriptions to be paid for by the polluters?

55) <u>CDHS Response</u>: CDHS has made recommendations in the PHA for medical monitoring. We are willing to meet/speak with Judge Ilston about the PHA and recommendations if she requests such a meeting.

70. Why with the toxicological evaluation, did CDHS not look into children at Beachtel Grove School and Blosser Lane School for cancer and noncancer effects past or present?

56) <u>CDHS Response</u>: As stated earlier, students at Baechtel Grove Middle School and Blosser Lane Elementary School were considered in the evaluation. We did not estimate theoretical increased cancer risk for children at these schools because the exposure duration was less that the minimum nine years recommended for estimating increased cancer risks. Please refer to the Toxicological section of the PHA.

Noncancer Health Effects Evaluation

"These health comparison values (this is a threshold value with added uncertainty factors). They only consider noncancer effects. Because they are based only on information currently available, some uncertainly is always associated with the health comparison value."

71. Why won't the CDHS look at other areas and test subjects that has been contaminated with hexavalent chromium and used their data on our health issues not just workers?

57) <u>CDHS Response</u>: CDHS located two or three studies of environmental exposures to chromium (not from plating); no health effects were found in any of the studies. CDHS does not conduct the type of research suggested by the comment.

72. Did the CDHS look into any Citizens health issues that were related to Remco contaminates such as Citizens that have lived next to Remco for years?

58) <u>CDHS Response</u>: ***Yes, CDHS informally gathered community health and exposure concerns. Please refer to the Community Health Concerns section.***

"The greater the uncertainty in our knowledge the greater the safety factor, and the lower the health comparison value. Exceeding a health comparison value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration."

I can't believe that the CDHS and the ATSDR explains that the greater the uncertainty in their knowledge the greater the safety factor.

74. How by not having knowledge makes the toxicity of hexavalent chromium SAFE?

59) <u>CDHS Response</u>: ***The discussion in the PHA about hexavalent chromium toxicity does not state/suggest hexavalent chromium is safe, based on a lack of knowledge. The less knowledge there is about a contaminant, the more health protective the standards are (e.g., "the greater the safety/uncertainty factor").***

"Exceeding a health comparison value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration."

75. Why if a contaminant is above Office of Environmental Health Hazard levels (LOAEL) and is spread though out the air in the Willits area why on earth is it not considered a health threat?

60) <u>CDHS Response</u>: ***Health comparison values are often calculated from a lowest observed adverse effect level (LOAEL) and additional uncertainty factors. If a contaminant "spread throughout the air" at levels comparable to a LOAEL, it would be considered a potential health threat.***

"CDHS compared the annual average concentrations of hexavalent chromium estimated by the air model to evaluate the potential noncancer effects for each group of people during each time period."

76. What if a person was at or near the Remco site everyday for only a few hours would that be a different adverse effect to hexavalent chromium or other levels of contaminates?

61) <u>CDHS Response</u>: ***It is possible for a person to experience noncancer health effects from different exposure durations, depending on the location in the community, the time period, and the amount of hexavalent chromium in the air and the physical characteristics of the person.***

"Exposures for people living, working and going to school outside the purple contour on Figure 5 during the time period 1991-1995 did not exceed the health comparison value, and thus no noncancer health effects would be expected."

77. What if PHA did not have the right data to prove that there was more releases of hexavalent chromium in the air around Willits would this PHA be change to show there were and are more health problems?

***62) CDHS Response*: The PHA does not have the ability to determine a cause and effect relationship or whether there are more health problems in Willits. The air modeling provides an estimation of what the level of exposure may have been in the past, which helps in understanding the possibility for a health effect to have occurred or be occurring. The final PHA has incorporated additional information obtained after the public comment draft, which provides better information for estimating past exposure.**

"Thus, if an exposure exceeds the health comparison values, a health effect will not necessarily occur."

78. Why not, if there is more exposures to higher levels to hexavalent chromium won't it seem possible that some health issues can be cause to these higher levels?

***63) CDHS Response*: The comment is correct; the higher the exposure, the greater chance for certain health issues.**

79. What about effects on Willits Citizens when they were exposed to more than one of the Remco chemicals at all times such as other heavy metals or VOCs. Would the effects from mixtures of different Remco chemicals be different than just the one of hexavalent chromium?

***64) CDHS Response*: Exposure to chemical mixtures is not well studied. Synergism occurs when the combined toxic effects of two or more chemicals are greater than each chemical alone. This issue has not been studied and it is uncertain if there is a synergistic effect between VOCs and chromium. Antagonistic effects occur when two chemicals interfere with each other's actions, leading to a less toxic compound. It is not known if there is an antagonistic effect from exposure to chromium and VOCs.**

There has been very limited toxicological study of the effects of chromium in combination with other chemicals. Most of the knowledge on health effects from hexavalent chromium exposure comes from studies of workers. These studies are typically based on workers in a particular facility. Although such workers often have more than one chemical exposure, the studies generally address the main exposure thought to be responsible for any health effects found, although the authors may note the possibility for another workplace contaminant to be contributing to any effect seen.

In animal studies on the other hand, the researcher can control the animal's environment and better isolate the exposure. In one study, for example, the effects of trivalent chromium and hexavalent chromium (sodium chromate VI) on liver toxicity from exposure to carbon tetrachloride (not a Remco related VOC) were studied by pretreating cultures of mouse hepatocytes (36). Results showed pretreatment of hexavalent chromium significantly reduced cell toxicity and lipid peroxidation caused by carbon tetrachloride exposure. Pretreatment with trivalent chromium did not have any effect on cell toxicity (36).

This was discussed in the community concerns section of the document, as it was raised as a concern by a number of community members.

"There are groups of people living, working, and going to school near Remco who might be more susceptible to health effects from chromium exposure than the typical worker."

80. Why are some groups of people more susceptible to health effects than the typical worker to chromium?

65) <u>CDHS Response</u>: A person's sensitivity to health effects can be related to many factors such as age, occupation, pre-existing disease, genetics, or lifestyle habits (smoking, diet, and alcohol consumption). Workers are generally considered a "healthy population." Susceptible populations generally include children, the elderly, and people with compromised immune systems.

"The following groups of people/time periods do not exceed these noncancer effect levels (0.2 $\mu g/m^3$ for adults; 0.02 $\mu g/m^3$ for children and other sensitive populations) and thus noncancer health effects would not be expected to have occurred."

1964-1995 How does CDHS know when there is not enough data to prove this fact?

66) <u>CDHS Response</u>: The PHA does not have the ability to determine a cause and effect relationship or whether there are more health problems in Willits. The air modeling provides an estimation of what the level of exposure may have been in the past, which helps in understanding the possibility for a health effect to have occurred or be occurring. The final PHA has incorporated additional information obtained after the public comment draft, which provides better information for estimating past exposure.

Table 6. Population Group Most Likely To Experience Noncancer Effects From Historical Air Releases During Certain Time Periods

81. We WECJ disagree with this chart within the color lines 1976-1995 because we have documents that explain scrubber were not working properly and were shut down for at leased two months. And we believe that all Willits Citizens and tourist were exposed to a horrendous amount of Remco contaminants. Can the CDHS or ATSDR explain differently?

67) <u>CDHS Response</u>: Comment noted. Since the release of the public comment draft of the PHA, CDHS has obtained information written by the Abex Corporation indicating the emission control equipment used at Remco (prior to 1989) was not working effectively, based on chrome staining and residue on the roof. Test results of chromium in runoff water provide added confirmation to the Abex Corporation's evaluation of Remco's emission control equipment. The air model has been rerun to account for this information and a discussion of the uncertainty presented in the Limitations of Evaluation Section of the PHA and in the ATSDR air model report in Appendix D.

82. Is cancer caused from environmental exposures or from toxic exposures, or both?

68) <u>CDHS Response</u>*: *The USEPA defines environmental exposure as "human exposure to pollutants originating from facility emissions. Threshold levels are not necessarily surpassed, but low-level chronic pollutant exposure is one of the most common forms of environmental exposure." Exposure from Remco would be considered environmental exposure.

Cancer is a common disease with many known risk factors. With regard to hexavalent chromium (focus of the PHA), we do not know the amount of hexavalent chromium that would be required to show a cause and effect relationship. We can only provide a theoretical increased risk from exposure that is averaged over a lifetime. Please refer to the Community Health Concerns/Health Concerns Evaluation section for a more detailed discussion on cancer health effects.

"CDHS used recommended nine-year minimum exposure duration as basis for estimating theoretical increased cancer risks."

83. Who recommended the nine-year minimum duration for estimating increased cancer risks?

69) <u>CDHS Response</u>*: *Refer to reference #4, as cited in the PHA.

"Past exposures are based slowly on data produced by air modeling, not actual measurements and theoretical cancer risks estimates are calculated using data extrapolated from worker populations."

84. Did CDHS use estimates from Remco workers?

70) <u>CDHS Response</u>*: *No, please refer to the Past Completed Exposure Pathway section for a discussion on exposure to Remco workers.

"Cancer risk estimates are a tool to help determine if further action is needed and they should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk is unknown and may be as low as zero (42)."

85. From 1964-1995 was all documentation used to interpret the actual prediction of cancer cases in Willits?

86. Since the Willits community has been exposed to different levels of hexavalent chromium in our air, how many residents can expect cancer in their lifetime?

87. If Baechtel Grove staff is at risk for a higher increased cancer? Why are not the children at risk also?

71) <u>CDHS Response</u>*: *All available data was used to estimate the theoretical increased cancer risk. As indicated by the comment, which quotes the PHA, we cannot predict how many people will develop cancer. Increased cancer risk estimates are based on studies that look at exposures averaged over a lifetime. At this time we do not have a method to determine cancer risk for periods of exposure of less than 9 years. It is not considered scientifically defensible to

estimate cancer risk from short-term exposure (less than 9 years in duration) because the cancer slope factor is derived from a long-term study of workers. There was a three-year attendance period for Baechtel Grove students, which is less than the 9 years recommended for estimating cancer risk. This information is provided in the Increased Cancer Risk Estimates for the Willits Community section in the PHA.

Comparison Of Occupational Chromium Levels With Air Modeling Levels Estimated Near Remco

"Another way to try to understand what the cancer risk might have been for the community is to look directly at how much additional cancer was found among chromium workers who were exposed to certain amounts of chromium."

88. How many hours and days does it take to become exposed to chromium to cause cancer?

72) <u>CDHS Response</u>: We do not know what amount of hexavalent chromium or the number of hours of exposure that would be required to show a cause and effect relationship. In worker studies, hexavalent chromium has been shown to increase the number of lung cancers in workers. The levels these workers were exposed to were much higher than what has been estimated in the Willits community (refer to Table 6 for examples of hexavalent chromium levels seen worker populations). Further, not every worker developed lung cancer. We can only provide a theoretical increased risk from exposure that is averaged over a lifetime. The calculations used to estimate theoretical increased cancer risk take into account sensitive populations, such as children, the elderly and immune compromised individuals.

<u>Information Provided by the Cancer Review</u>

"The cancer review reports two main pieces of information: (1 the number of new cases of cancer that occurred in a particular area within a specific time; and 2) an estimate of how many cases would typically be expected for that area, given the number of people who live there and other factors."

89. Could certain people be diagnose with cancer in other areas instead of Willits or the surrounding area and not be in the cancer registry for the Willits census tract?

90. Why is a certain time use when sometimes it takes twenty to thirty years to develop cancer?

91. What was the time frame the CDHS used for this PHA on cancer?

92. Did CDHS use all the population in and around the surrounding area of Willits including the people that move away?

93. What are the other factors that were used for this cancer review?

94. Since the Cancer registry used only people that live here from 1988 to 2000 the levels would be to small to show cancer because most people that was exposed to the highest levels of hexavalent chromium move from Willits because of to few

jobs. So can the CDHS go back and look up all the people that lived here from the time Remco started polluting our air or when the laws went into affect?

73) <u>CDHS Response</u>*: *Please refer to the Cancer Review Data for Willits section of the PHA for a description of the cancer review. The comment is correct that people who moved away from Willits and were diagnosed with cancer would not be included in the review. As discussed in the PHA, this is one of the limitations with cancer registry data. The time frame used was based on all available data at the time. The cancer review compared the numbers of cancer in the community to what would be expected for this population, based on the ages and sex of the population.

It would be difficult to go back and "look up" all the people that lived in Willits, as there is no single record of who lived in an area at a given time. The Cancer Registry only has information about where someone lived who was diagnosed with cancer, not who else was living there. Sometimes studies use other information, such as property ownership, but that would not be a complete or representative record of who was actually living there, as only some people are property owners, and some property owners do not live on their property.

<u>Results of Analysis of all Cancer Types Combined. 1988-2000</u>

95. Again how can the CDHS figure that the number of cases is expected when a lot of residents were diagnosed with cancer outside of this area?

74) <u>CDHS Response</u>*: *Please refer to CDHS response #73.

96. Why is cancer expected in the first place?

75) <u>CDHS Response</u>*: *Cancer is a multi-step process that occurs mostly in later years because these steps accumulate. There are many known risk factors for cancer such as diet, lifestyle, and genetics. In fact, our body's natural metabolic process also contributes to cancer formation. In very simplistic terms, the process of metabolism damages cells (oxidative stress), which can lead to damage to the DNA and the proliferation of cancer. Cancer is a part of the aging process, but there is also childhood cancer.

Please refer to the Cancer Health Effects subheading, with the Community Health Concerns/Health Concerns Evaluation section in the PHA for a general discussion on cancer.

97. So in twenty to thirty years is the CDHS going to include all of us from 1988 to 2018 in their PHA because doesn't it take that long to get cancer from hexavalent chromium?

76) <u>CDHS Response</u>*: *The type of follow-up suggested by the comment is out of the scope of the PHA process. While we understand the community's interest in such an activity, the limitations in reviewing cancer registry data currently would be the same in 2018, as the same limitations would apply, and as people will continue to move in and out of the area.

Other Potential Sources of Exposure Not Evaluated (DATA GAPS)

"Evaporation unit in the northern bermed area of the site, used to evaporate chrome wastewater in the late 1980s (potential hexavalent chromium releases."

98. This evaporation unit was used also during the 1990s because ex-employees said they would burned a lot of barrels with mixed chemicals for days and would have to jack hammer the resin out of the pit before the agencies would come to inspect. Does the CDHS have this information included in this PHA?

77) <u>CDHS Response</u>*: *Since the public comment period, we have spoken to a former worker who stated VOC wastes were also evaporated in the bermed area; he also discussed the resin waste mentioned in the comment. We have included this information in the final PHA.

Quality Assurance and Quality Control

99. Why did CDHS assume that all quality control measures were done right when in the past most had different kinds of mistakes for the quality control measures?

78) <u>CDHS Response</u>*: *In general, documents containing environmental data undergo a quality assurance and quality control (QA/QC) evaluation by individuals with expertise in the field of QA/QC. Most of these documents are generated for regulatory purposes and undergo an additional review by the regulatory agency for which the documents are written.

ATSDR staff evaluated the data used for the air modeling (source tests and MET data), noting problems with these data. ATSDR has resolved these issues by using alternative data sources in the revised air modeling. ATSDR used emission rate data developed by the USEPA as needed; the MET data issue was resolved by using 5 years of local MET data to develop a "typical year."

100. Did the REAC/Lockheed Martin/ATSDR use all documents that pertained to all the scrubber information through out the years Remco was in business?

79) <u>CDHS Response</u>*: *Lockheed Martin used all the information available at the time to conduct the air modeling. However, since the public comment release of the PHA, additional information has become available, requiring a revision of the air model. We have included, in the PHA, a discussion of the emission control equipment used at Remco.

Process for Gathering Community Health Concerns

101. In 1982 when Dolores Evans was complaining about the yellow water she and other Willits Citizens had concerns when Remco was contaminating the Baechtel Creek why didn't the CDHS look into their concerns?

80) CDHS Response*: *CDHS is aware of concerns relating to past releases of contaminants to Baechtel Creek. We will be addressing this issue in the future comprehensive PHA.

102. How can the CDHS explain to the Willits Citizens when they really have not reached all of the community, or know of all their health issues that relate to hexavalent chromium?

81) CDHS Response*: *The various methods used to gather community concerns, are described in the Process for Gathering Community Health Concerns section of the PHA. We will continue documenting community concerns throughout the PHA process.

103. For years even our own doctors have said there is no problem with us from being exposed to hexavalent chromium, or there is no problem with us being exposed to any of Remco contaminates, so why is the CDHS looking into what the Willits doctors have to say?

82) <u>CDHS Response</u>*: *CDHS interviewed residents, business owners, school officials, and local physicians as part of the initial outreach conducted at the site. This is important in order to gain a more comprehensive understanding of concerns throughout the community.

Community Concerns and Health Effects Evaluation

104. Would the health effects change or become worse when other chemicals of concern is involved along with hexavalent chromium via the inhalation?

83) <u>CDHS Response</u>*: *CDHS evaluated health effects from exposure for which adequate data is available. For example, we were able to estimate exposure from inhalation of hexavalent chromium but not VOCs. Exposure to chemical mixtures is not well studied. Synergism occurs when the combined toxic effects of two or more chemicals are greater than each chemical alone.

105. If a poor diet can cause cancer wouldn't the other counties have more cancer than America?

84) <u>CDHS Response</u>*: *Traditional diets in many less developed countries may offer greater protection against cancer than typical American diets. Studies have found that when people immigrate, their cancer rates become like the rates of persons in the wealthier country to which they have moved. This is thought to have to do with differences such as diet. A wide range of scientific evidence has found that diets high in fiber, grains, fresh fruits and vegetables, and low in animal fat are associated with lower risk of cancer.

106. Is it true that with ethnic groups most cancers are caused from chemicals such as pesticides etc.?

85) <u>CDHS Response</u>*: *There are differences in cancer rates between ethnic groups, and some types of cancer among ethnic populations are higher than among whites, and some are lower. The same known risk factors for cancer apply to ethnic groups, but different ethnic groups may experience these risk factors to differing degrees. For example, there are higher rates of prostate cancer in African American men, which is thought to be linked to higher testosterone levels.

107. Is it true that most cancer are caused where the body is the weakest?

86) <u>CDHS Response</u>*: *Not exactly. Cancer can sometime occur at a location in the body where there has been injury, such as skin cancer from ultraviolet radiation, or lung cancer from smoking. However, there is not always a clear reason why cancer develops in a certain location in the body. Cancer develops because of damage to DNA, which could occur in various parts of the body. DNA directs all cell activities. Usually, the body can repair DNA when it becomes damaged, or else the cell with the damaged DNA dies, but in cancer cells, the damaged DNA is not repaired. Normal cells have a specific pattern of how they grow, divide,

and then die. However, cancer cells, instead of dying, outlive normal cells and continue to form new abnormal cells. Cancer cells often travel to other parts of the body where they begin to grow and replace normal tissue. This process, called metastasis, occurs as the cancer cells get into the bloodstream or lymph vessels of our body. Some cancers, like leukemia, do not form tumors. Instead, these cancer cells involve the blood and blood-forming organs, and circulate through other tissues where they grow.

108. Is it true that most elderly people get cancer because their skin is thinner and their health is weaker than adults and not because they are old?

87) <u>CDHS Response</u>: Cancer isn't due to thin skin. The fact that cancer develops later in life has to do with the biology of the aging and the process of cancer development. Cancer is a multi-step process. Cancer develops because of damage to DNA and then proliferation of the changed cell. Cancer occurs mostly in later years because the steps have accumulated.

109. If a person lives where it is not contaminated ever do they have a great chance of not getting cancer when it does not run in their family?

88) <u>CDHS Response</u>: Although a person could live where there are no manmade chemicals, everyone can be exposed to naturally occurring carcinogens, such as sunlight, some plant toxins, or the natural hormones one has in the body. Also, not everyone gets cancer, even if it runs in their family and even if they are exposed to carcinogens.

110. Why is breast cancer found higher in contaminated areas, than where there is no contamination?

89) <u>CDHS Response</u>: Actually, in California, higher rates of breast cancer tend to be in the areas that would not be considered industrial or contaminated. In general, rates of breast cancer are higher among women who have more education and income, and because they are more affluent, they tend to live in less contaminated areas. The reason why these women have more breast cancer is because of the natural hormones in the body that are thought to contribute to breast cancer. These hormones change during pregnancy and while a woman is nursing a baby. Because women with more education and income are more likely to have children later in life (after going to school longer), they are exposed to their bodies' own natural hormones in a different pattern than women who become pregnant and/or nurse their children when they are younger. This makes those women who have children later in life more likely to have breast cancer than women who have children earlier in life.

111. Is it true that cigarettes have the same contaminants as Remco?

90) <u>CDHS Response</u>: Cigarette smoke contains more than 4,000 compounds, including known or suspected carcinogens such as chromium, nickel, cadmium, lead, arsenic, benzene, nitrosamines, dioxins, polycyclic aromatic hydrocarbons (PAHs), and formaldehyde. Some of these chemicals, such as chromium, PAHs and other metals may be present at Remco.

112. Can hexavalent chromium be inhaled and go to the lungs and be spread to the blood system to the brain and stay there for years?

91) <u>CDHS Response</u>*: *No, in fact, autopsy studies of workers do not show that chromium goes into the brain.

113. Why did it take CDHS and ATSDR twenty to thirty years to tell the residents of Willits that they have an increase risk of getting cancer?

92) <u>CDHS Response</u>*: *The legislative branch of government (elected officials) determines the resources and mandates for the executive branch of government (e.g., CDHS). Essentially no state resources have been allocated, and limited federal resources are available to CDHS for investigations of environmental health issues. The citizens of Willits need to express this issue with their elected officials.

114. Could a direct exposure to toxic chromium or other Remco chemicals be the reason why so many women lost their babies here in Willits?

93) <u>CDHS Response</u>*: *Studies of workers have indicated that breathing hexavalent chromium may have an effect on male reproductivity. There is not enough information to determine whether breathing hexavalent chromium effects female reproductivity. Please refer to Appendix F for a discussion on reproductive health and environmental factors.

<u>Allergies</u>

115. So residents can get nosebleeds, allergies, and asthma, and kidney problems from being exposed to hexavalent?

94) <u>CDHS Response</u>*: *It is possible that some residents may have experienced these noncancer health effects, depending on the level of exposure. Please refer to the Public Health Implications section in the PHA and Appendix E (Toxicology of Chromium) for a detailed discussion of the health effects associated with inhalation of hexavalent chromium and the populations potentially impacted.

116. Can the CDHS explain why everyone just about in Willits had migraine headaches when Remco was in business?

95) <u>CDHS Response</u>*: *Headaches are common and can be caused by many factors making it impossible for CDHS to determine why people in Willits have or had headaches in the past. Chromium exposure has not been shown to be associated with migraine headaches. Please refer to the discussion on headaches and migraines in the Community Health Concerns/Health Concerns Evaluation section of the PHA.

117. Why hasn't the other Remco dumpsites been included in this PHA?

96) <u>CDHS Response</u>*: *This PHA addressed air releases of hexavalent chromium from Remco.

118. Aren't underground contaminations from Paige Pits twelve miles now?

97) CDHS Response*: *CDHS does not have any knowledge of the groundwater issues at Paige Pits. This information is available from the City of Willits and the RWQCB.

119. Is it true that during the time from early 1960s to middle 1970s Wilson Paige burned Remco chemicals and the smoke drifted throughout the Willits Valley?

98) <u>CDHS Response</u>*: *CDHS is aware that wastes were burned at Paige Pits. We are not aware of any information regarding the spread of contaminants throughout the Willits valley, as a result of this burning. While it is true that smoke generated from burning will drift in the air, without detailed information (e.g., air measurements, waste makeup, burn schedule, etc.) about the burn practice there is no way to know where the smoke went and what chemicals it may have contained.

120. Why do we need medical monitoring, don't we need health care providers and our medications paid for first?

99) <u>CDHS Response</u>*: *The medical monitoring is specific to addressing potential health problems associated with exposure to hexavalent chromium. If the medical monitoring is funded, impacted community members should be able to see a physician trained in environmental and occupational health.

121. What was the cause for so many people in Willits to have a metal taste in their mouth for years while Remco was in business?

100) <u>CDHS Response</u>*: *There is no way to definitively determine what caused the metal taste reported by many residents in Willits; however, studies of workers have shown that breathing hexavalent chromium can affect a person's sense of smell.

122. If Willits residents were not expose to Remco chemicals in the 90s that cause harm why did most of them lose their taste and smell senses during the time Remco was in business?

101) <u>CDHS Response</u>*: *Breathing hexavalent chromium can affect a person's sense of smell.

123. If Abex/Remco did not pollute three miles from Remco why did they have a map that shows the three-mile air circumference?

102) <u>CDHS Response</u>*: *The PHA provides maps that show the estimated air levels of hexavalent chromium in different areas of the community, extending far beyond the site boundary as suggested by the comment. Hexavalent chromium is expected to convert to non-toxic trivalent chromium in soil, in the presence of organic matter. Off-site soil tests confirm that this conversion has occurred.

124. Can diabetes be caused form Remco contaminates?

103) <u>CDHS Response</u>*: *Please refer to Appendix F (Evaluation of Community Health Concerns) for a discussion on the main causes of diabetes. The association between diabetes and chemical exposure is not well studied.

125. What other birth effects can be cause from Remco pollutions?

104) <u>CDHS Response</u>: Please refer to Appendix F (Evaluation of Community Health Concerns) for a discussion of reproductive health. This PHA focused on health effects associated with inhalation of hexavalent chromium.

126. Will the CDHS look into all the contamination from Remco so that this PHA could be complete especially VOCs?

105) <u>CDHS Response</u>: The comprehensive PHA will evaluate potential exposure to all site-related contaminants in all media (soil, water, air, etc.). However, the air pathway, for the most part, was evaluated in this PHA. As stated earlier, VOCs released to the air could not be estimated because a lack of data. We will address this pathway in the second PHA to the extent possible.

127. Will CDHS look into all dumpsite related to Remco contaminations?

106) <u>CDHS Response</u>: There are limited resources for environmental issues for the entire state. At this time, it is unclear whether CDHS will have the resources available to evaluate "all" the alleged dumpsites. If environmental data becomes available indicating the possibility for a person to come in contact with contaminated media (soil, media, etc.), CDHS will work with the City of Willits and the RWQCB to identify and eliminate potential exposures.

Willits Citizens for Environmental Justice

And other concern Citizens

[Letter signed by 15 community members]

Comments Submitted by the California Regional Water Quality Control Board, North Coast Region

Regional Water Board staff is in receipt of the *Public Health Assessment, Evaluation of Exposure to Historic Air Releases, Abex/Remco Hydraulics Facility* Report prepared by the California Department of Health Services (CDHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). CDHS recommends performing the following actions based on the conclusion that releases of airborne hexavalent chromium posed a public health hazard during the period 1965 to 1995:

1. Medical monitoring/clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to air releases of hexavalent chromium;

2. Counseling and stress support for impacted residents and workers, as needed; and

3. Provisions and implementation of adequate measures to mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site. The mitigation measures should be conducted in conjunction with air monitoring that is adequate to protect public health.

Regional Water Board staff fully support CDHS's recommendations and look forward to our continued joint participation in community outreach associated with the investigation and cleanup of the Former Remco Hydraulics site.

[Letter signed by the Executive Officer]

Comments Submitted by Technical Outreach Services For Communities (TOSC)

Cancer Review

Use of 99% confidence intervals: It may have been more appropriate to use 95% confidence intervals rather than 99% confidence intervals used by the authors, and displayed in Table 9. Given the known exposures to hexavalent chromium, is it wise to use more stringent criteria for determining significance levels? We would suggest that since there is concern about protecting the exposed community, it might be better not to set the bar so high for determining significant exposures. This more inclusive approach might also be recommended since other potential routes of exposure (i.e., ingestion) were not considered in this assessment.

CDHS Response: ***Use of the 99% confidence interval is standard practice for the cancer registry. To have exceeded the 99% confidence interval, 37 additional cases of lung cancer would be required for this period. A narrower confidence interval would not necessarily have changed the conclusion that the additional 12 found was within a range that could have typically occurred by chance.***

Evaluation of Chromium Exposure Estimates

It is possible that the risk for some residents may have been underestimated. The 16hr/d, 5 d/wk, 50 wk/yr scenario is probably appropriate for those who work outside the home. If residents are homebound or if they work primarily in the home, this may underestimate exposure. In these cases the authors should consider using a 24 hr/d, 7 d/wk, 50 wk/yr exposure scenario.

CDHS Response: ***The exposure assumption used in the draft PHA was based on the Remco's permit from Mendocino County Air Quality Management District. Since the public comment draft, CDHS has obtained additional information indicating Remco operated outside their operating permit. In the final PHA, CDHS evaluated potential health impacts to residents using a 24 hr/day, 7 day/wk, 50 wk/yr exposure assumption.***

Recommendations

TOSC supports the recommendations of this assessment as appropriate. Considering the likelihood of significant hexavalent chromium exposures, medical monitoring and stress support should receive serious consideration. Without question resuspension of contaminated dust during site activities should be mitigated to the extent possible.

Comments Submitted by the County of Mendocino Department of Public Health Division of Environmental Health (insert county letter)

Dear Chief:

The Mendocino County Department of Public Health has reviewed the draft Public Assessment for the Abex/Remco Hydraulics Facility. The report is dated July 21, 2003.

We concur with the conclusions and recommendations in the report. We understand the limitations of this type of assessment and believe the State of California Department of Health Services did a credible job with available information.

[Letter signed by the Environmental Health Director, Mendocino County Department of Public Health]

Comments Submitted by Erler and Kalinowski, Inc., ("EKI") on behalf of the City of Willits

The draft PHA concluded that: (1) there was an increase in the theoretical cancer risk to certain populations in Willits as a result of airborne releases of hexavalent chromium during past operations of the Remco facility[9], (2) the number of observed actual cancer cases (for all cancer types combined based on a review of cancer data for the Willits community) was "very similar" to the number of expected cases due to other causes; (3) further community-related actions should be implemented including medical monitoring or clinical evaluation, counseling, and stress support; and (4) implementation of adequate construction measures should be taken to mitigate re-suspension of hexavalent chromium-contaminated dusts or soil that could be generated during future remedial activities at the Remco Site.

CONCLUSIONS OF EKI's REVIEW

EKI's review focused on the draft PHA's air dispersion modeling study used to estimate past hexavalent chromium exposures of people living and working in the vicinity of the Remco facility and the theoretical cancer risk estimates based on that modeling. As described below, there were numerous assumptions made in the air dispersion modeling, and EKI is uncertain whether the estimated airborne hexavalent chromium concentrations generated by the modeling summarized in the draft PHA are reasonable representations of actual historical airborne chromium concentrations. EKI acknowledges that it may not be possible to better redefine many assumptions used to generate model input; however, as described below, EKI believes that clarifications regarding assumptions are needed and would be helpful to readers of the PHA. In lieu of more accurate input data, a sensitivity analysis could also be performed to better understand the impacts of critical assumptions on the model outputs. Because no sensitivity analyses were performed on the model simulations, the consequences of the major assumptions used cannot be evaluated.

Thus, EKI cannot agree nor disagree with conclusions regarding the estimates of historic airborne hexavalent chromium concentrations and resulting estimated cancer risks. EKI recommends that the CDHS and ASTDR revise and reissue a second draft PHA that will include additional and appropriate details on the assumptions used, sources of information supporting any assumptions, and clear documentation for all modeling runs, as well as, respond to specific comments noted below and those provided by other commenters. In EKI's opinion, it is important to the community that these questions be resolved before proceeding to discuss the need for additional actions to assess the potential impacts of past activities at the Remco facility.

EKI has no comment on the review of historic cancer data for the Willits community. Based upon the issues raised herein, EKI cannot at this time comment on the appropriateness of medical/clinical monitoring mentioned in the draft PHA. EKI agrees that adequate measures need to be taken during construction to mitigate potential re-suspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the Remco Site.

---

[9] It is noted that the PHA states that cancer risk estimates are a tool and "should not be interpreted as an accurate prediction of the exact number of cancer cases that actually occur. The actual risk may be as low a zero".

EKI has previously submitted comments to the Willits Environmental Remediation Trust regarding dust control and air monitoring conducted during remedial activities (letter of 2 July 2003).

General Comments

According to the draft PHA, the CDHS and ASTDR evaluated past community exposures to hexavalent chromium emissions and concluded that health effects were likely due to such historic exposures. The potential exposures (and theoretical health effects) are believed to have differed during different periods of operations at the Remco facility due to different operating procedures and air pollution control equipment. As noted in the draft PHA, during the years of plating operations at the Remco Site, no known actual measurements of chemicals in the ambient air were taken on the property or off-site. Therefore, the draft PHA relied upon an air dispersion modeling study conducted by a subcontractor to ASTDR to estimate airborne concentrations of hexavalent chromium around the facility. The estimated airborne hexavalent chromium concentrations, for different periods of operations, were then used to calculate theoretical excess lifetime cancer risks resulting from inhalation of airborne hexavalent chromium. The State of California has classified hexavalent chromium as a toxic air contaminant and a potential human carcinogen and has published theoretical cancer potency factors for use in estimation of cancer risks, on a statistical basis, for exposed populations, i.e., risk of cancer incidence per hundreds or thousands of individuals so exposed. Critical input parameters for the air dispersion model included: vent configuration for each source at the facility, emission rate of hexavalent chromium from the each source at the facility, efficiency of emission control devices on each source (all of which changed over time), and climatic conditions for these past years (which were estimated based on recent meteorological data from some local and some not so local stations).

EKI requested but did not receive permission from the CDHS to talk with the air quality scientist who performed the air dispersion model simulations provided in the draft PHA. EKI requested and received certain backup information used in preparation of the draft PHA, including two documents regarding past emission testing at the facility, noted below. EKI also received a CD reportedly containing input and output computer files from the modeling study performed by ATSDR's contractor on behalf of the CDHS. However, EKI did not evaluate the specific information on the CD due to the volume of the information on the CD and the time that would be required to view and perform a review of the information. EKI believes that a second draft PHA that provides clearer statements of assumptions and better documentation on supporting information including pertinent final computer modeling runs will better facilitate review by the City of Willits, e.g., as opposed to attempting to decipher the pertinent modeling files on the CD.

***CDHS Response*: CDHS responded to EKI's initial questions concerning the air dispersion model, by communicating your questions to the Lockheed Martin staff ("air quality scientist"). We provided EKI with their response along with all the supporting data. Apparently, EKI found the information too voluminous to review and is suggesting that another draft be issued. It is disappointing that the City of Willits consultant (EKI) did not provide a thorough review of the data and formulate independent conclusions. CDHS provided a very lengthy comment period, spanning from July 21, 2003 through October 20, 2003 (3 months), more than adequate time for EKI to conduct an independent and thorough review of the PHA and**

supporting information. CDHS and ATSDR have addressed all the comments received on the draft PHA and will not be reissuing another draft for comment. Additional clarifying information has been included in the final PHA.

With regard to assumptions on historic emissions from the facility, the draft PHA used three time periods of operation to calculate airborne hexavalent chromium concentrations:

- 1964 to 1975 – Scenario 1,
- 1976 to 1990 – Scenario 2, and
- 1991 to 1995 – Scenario 3.

These three time intervals were selected based upon assumptions about sources (plating tanks) used at the facility, vent configuration for each source, and efficiency of emission control devices on the sources, based CDHS's interpretation of available information. Some questions on key assumptions are noted below.

<u>Time Periods of Operation</u>

As noted above, three time periods of operation were examined to calculate airborne hexavalent chromium concentrations (1964 to 1975 – Scenario 1; 1976 to 1990 – Scenario 2; and 1991 to 1995 – Scenario 3) (as reported on page 9 of the draft PHA). These time periods are supposed to represent relatively consistent operations and equipment. It is not clear from the available historic information that this is the case. For instance, on page 9 of the draft PHA, it is stated that in 1989 a new scrubber was installed. It is not clear why Scenario 3 begins in 1991 instead of 1989.

<u>CDHS Response</u>**: **In 1989, the efficiency of the new scrubber was rated at <98.6%, generally consistent with the original assumption used for Scenario 2 (98% emission control). As a result, Remco did not meet emission control regulations (page 12, public comment draft PHA). In November 1990, Remco acquired additional equipment (filter) to improve the scrubber's efficiency. In 1991, source testing indicated an average scrubber efficiency of 99.991% (page 12, public comment draft PHA). This was the rational used in starting Scenario 3 in 1991, rather than 1989. Additional clarification has been added to the final PHA.

<u>Emission Rates</u>

The emission rates of hexavalent chromium for the three scenarios in the draft PHA appear to be calculated as follows:

- Scenario 1 emission rates appear to be calculated based upon a back calculation of "uncontrolled" emission using "controlled" emissions measured during testing conducted in 1989[10] (i.e., during the time period for Scenario 2). To calculate uncontrolled emissions, the ASTDR contractor assumed the control device was 98% efficient in 1989.

[10] Galson Technical Services *Source Emission Testing of the Plating Tanks Scrubber Exhaust Stack at Remco Hydraulics, Inc. in Willits CA*, May 1989.

- Scenario 2 emission rates were also calculated based upon controlled emissions measured during the 1989 tests, which the ATSDR contractor reports as 98% removal. However, it is not clear how the reported removal efficiency of 98% was obtained for 1989, because the 1989 emission test only provides information on emissions measured in exhaust air following the control device; no uncontrolled source emission measurements or assumptions are provided in the cited source test report.
- Scenario 3 emission rates were based on 1991[11] measurements of hexavalent chromium before and after the emission control devices, which reportedly resulted in an average removal efficiency of 99.991%.[12]

To calculate the total hexavalent chromium emissions for each Scenario, an electricity usage rate for each chromium tank was also assumed. The electricity usage for Scenarios 1 and 2 were based on three days of source testing conducted in 1989. The electricity usage for Scenario 3 was based on three source tests conducted in 1991. The draft PHA assumed emissions occurred 5 days a week from 7 AM to 11 PM based upon a March 1983 permit to the Mendocino Air Pollution Control District. Although the data used for electricity usage and operating hours is likely the best available data, they are limited in their reflection of actual running conditions throughout the Remco facility operations.

CDHS Response: ***It is correct that these data are limited in their reflection of the actual running conditions at Remco, as it does not account for upset conditions (times when emissions would be much greater than estimated) or times when the tanks were in repair or not in use, resulting in potentially lower concentrations. The assumption that emissions occurred 5 days per week from 7AM to 11PM, as stated in Mendocino County Air Pollution Control District permit, is likely to underestimate emissions as former workers have stated that plating operations often occurred 24 hours per day, 7 days per week (C. Nickerman, Remco employee [1984 – 1986), personal communication November 11, 2003) (R. Wake, Remco employee [1972 – 1991], personal communication November 19, 2003) (C Douglas, Remco employee [1974 – 1988], personal communication November 20, 2003) (F. Vincent, Remco Worker [1967 – 1995], personal communication January 6, 2004).***

Vent Configurations

The PHA document on page 83 states that Scenario 1 was modeled with Tanks 1 and 2 as a single "point source" (i.e., vented through the roof in a single stack) and with Tanks 3, 4, and 5 as "area sources" (i.e., no separate stacks) all with uncontrolled emissions (0% removal efficiency).

The PHA document states that Scenario 2 was modeled with Tanks 1 through 7 as a single point source (vented to the roof) and discharged to the air out a single stack from a scrubber that was

---

[11] Advanced Systems Technology, Inc. *Hexavalent Chromium Emissions Evaluation, Remco Hydraulics, Willits, California*, May 1992.

[12] EKI notes that the emission control device in use during the 1989 testing was the same as the device used in the 1991 testing. It is not clear why efficiency of the emission control device changed so dramatically from 1989 to 1991.

98% efficient in removing hexavalent chromium (top of page 83) AND that Scenario 2 was modeled with Tanks 1 and 2 as a point source and Tanks 3 through 7 as area sources (bottom of page 83).

The PHA document states that Scenario 3 was modeled with Tanks 1 through 7 as a single point source (vented from the roof in single stack) with a scrubber that was 99.991% efficient in removing hexavalent chromium (top of page 83) AND that Scenario 3 was modeled with Tanks 1 and 2 as a point source and Tanks 3 through 7 as area sources (top of page 84). EKI notes that an example ISCST3 input provided in Appendix C of *The Final Report Atmospheric Dispersion Modeling Remco Hydraulics, Inc. Site, Willits, CA* indicates that Scenario 3 was modeled with Tanks 1 and 2 as a point source and Tanks 3 through 7 as area sources.

Thus, the text of the PHA presents different source configurations for Scenarios 2 and 3, although the CDSH indicated verbally that all Scenario 2 and Scenario 3 air dispersion modeling simulations assumed the tanks were point sources.

CDHS Response: ***CDHS recognizes the description on the "example" ISCST3 worksheet contained in the Lockheed Martin report appears to be inconsistent with the description in report and the PHA. CDHS identified this inconsistency as well and contacted Lockheed Martin staff for clarification. We were told that scenario 2 and scenario 3 were modeled as point sources, as described in the PHA and in the Lockheed Martin report. The "example" ISCST3 worksheet provided by Lockheed Martin was meant to show the reader an example of the air model input; it does not include all the inputs used in the model, how they are adjusted, or information (outputs) generated by the model. A complete set of air dispersion input/outputs would consist of many worksheets. The complete air dispersion model was provided to EKI for review. According to the comments, EKI did not review the information because it was too voluminous; as a result EKI did not verify the approach that was taken.***

Since the public comment release of the PHA, CDHS has obtained information (not previously known or available to CDHS) regarding vapor collection equipment used at the site. This additional information has been used to refine the air model and to modify the source configuration of the outdoor vertical tanks during scenario 1 (1963 − 1975). From at least 1972, the outdoor vertical tanks were reportedly attached to a collection system that pulled the vapors from the top of the tanks and vented the chromic acid vapors through a stack that was attached to the outside of the building, adjacent to the tanks. These tanks have been modeled as area sources with a release height of 12 feet (this is discussed in greater detail in CDHS' response to Latham and Watkins comments and in the final PHA).

Other Modeling Assumptions

It Is Noted That Other Assumption Were Used To Estimate Parameters Required As Inputs To The Air Dispersion Modeling. These Assumptions Included:

- Stack gas exit temperatures, exit velocities, and stack diameters were derived from the emission reports cited in footnotes 3 and 4.
- Weather observations used in the simulations were obtained from the following sources: (1) surface air data from 1997 through 2000 from an air monitoring station in Willits,

California on the roof of the Safeway Supermarket across from the Site, (2) upper air data from 1997 through 2000 from Oakland, California, and (3) cloud cover/cloud height data from 1997 through 2000 from Ukiah, California.

Although the data used may be the best available data, they are limited in their reflection of actual running conditions throughout the Remco facility operations and weather conditions during Remco facility operations.

***CDHS Response*: The local meteorological (MET) data used to model past air releases from Remco is better than most modeling situations used to predict future impacts to communities as part of a risk assessment. For instance, risk assessments generally use default regulatory MET data to evaluate potential impacts to communities, resulting in very conservative values that can be up to 20 times higher than what would be predicted using local data (D. Wolbach, MCAQMD, personal communication November 12, 2003).**

Specific Comments

EKI offers the following specific comments on the draft PHA:

1. It would be useful to perform sensitivity analyses for uncertain parameters. This is especially important because of the numerous assumptions required to conduct the model simulations, as noted above. The draft PHA states that "the predicted concentrations should be thought of as the best central estimate with error bounds"; however, the draft report does not provide any information regarding the magnitude of the possible error bounds. For example, varying chromium emission rates would provide useful information regarding ranges of airborne chromium concentrations used to estimate cancer risks for each of the three scenarios.

***CDHS Response*: Additional information has been provided relative to the assumptions and uncertainties of the air model. Please refer to the ATSDR air modeling report in Appendix D.**

2. To estimate cancer risk, the modeled historic concentrations of hexavalent chromium in air, exposure assumptions for different groups of potentially exposed populations (e.g., body weight, inhalation rate), and a cancer potency (slope) factor for hexavalent chromium were used (page 22 of the draft PHA). However, the slope factor that was actually used was not presented in the document. EKI notes that the cancer slope for hexavalent chromium used by California EPA is 510 per (mg/kg-day; the unit risk factor is 0.15 per (ug/m^3) while the cancer slope factor used by the Federal EPA is much less stringent, i.e., currently 42 per (mg/kg-day; based on the published unit risk factor of 0.012 ug/m^3). It would be useful to present the specific slope factor actually used in the calculations in the draft PHA, as well as a discussion regarding uncertainties due to this difference in published slope factors and sensitivity of estimated cancer risks reflecting this uncertainty.

***CDHS Response*: We have included additional information about the slope factor/unit risk in the final PHA.**

3. Considering the source configurations modeled during Scenario 1 (point plus area sources as listed in the sole model run reprinted in Appendix C of the draft PHA) are

quite different than source configurations modeled during Scenarios 2 and 3 (point sources only stated in the text of draft PHA) one might expect different configurations of the annual average, ground-level concentrations of airborne hexavalent chromium (Figures 3, 4, and 5) produced by the model for each scenario, i.e., potentially differing locations for maximum concentrations and the shape of the “plume”. It would be useful to evaluate the contribution of the area sources versus the point sources for Scenario 1 to ascertain whether resulting airborne hexavalent chromium plume configurations are reasonable.

CDHS Response: ***The comment is correct in that the source configuration impacts the overall shape of the plume and ground level concentrations of hexavalent chromium. Differences in the estimated ground level concentrations of hexavalent chromium and plume shape are discussed in final PHA.***

As discussed above, because of the questions regarding the underlying air modeling results, EKI cannot agree nor disagree with conclusions regarding the estimates of historic airborne hexavalent chromium concentrations and resulting estimated cancer risks. EKI recommends that the CDHS and ASTDR revise and reissue a second draft PHA that will include additional and appropriate details on the assumptions used, sources of information supporting any assumptions, and clear documentation for all modeling runs, as well as, respond to specific comments noted below and those provided by other commenters. In EKI’s opinion, it is important to the community that these questions be resolved before proceeding to discuss the need for additional actions to assess the potential impacts of past activities at the Remco facility.

We are pleased to have the opportunity to work with you on this project and look forward to reviewing a second draft PHA. Please call if you have questions or concerns.

CDHS Response: ***Documentation (references) is/was provided to support all the assumptions used for the air model and in the health assessment. Additionally, EKI was provided with all of the air model inputs/outputs (“modeling runs”). As stated earlier, CDHS did not include these data (computer modeling worksheets) due to the volume. It appears the voluminous nature of these data was even a barrier for EKI to review and draw independent conclusions on the PHA. Thus, the final PHA does not include this information, though it is available upon request. CDHS has provided additional information in the PHA addressing assumptions used in the air model and PHA.***

ATSDR/CDHS have reviewed and addressed all the comments submitted on the draft PHA. CDHS obtained additional information (previously not provided to CDHS) and conducted additional inquiry, which has allowed for a more accurate depiction of past releases and potential exposure. The air model and exposure assessment have been revised to reflect this information and a discussion provided in the final PHA. While some of the assumptions used in the PHA have changed, the conclusions and recommendations have not been altered from those presented in the public comment draft PHA. ATSDR/CDHS will not reissue another draft for comment.

[Letter signed by the Vice President of Erler and Kalinowski, Inc.]

Comments Submitted by Latham and Watkins LLP on behalf of Whitman Corporation/Pepsi America

Summary of Comments

The Draft Public Health Assessment (the "Report" or the "CDHS Draft Report") prepared by the California Department of Health Services ("CDHS") is based upon a series of incorrect assumptions about the operating history of the former Remco Facility. As described in greater detail below, the Report mistakenly models more than 40 years of plating tank operation that never took place at the Remco Facility (Tab 2, pp. 1-2 and App. A; Tabs 4, 5), employs massively inflated assumptions concerning the amount of electricity used for chrome plating at the Remco Facility (Tab 2, pp. 6-11; Tab 6), and incorrectly assumes that there were no emission controls employed during the first 12 years of plating operations (Tab 2, pp. 3-6; Tab 7). The Report uses these erroneous operating assumptions (and others) as input to a computer air model, and the model output is used to calculate a hypothetical health risk. The result is a Report that grossly exaggerates the modeled chromium emissions from the Remco Facility and therefore greatly overestimates the hypothetical health risk.

The air modeling performed to estimate the dispersion of these emissions is also flawed. The model inputs include incorrect tank locations, stack emissions specified as ground level emissions, and mistakenly high emission rates for individual tanks. Tab 3, pp. 7-10. These errors artificially increase the modeled airborne chrome six concentrations, particularly the highest modeled concentrations closest to the source. Tab 3, pp. 7-10, 37-39. The modeling is also based upon unreliable meteorological data that was not gathered with the quality assurance prescribed for regulatory dispersion modeling. Discrepancies in the meteorological data collected, including wind speed and wind direction, confirm that the data is problematic. Tab 3, pp. 13-34. The air model contours are also fundamentally flawed because a mapping or coordinate error caused the highest concentrations of modeled emissions to be displayed approximately 250 meters south of the former Remco Facility. Tab 3, pp. 4-7 and Figure 2-1.

The CDHS Draft Report's modeling conclusions and the theoretical risk calculated based upon those conclusions are also called into question by observations in Willits. No elevated levels of chromium were found in soil testing in the areas the model predicts to have the highest airborne chromium concentrations. In addition, the Report concludes that, for all cancer types CDHS reviewed, the number of new cancer cases actually observed from 1988 to 2000 "was within the range of what would be expected, as was the overall number of cancer cases observed." Report p. 29. The CDHS Draft Report's findings concerning actual cancer cases in Willits are consistent with two other studies reviewing cancer data and concluding that the number of observed cancer cases in Willits is within the range of what would be expected in a normal population. Tab 27; Tab 28.

Whitman Corporation provides the following comments summarizing some of the key errors and incorrect assumptions in the Report. These problems are so pervasive that the CDHS Draft Report and the underlying computer modeling report prepared by Lockheed must be withdrawn. They cannot be used to estimate any hypothetical health risk purportedly associated with the operation of the former Remco Facility. A new report should be prepared that realistically defines the historical plating operations based upon the available records and testimony and reasonably estimates the dispersion of emissions from those operations using reliable meteorological data.

CDHS Response to Summary: The Latham and Watkins "summary of comments" discuss two main topics: 1) the assumptions used in the air model and; 2) the assumptions used in exposure evaluation. First we will provide a general response about the assumptions used in the air model, then the exposure assumption commented on by Latham and Watkins.

CDHS has reviewed the vast amount of information provided as support to the Latham and Watkins comments. The information provided contains no site-specific technical documentation that would invalidate the assumptions used to develop the air model (electrical usage, emission control equipment, etc.).

Another important parameter used in the air model is the weather or meteorological (MET) data. In 2003, Latham and Watkins consultant identified issues (mechanical) with the Mendocino County Air Quality Management District (MCAQMD) MET station. According to MCAQMD, the mechanical issues identified with the MET station predated the data set (1997 – 2000) used for the air modeling. Never the less, the knowledge that some issues had been identified with MET station prompted ATSDR to critically analyze the MET data used in the air modeling for the Remco site. ATSDR identified some minor inconsistencies in these data. As a result the air model was rerun using revised MET data.

One assumption used in evaluating exposure and potential health effects is the duration of exposure. Latham and Watkins assert the health risks were overestimated, because "40-years" of plating tank operation was assumed, that reportedly never occurred. The comment is in reference to the plating tank installation history/timeline used in the PHA, which CDHS obtained from Remco reports that now the responsible party say are in error. Since Remco reportedly only conducted plating for 32 years, it appears that Latham and Watkins is adding the number of years that each tank operated individually (i.e., Tank 1 operated for 35 years, Tank 2 operated for 35 years, Tank 3 operated for 27 years, etc.). The comment fails to provide the total number of years of plating tank operations considering all the tanks. Thus, in the interest in providing a more balanced perspective, CDHS calculated the total number of plating tank years at Remco, using the Latham and Watkins approach and a revised tank installation timeline (Table 1, Final PHA). This resulted in a total of 169 years of plating tank operation, after the 40-year calculation by Latham and Watkins was subtracted out. The potential health risk for the Willits community resulting from 169 years of plating tank operations is consistent with the health risk from 209 years of plating tank operations (169 years + 40 years); Willits residents and workers could have experienced non-cancer adverse health effects over a large area of Willits. These exposures presented a high increased risk of cancer, depending on where a person lived or worked. Thus, the inclusion or exclusion of an additional "40-years" of tank operation does not have much of an influence on the potential health risk estimated for the Willits community.

In summary, the air model and exposure assessment has been revised to reflect information not previously provided or available to CDHS. This has allowed for an even more accurate understanding of the historic plating operations at Remco as well a more comprehensive analysis of the air modeling parameters and associated uncertainty. While the model outputs

varied slightly, as expected, it did not substantially change the overall exposure picture for Willits residents. Further, ATSDR determined that hexavalent chromium releases from 1975 – 1995, were likely orders of magnitude higher than estimates produced by the air model. Thus, the potential health risk was not "greatly overestimated" as suggested by the comment; the possibility that potential health risks were underestimated is of greater concern.

Chrome-Plating Operations

Plating Tank History

In the 1940s, the former Remco Facility began operations as a machine shop on Main Street in Willits, California. Records and testimony suggest that chrome plating activities at the former Remco Facility began in the mid-1960s and continued until it closed in 1995.

The CDHS Draft Report uses computer modeling by Lockheed to estimate the dispersion of chromium emissions from the Remco Facility for the years 1964 through 1995. The model as a tool is only as accurate as the inputs provided. One primary reason this model and the CDHS Draft Report significantly overstate historical Remco emissions is that the computer modeling assumed many of the plating tanks were operated for more years than actually took place. As set forth in greater detail in the attached documentation, aerial photographs, equipment inventories, employee testimony and other documentation confirm that many of the tanks were not even constructed when the model assumes they were emitting chromium. Tab 1, pp. 1-12; Tab 2, pp. 1-2, and App. A; Tabs 4, 5, 8-15). These records suggest that plating operations began modestly with one or two tanks in the mid-1960s, increased to five tanks by approximately 1973, and ultimately included six tanks (and very infrequently seven tanks) in the 1980s and 1990s. Tab 1, pp. 1-12; Tab 2, pp. 1-2, and App. A.

In contrast, the Report relies upon unsubstantiated and incorrect assumptions in secondary documents to conclude that the tanks were installed much earlier. Report pp. 8-9; Tab 1, pp. 8-9. For example, the model input assumes that five tanks were in full operation from 1966 to 1976. Report p. 9. In fact, correspondence between Remco and the RWQCB from 1971 demonstrates that only three tanks (one of them smaller and with one third the electrical capacity assumed in the modeling) were in operation by that time. Tab 15. Similarly, while the Report concedes that Tank 7 was not installed until approximately 1982 (Report p. 9), and documents and testimony suggest Tank 7 was only sporadically used for plating in 1990 and 1991 (Tab 1, pp. 10-12; Tab 2, p. 10), the modeling assumes that it was operating full time from 1976 through 1995 (Report p. 9 and Appendix D).

There is no credible evidence that five chrome plating tanks were installed at Remco by 1966. These mistaken assumptions regarding the years of installation and operation for the chrome plating tanks cause the Report to model more than 40 years of individual chrome tank operations that never took place. Tab 4. These errors substantially overestimate the emissions and inflate the calculated risk.

1) <u>CDHS Response</u>*: *CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the public comment draft was issued, which has been incorporated. As expected the changes to the model altered the output somewhat, but did not substantially change the overall exposure

picture for Willits residents. Further, ATSDR determined that releases of hexavalent chromium were likely orders of magnitude higher than those estimated by the model, due to operational issues identified during source testing (Appendix D).

Conflicting information regarding the early time periods of Remco operations posed a challenge in establishing modeling assumptions regarding the tank installation and emission control history. While we make every effort to be as accurate as possible, given the choice of potential exposure scenarios (tanks installation timeline), we chose to use a scenario (published in Remco reports) that would not underestimate exposures and potential adverse health effects.

CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees who combined, worked in Remco's plating department from 1967 – 1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon (Final RI)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity (ref. 9, 184, 185)—replaced in ~1968: 12 x 5.5x7, 3200 gallon (Tab 2 p. 15)

Tank 3: 1968: 3' diameter x 32' deep (Final RI, Tabs 35,49-51)

Tank 4: 1973: 4' diameter x 38' deep (Final RI, Tabs 35, 49-51)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, Tabs 49-51)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI, Tabs 35, 49-51)

Tank 7: 1982: 4' dia meter x 60' deep (Final RI prior to 11/25/02 revision, Tabs 35, 49-51)

(Note: Tabs refer to documentation provided with Latham and Watkins comments.)

CDHS has received comments from the WERT and Latham and Watkins (Whitman/Pepsi America's lawyers) for using data presented in earlier reports and employee testimony rather than using information presented in the Final Remedial Investigation Report (RI), which according to Latham and Watkins contains the most comprehensive information available. However, it appears the actual installation dates for the vertical underground plating tanks is still a source of deliberation, as information presented in the Final RI report has changed once again. The most recent change was a revision to the April 2002 RI report, written by Montgomery Watson Harza, Inc. (MWH). On November 25, 2002, MWH sent a revised table titled, "Table 2-2 Chrome Plating Tank Construction Specifications" in which the construction date for Tank No. 7 was changed from 1981 to 1986. CDHS staff has a copy of a 1983 inspection report from the Mendocino County Air Quality Management District (MCQAMD) that indicates there were seven plating tanks were in operation (147). This information clearly contradicts the most recent change to the tank construction timeline as asserted by the responsible party's consultant.

CDHS identified other inconsistencies with the construction dates of the first three vertical tanks, based on former employee testimony. For example, a former employee who began

working at Remco in 1969, testified that there were three outdoor vertical tanks operating when he first began working at Remco, not one, which would have been the case using the later timeline proposed by the RP's consultants and lawyers (Straight 1997). Testimony given by another employee, who began working at Remco in 1972, stated that there were 3 outdoor tanks (Tanks 3-5) operating during the onset of his employ (Wake 1996), which would not have been the case with the later timeline, that suggests there were two outdoor tanks in 1972 (Tanks 3and 5); and the most recent timeline proposed by the RP's lawyers suggesting Tanks 4 and 5 were installed in 1973. Testimony given by another employee suggests that a deep tank (15-20 feet) was in operation in 1963 (Figg-Hoblyn 1997). As stated in the PHA, on a number of occasions CDHS attempted to obtain additional clarification from MWH and the WERT regarding inconsistencies between the tank installation timelines, and received none. It is for these reasons CDHS appropriately chose to use a more conservative timeline in evaluating potential exposures.

Even with the changes in the tank installation and emission control timelines (and meteorological data – discussed later), the air model estimates are consistent and elevated. Thus, debating minor details where there is no definitive information does not alter the bottom line: Remco operated one of the largest chromium plating facilities in the country, releasing hexavalent chromium for many years, which could have affected the health of Willits residents.

Emission Controls

One of the most significant errors made in the CDHS Draft Report is the incorrect assumption that there were no emission controls at the Remco Facility from 1964 to 1976. Emission controls in chrome plating include foam blanket additives, poly balls, covers, de-misters and scrubbers that can reduce chromium emissions by up to 99% or more. Tab 2, pp. 3-6. Based solely upon a conversation with a Mendocino County Air Quality Management District representative who never went to Remco while it was operating (and who admits that he has no personal knowledge of when emission controls were installed at Remco (Tab 29, pp. 17, 40-41)), the Report assumes that there were no steps to control emissions at Remco until 1976 (Report p. 8). In fact, testimony of former employees, equipment inventories, and facility drawings confirm that various methods were used to reduce emissions even during the earliest years of chrome plating operations. Tab 1, pp. 1-12; Tab 2, pp. 3-6 and App. B; Tabs 16-21.

As described in the attached analysis, there are several common methods in the plating industry to physically restrict chrome tank emissions. Tab 2, pp. 3-6 and App. B; Tab 7. Consistent with these historical industry practices, testimony from former Remco employees indicates that, during the earliest years of chrome plating operations, the Remco Facility used: polyurethane balls that restrict emissions by floating on the surface of the plating tank; foam mist suppressants applied to the tank surface; and plastic tarps laid over the tanks during chrome plating to physically reduce emissions. Tab 1, pp. 3-12; Tab 2, pp. 3-6 and App. B; Tabs 7, 22, 23. Other testimony indicates that the ventilation system included a "baffled" or a "chevron" style mist eliminator in these early years. Tab 1, pp. 1-4; Tab 2, pp. 3-5 and App. B; Tabs 22, 24. Equipment inventory records describe the purchase of fume scrubbers dating back to 1970 (Tabs 16-18) and a mist eliminator by 1973 (Tab 20). Plant diagrams identify the presence of a mist eliminator in the chrome department by the time it was expanded to five tanks in approximately 1973 (Tab 19) and Water Board communications confirm that emission controls were operating by 1974 (Tab 21, 43, 44). Studies of the various emission control technologies confirm that even these earlier forms of emission control techniques would have reduced emissions by 72% to 98%. Tab 2, p. 5. The Report models the emissions from 1966 to 1976 assuming five tanks operated with no emission controls (Report pp. 8-9 and Appendix D), when the attached information and analysis suggests that there were three tanks operating with emission controls for most of this time period (Tab 1, pp. 1-5; Tab 2, pp. 1-3, 5 and App. A and B; Tab 21).

There is simply no basis for the assumption that emission controls were not utilized at Remco until 1976. Tab 7. The failure to include any emission control factor for the first twelve years of plating operations has caused a gross overestimate of the highest modeled emissions and the time period over which those modeled emissions are assumed to occur.

2) <u>CDHS Response</u>: CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco, resulting in a better understanding of past operations at Remco. This has allowed the opportunity to provide an even more accurate depiction of past releases. As a result, revisions have been made to both the early and middle time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated reflect revised MET data.

The modeling conducted for 1976 – 1990 time period utilized the assumption that emissions were controlled by 98%. This assumption was based on limited site-related information, communications with MCAQMD staff, and information provided in USEPA guidance (16). It now appears this was an overestimation of control, as the documentation in 1986, from the Abex Corporation, Environmental Control Manager Charles H. Borcherding indicates the equipment used (demisters) did not qualify as scrubbers and were not adequate at removing material (chromium) from the "vapor state" (demister exhaust) (17, 18). In other Abex Corporation documentation entitled, "<u>Priority 1 Critical—An environmental problem that would be severe enough to cause a real embarrassment to the company—has the potential to endanger the environment or life</u>", Abex states, the "chrome vapor exhaust equipment is ineffective" (18). Other documentation (written and photo) show/discuss roof staining from deposition of chromic acid on the roof adjacent to the demister exhaust, along with documentation of chromium in run-off water, further indicate the demisters were not efficient (1, 148-150). As stated earlier, Latham and Watkins has not provided any technical information on the control efficiency for the demisters that were used at Remco, starting in the late 1970s. The historical record (and comments submitted by Latham and Watkins) suggests the demisters used at Remco in the late 1970s were consistent with the Chevron-blade mist eliminator. In the absence of site-specific technical information, CDHS reviewed documentation published by the USEPA and contacted experts in the field. The efficiency of Chevron-blade mist eliminator, as cited by the USEPA, ranges from 83-91%. Testimony given by MCAQMD staff, indicate an efficiency range between 40-80%; the higher level of

efficiency (80%) would require adequate maintenance of the system {, September 2003 #190}. As discussed above, it does not appear the systems at Remco were effective at controlling emissions at these higher levels (80%).

Based on the documentation, a true "scrubber" was not added to the facility until 1989 (17). In April 1989, source tests were conducted and the new system did not meet permit requirements of 98.6% efficiency or a scrubber exhaust emission rate of less than 0.006 mg/amp-hr (Galson 1989). It was not until 1991, after an additional filter was added, that this system was estimated to be 99.991% efficient, under optimal operating conditions (14).

The comments suggest during the earliest time period (1964 – 1975) emission controls, consisting of Udylite model 30 and model 60 fan fume scrubbers, polyurethane (poly) balls and foam mist suppressants (Foam-Lok) were used, resulting in 72-98% control of emissions. The only supporting information provided with the comments for the use of poly balls was from testimony given by John Figg-Hoblyn, in which he states, "at one time we even had balls floating on the tank"; he does not specify a time period, frequency of use, or which tanks they were used on. In testimony given by Mr. Figg-Hoblyn (worked in plating department), it is clear that he has trouble remembering the timing of events at Remco. For example, when asked in what decade (1960s or 1970s) the first outdoor plating tank went in, Mr. Figg-Hoblyn could not remember. Yet in other testimony, he states that an outdoor tank existed in 1963. CDHS spoke with a former Remco employee who worked in the plating department from 1972 – 1991 (19 years) about the use of poly ball and Foam-Lok. We were informed that during his 19 years in the plating department, they never used poly balls; Foam-Lok was used very infrequently (about a dozen times) from 1972 – 1976, and only on the indoor horizontal tanks (R. Wake Remco employee [1972 – 1991], personal communication November 19, 2003). CDHS interviewed another former employee who worked in the plating department at Remco from 1967 – 1995. This employee stated that there were three above ground plating tanks in 1967, two were rectangular (about 12 to 15 feet long by 7 to 8 feet wide) and the other was cylindrical in shape and stood about 12 feet high with an approximate diameter of 48 inches. He said the tanks were not attached to any type of emission control equipment until about 1968, at which time a collection system was installed that pulled the fumes from the tanks and discharged them out the roof. Prior to the collection system the chromic acid vapors inside the building were controlled with a foam mist suppressant (Foam-Lok) and "styrofoam Ts". Once the collection system was installed, the practice of using styrofoam Ts and Foam-Lok ceased (F. Vincent, Remco employee (1967–1995), personal communication January 6, 2004). It appears that up until 1968, emissions from the plating activities were controlled to a certain degree and contained within the plating area. The only corporate documentation CDHS has reviewed regarding poly balls or any surface tension reducer was in the 1986 Charles Borcherding correspondence, in which he suggests that using poly balls may help reduce the "quantity of contaminants reaching the roof" (17).

Latham and Watkins consultant Frank Altmayer asserts a scrubber "with serpentine baffles", commonly known as a chevron blade mist eliminator was in place in 1963, based on Mr. Figg-Hoblyn's testimony. Again, there was no time period specified in Mr. Figg-Hoblyn's testimony. Corporate records indicate this type of control equipment (mist eliminator) was purchased in the mid-1970s and according to former workers installed in the late 1970s (R. Wake, Remco employee [1971 – 1992], personal communication November 19, 2003). With

regard to the Udylite fan fume scrubbers, Mr. Altmayer, who states in his comments that he is an expert in "chrome-plating operations and technologies (equipment)" is apparently unfamiliar and looking for information about this type of equipment. CDHS found an inquiry from Mr. Altmayer on the Internet at www.finishing.com ("The home page of the finishing industry"), in which he states, "I am looking for anyone that has information on some plating equipment from the 1970s. Specifically, does anyone have information on a model 30 or model 60 Udylite scrubber?" Thus, the Latham and Watkins assertion that from 1964 – 1975, emissions were controlled by 72-98% is based solely on the use of poly balls and Foam-Lok. It appears that that for a portion of that time period 1963 – 1967, emissions were controlled at some level. For the remainder of the time period (1968 – 1975), CDHS' original assumption that emissions were uncontrolled is appropriate and supported by the historical record as well as other experts in the field. We have modified the air model and exposure assessment to reflect the 4 years (1963 – 1967) when the two indoor tanks had controls through the use of styrofoam Ts and foam mist suppressant.

Since the release of the public comment draft of the PHA, CDHS learned that in 1972, the outdoor tanks had some type of exhaust collection system that pulled the vapors off the tanks and exhausted it up into the air at a height of about 10-12 feet. The system was reportedly attached to the outside of the building and consisted of a large fan with a pipe (about 3 feet in diameter by 10-12 feet tall) that contained a single spray bar (R. Wake, Remco employee [1972 – 1991], personal communication November 19, 2003). CDHS spoke with Dean Wolbach of the MCAQMD about the efficiency of this type of system, based on his 30+ years of experience. He informed CDHS that this type of system would not be efficient at removing hexavalent chromium from the tank vapors and he is not aware of any testing of such systems (D. Wolbach, MCAQMD, personal communications November 25, 2003). Thus, from 1968 – 1975, emissions from the outdoor vertical tanks have been characterized as uncontrolled. MCAQMD staff concurs with this characterization (D. Wolbach, MCAQMD, personal communications November 25, 2003).

Latham and Watkins's consultant suggests the hardware on the vertical tanks would act as a partial lid, reducing the amount of "raw chromic acid" leaving the tank. Latham and Watkins did not provide any site-specific information needed to evaluate this assertion in a quantitative manner.

Tank and Rectifier Operating Assumptions

For plating operations, the lower the electrical usage, the lower the emissions. The modeling underlying the CDHS Draft Report is corrupted by erroneous assumptions concerning the available electrical capacity, the number of hours the tanks were operated and the amount of electricity used in Remco plating operations.

Plating tanks run on DC current from generators or rectifiers. The CDHS Draft Report compounds the errors regarding tank installation dates described above by completely failing to consider the rectifier purchase dates for the electrical capacity used to operate these tanks. The Report mistakenly assumes that the electrical capacity identified in permits and emission testing from the 1980s and 1990s was available each year from 1964 to 1976. Report Appendix D. Purchase records, facility diagrams and equipment inventories indicate that the actual electrical capacity for chrome plating during 1964 to 1974 was thousands of amps less than assumed by

CDHS. Tab 2, pp. 2, 6-10, and App. A, App. C, App. G, and App. H. The Report grossly inflates the modeled emissions by mistakenly assuming that the tanks were operated at or near this maximum electrical capacity that was not even installed for 16 hours per day, 5 days per week, 52 weeks per year. The result is a modeling exercise that is based upon more than 700 million amp hours of electricity from 1964 through 1975 from rectifiers that were not even installed. Tab 2, pp. 6-10, and App. C, App G and App. H; Tab 6.

Other erroneous operating assumptions are also embedded in the modeling. Plating tanks are emission tested or permitted at or near their electrical capacity. When operated for plating, however, they are generally operated at lower electrical rates determined by the plating task to be performed. It is unrealistic to assume that plating tanks are operated every minute of the work day. Parts are plated on demand. As business cycles change from month-to-month or year-to-year, tanks may be idle for days at a time as Remco records confirm. As described in the attached analysis, plating operations are interrupted for loading of parts, inspection, jigging to start the plating operation, reworking the parts and other non-plating operations. Analysis of Remco records suggests that tanks may have operated less than 20 percent of the available plant operating hours. Tab 2, pp. 6-10. Remco records concerning the electricity used for chrome plating in 1991 and 1992 demonstrate how the Report's unrealistic operating assumptions can mistakenly inflate the electrical usage by millions of amp hours in a given year. Tab 2, p. 7-8; Tab 64.

A comparison of Remco Facility chrome purchase records with model assumptions demonstrates that Remco did not purchase enough chromium to operate in the manner described in the Report's inflated assumptions. For certain years, the Report's mistaken operating assumptions would require the purchase of more than double the chromium actually purchased or used in plating by the Remco Facility. Tab 2, pp. 10-11. The Report's unrealistic operating assumptions inflate the estimated emissions.

3) <u>ATSDR/CDHS Response</u>*: *Latham and Watkins often confuses model assumptions with assumptions used for risk characterization, as most of the comments and documentation relate to installation of the tank(s) and scrubber/emission control usage. Assumptions related to the tank installation timeline and history of scrubber usage have been addressed by CDHS.

Latham and Watkins asserts that the input data used for the air modeling overestimated the amount of electricity used between 1964 – 1974, and thus provided an inflated estimation of the emissions. The electrical usage data used by Lockheed and ATSDR is based on testing conducted at the Remco facility—testing which is done at optimized conditions, not worst case. Modeling was limited to the permitted hours, which are known to have been exceeded. The Latham and Watkins information provided to support the time line assertion relates primarily to the rectifiers used for Tank 1 and Tank 2, the surface area for the "early" Tank 2 and the assumption (based on the permit) that the plant operated 16 hours per day, 5 days per week. The overall contribution of Tank 1 and Tank 2 on the annual average for the 1964 – 1976 time period and resulting risk is minimal and will be addressed in further detail later. With regard to the plant operating assumptions, former workers report that plating activities often ran 24 hours per day, seven days per week (C. Nickerman, Remco employee [1984 – 1986], personal communication November 11, 2003) (R. Wake, Remco employee [1972 – 1991], personal communication November 19, 2003) (C Douglas, Remco employee [1974 – 1988], personal communication November 20, 2003) (F. Vincent, Remco Worker [1967 – 1995],

personal communication January 6, 2004) and the report from the EPA testing in 1991 (Advanced System's Technology, 1991) . Thus, for modeling purposes the assumption that the plant operated 16 hours/day probably underestimate emissions or at the very least average out the times when the tanks were being loaded, repaired or not operating. However, CDHS has revised the risk calculations to reflect a 24-hour/day exposure scenario. The 24-hour per day exposure assumption is appropriate for the above stated reason. Furthermore, there is evidence (Tab E, MCI 012 1470) that emissions continued during the non-operational periods (when no power was used). Since the half-life for hexavalent chromium in the atmosphere is estimated at 13 hours, even if the plant stopped operating after 16 hours, hexavalent chromium could still be present in the air.

Records relating to electrical usage provided by Latham and Watkins (referred to as the REMCO tests) are from three occasions (8/30/89, 2/21/90, 5/23/90), when Remco conducted tests on the scrubber recording the amperage (amps) on the tanks over a 2-3 day period. The amps recorded during these tests are similar with the Galson source test data, utilized for the air modeling. The REMCO tests used approximately the same amps applied in the Galson source test for tanks 2A, 3, 4, 5, and 6, but also included tank 1A. The plating solutions contained similar amounts of chromium and acid, albeit lower during each of the REMCO tests. Most importantly, the scrubber solution had lower initial chrome levels for the REMCO tests–essentially started "clean" (discussed further below). Latham and Watkins also provided handwritten logs and adding machine tape showing chrome tank total amp hours from 1992. Source testing in 1991 was used to model the 1991 – 1995 time period; substituting the amp data from 1992 would not significantly change the results of the modeling. The 1992 data does not provide an accurate proxy for emissions that occurred prior to regulations requiring facilities to reduce emissions. It is our understanding that the workload at REMCO began to decline 1991, which could account (in conjunction with trying to meet compliance) for the lower electrical usage. The 1989 source test conducted by Galson was used in the air model because it contained fewer errors or omissions than other tests and because provides information most reflective of the earlier time periods, prior to regulations and the decline in workload (11). The Galson report was reviewed by Lockheed Martin and ATSDR staff and determined be of acceptable quality for the purpose of air dispersion modeling—with the exception that the samples may be biased low due to the long holding times and may be biased low because the chrome content in the scrubber solution started clean.

Furthermore, ATSDR must stress that stack testing is a planned event, not a surprise check on air pollution. Therefore, stack testing is performed in a manner, which is designed to test if the air pollution control (APC) device can work according to the design parameters if operated properly. For an APC device to achieve the desired performance, the re-circulating tanks need to be filled to the proper level, the scrubber solution needs to be clean, the blowers need to produce the proper draft, and pre-testing must ensure that no cyclonic conditions exist (possibly caused by drafts from other facility operations).

Apropos, to scrubber chrome solution, it should be noted that after only three tests, the scrubber solution had a chrome content of 5.5 oz/gal and that the air emission rate increased with each subsequent test run. For the fourth test, the scrubber chrome content was adjusted to 8.2 oz/gal (simulating about three more runs) and the resultant emission rate increased commensurately (over 20 times allowable levels). The trend revealed a 6.9% increase in chrome

emissions with each subsequent run. The fourth run (simulating a seventh run) produced 44% more chrome emissions than the first run. Some of the REMCO results confirm this, but there are some contradiction between pre and post testing. Scrubbers remove airborne chrome by capturing it into solution. If the scrubbers are producing the reported efficiency, then we would anticipate that scrubber chrome levels would increase after each test. The REMCO tests show no change in the chrome levels from the beginning to the end of each test; however, the levels do increase at the beginning of each test (indicating that the scrubber is working). After two tests (on May 90), the levels increased from 2.8 to 3.4 oz/gal an increase in 43%. The testing on February 90 was initiated with scrubber chrome levels of 1.4 oz/gal for Test 1 and 2.8 oz/gal for Test 2, indicating an increase of 100% after one round of testing (after 2 hours and 20 minutes). The test data was less reliable August 89, but it indicated an increase from 1.8 oz/gal to 4.1 oz/gal (from at the start of the Test 1 to the start of the Test 3). The Galson samples (April 89), tracks the scrubber readings from the point where "new water" is placed in the scrubber "at starting" of Test 1 (with no chrome measured) and subsequent readings –making it reliable.

All the tests report that the solution increases by more than 1 oz/gal per test --indicating that the scrubber solution can quickly become saturated—also indicating that the scrubber solution (liquid waste) will be greater than 2% after two batches. This fact was proven in the results. Every series of tests concluded with a scrubber chrome concentration above 2% (or 2.56 oz/gal). The lack of sufficient wastewater data corroborating the sampling data is alarming. Unfortunately, the operationally expedient scenario of not regularly replacing the water is documented along with the Galson test data. In the notes the new scrubber tank received "changed water" on March 29th and was 4.1 oz/gal on April 4th. Then, "new water" was placed in the scrubber on April 5th and it measured 5.5 oz/gal by April 6th. Later on April 7th chrome was added to the scrubber for testing purposes, making it 8.2 oz/gal; on April 10th, there was no report of water being added, but the concentration dropped to 7.5 oz/gal–either water was added to dilute the scrubber or some chrome escaped (0.7 oz/gal). Therefore, the documentation during testing indicates that no water was added for at least two subsequent 5-day periods—allowing the chrome scrubber concentrations to accumulate well beyond the scrubbers rated efficiency and allowing chrome to escape while the operations ceased.

Knowing that the scrubber's efficiency decreases as chrome is captured in solution (a fact), one can calculate that the scrubber's efficiency falls below 99.8% after two test runs. The REMCO Tests confirm that the efficiency decreases to 99.6% after three tests in August 89 which results in emissions rates three times the state permissible levels. The Galson samples show the continued degradation of efficiency after each subsequent test with the emissions exceeding permissible rates by a factor of 18 after Test 3 (and by a factor 21 by Test 4). Three days after the Galson tests were completed, the water remained unchanged.

As stated earlier stack testing is a planned event, usually conducted under optimal conditions. If operating conditions identified during stack testing were assumed for the air modeling, then model estimates for the later two time periods (1975 – 1989, 1989 – 1995) would have been orders of magnitude higher (Appendix D).

The revised report provides a description of the selected model inputs along with their justifications. The report provides evidence of REMCO's continued failure to meet emission control performance standards and documents knowing non-compliance with operation restrictions.

Modeling Errors

The modeling utilized to estimate the dispersion of emissions in the Report also includes numerous errors. Most importantly, as described above, the modeling includes more than 40 years of chrome plating tank operations that never took place, incorrectly assumes there were no emission controls for 12 years of operations and models hundreds of millions of amp hours of electrical usage from rectifiers that did not exist. No model can accurately predict the dispersion of emissions if it is based upon fundamentally incorrect assumptions concerning the amount and duration of emissions.

The modeling errors also include incorrect identification of the location, type and dispersion of emissions. Among other things, the model input incorrectly describes the location of the tanks, the elevation of the Remco Facility and the form of emissions (stack emissions modeled at ground level). Tab 3, pp. 8-10. By failing to properly account for the surface area of the tanks, the model input also overstates emission rates. Tab 3, pp. 7-8. If source locations and emission rates are incorrectly specified, the dispersion of emissions will be incorrectly modeled.

The emission contours in the Report are mistakenly centered approximately 250 meters south of the former Remco Facility, when the modeling output describes the highest concentrations to be located within 20 meters of the scrubber exhaust stack. This is caused by incorrectly specifying the map coordinates used to locate the contours in relation to the former. Remco Facility. Tab 3, pp. 4-7 and Figure 2-1.

4) ATSDR Response: Although the facility's emission and operation records are sparse, even those collected during the planned sampling events (under optimized conditions) indicate that chromium releases exceeded allowable levels. The amp hours required to plate during an optimal test are consistent with those used in the modeling. While data does show that there were days when Remco was operating only a percentage of a workday, there is also data that shows that emissions on other days were thousands of percent above permitted levels. Furthermore, there is evidence that REMCO willfully operated outside the permitted times while they knew that the air pollution controls were not functioning properly.

To mention the change of tank location distracts from the issue of the release of hexavalent chromium into the community: The location of tanks will do little to change historic averages of air concentrations throughout an air-shed. That is, if the tanks were at one end of the property instead of the other, the variability of wind direction will ensure that it blows into the ambient air at some point. If the tanks were actually closer to the homes than represented in the model, the resultant pollution will then be higher on the populations closer to REMCO than reported. The models were rerun by ATSDR with "cross hairs" placed at the center of all the sources (for reference).

Meteorological Data Problems

All of the modeling is highly unreliable because the dispersion is estimated using meteorological data gathered from a station which is not operated with the precision required to support this type of regulatory modeling analysis. EPA has published Meteorological Monitoring Guidance For Regulatory Modeling Applications. The Guidance describes the equipment, testing, calibration, auditing and other requirements necessary to produce meteorological data for these applications. Tab 3, pp. 15-16. The Willits station meteorological equipment is not sited, maintained or operated to meet the requirements of applicable EPA Guidance. Tab 3, pp. 15-26.

The data produced from the Willits station contains irregularities that raise numerous questions about its reliability. Several months of data collected in 1996 were discarded because of a CARB audit on the pollutant monitoring system that is also located at the Willits station. Tab 3, p. 26; Tab 25, p. 47:23 - 48:17. The wind speed data were adjusted (reduced) by approximately 2 mph beginning in July 1999, but not for earlier years. Tab 3, pp. 29-31 and Fig. 3-5. The wind speed data are identified as miles per hour in the MCAQMD electronic files, but after June 1998, the data appear to be provided in meters per second. Tab 3, pp. 29-31 and Fig. 3-5. The predominant wind direction data changed by approximately thirty degrees beginning in June 2001, and continues that revised pattern to the present. Tab 3, pp. 27-29 and Fig. 3-4. More recent data collected from a meteorological station at the former Remco Facility, suggest that the data after the thirty degree shift more accurately represent conditions in Willits.

The data provided to Lockheed include inconsistent and erroneous wind speed and wind direction data for substantial portions of the 1997-2000 data set used for the modeling.[13] Without audits and calibration records, there are no conclusive explanations for many of these data irregularities, and the data produced by the Willits meteorological station cannot be used to reliably calculate the dispersion of Remco emissions. See Tab 3, pp. 28-29, 33.

5) CDHS/ATSDR Response: CDHS received correspondence from the MCAQMD regarding an audit conducted on the MET (meteorological) station on the roof of the Safeway, near the Remco site (181). We were informed that MCAQMD staff and David Suder of Precise Environmental Consultants (Latham and Watkins consultant) evaluated the air districts MET station and discovered that there were notable inconsistencies with the data after 2002. The data used for modeling predated these inconsistencies, but ATSDR found some less significant artifacts. One artifact is the steady decline in the wind speed measurements after May of 1998, which may be the result of slow wearing. The MCAQMD estimates that the wind speed measurements are 30-40% lower. The specific impact will be addressed in the uncertainty section. However, mathematically a 40% decrease in wind speed will create a 40% increase in the predicted maximum concentrations, but will also prevent the plume from spreading downwind, thus decreasing the concentrations at other locations. From a public health perspective, long-term average cancer risk is not changed when the maximum levels are increased and the minimum levels are decreased by the same amount or vice versa.

[13] Despite numerous requests, the processed meteorological data have never been provided to Whitman. Discrepancies in the annual model output for 1997 – 2000 suggest that these meteorological data errors were not corrected before they were used as model input. Tab 3, p. 33. Without proper audits for the meteorological station, it is not certain that reliable corrections can be made for all of the meteorological data errors. Tab 3, p. 33.

ATSDR also discovered that the wind directions reported during 1997 contained two continuous unusual events (out of 8,760 hours). The events, which may be recalibration events, would not inhibit the ability to predict long-term average exposures. However, our scientists chose to leave this data out because of the existence of those events. Therefore, the revised modeling used only the best available data.

Willits Observations

The Report's modeled risk conclusions are also called into serious doubt by the soil and health data observed in Willits.

Normal Concentrations of Chromium in Soil

If the modeled airborne concentration of twenty micro grams per cubic meter actually took place for more than ten years south of the former Remco Facility as the Report computes, elevated levels of chromium in surface soils would be expected. However, testing found normal concentrations of chromium in soil where the model predicted the highest airborne concentrations. The absence of elevated levels of chromium in soil provides further evidence that the emissions modeled in the Report never happened.

6) <u>CDHS Response</u>**: **The amount of total chromium in soil as a result of deposition is a complex issue. Chromium is found naturally in soil with a great deal of variation. Surface soil collected in Willits has shown to contain total chromium concentrations ranging from 13.2 – 132 ppm. It is not possible to know how much of this is a result of deposition from Remco plating operations versus natural background. Background can vary greatly: one study by the U.S. Geologic Survey found an average value of total chromium of 41 ppm for the Western United States, but the upper end of the range would be greater than this. In order to determine deposition impacts from airborne emissions, a study of chromium fate and transport in soil, additional soil sampling, modeling and statistical analyses, would be required.

Normal Cancer Rates in Willits

The CDHS conducted its own review of cancer cases that occurred in Willits from 1988 to 2000. The Report found no excess cancers, concluding that "[f]or all individual cancer types reviewed, the number of new cases actually observed during this period, 1988-2000, was within the range of what would be expected, as was the overall number of cancer cases observed." Report p. 29.

These findings are consistent with two other analyses that have been conducted of cancer rates in the Willits area. In one study, the California Cancer Registry (a cooperative effort of the California Department of Health Services, the Public Health Institute, the California Association of Regional Cancer Registries, the Centers for Disease Control and the National Cancer Institute) reviewed new cancer cases from 1988 through 1997 in the census tract covering the Willits area. Using regional statistics, the study calculated the expected number of cancers considering the race, sex and age of the population in the census tract. This study concluded that there was "no meaningful or statistical difference between the number of observed and expected number of primary, malignant cancer cases ... in residents residing in this portion of Mendocino County during the period 1988-1997." Tab 27, p.2.

Another recent study of cancer mortality among residents of Willits was conducted at the request of Whitman Corporation by two epidemiologists, Drs. Michael Kelsh and Jack Mandel. The purpose of this study was to update and supplement the California Cancer Registry analysis of cancer rates in the Willits community. In the new study, the period of time that was examined was expanded to cover 1985 to 2000. In addition, more of the Willits population was included because the study relied on ZIP code designations (instead of one census tract that did not capture the entire Willits population). The new study also used a local population comparison, Mendocino County, which more closely matches the characteristics of the Willits population than the Northern California region as a whole. The study found that "over the sixteen-year study period (1985-2000), the Willits community did not experience excess mortality due to all causes, all cancers or lung cancer as compared to mortality rates for Mendocino County." Tab 28, p. 9. The study concluded that the findings "do not suggest excess overall cancer or lung-specific cancer in Willits that could be attributable to living near the hydraulic manufacturing facility." Tab 28, p. 9.

In short, the actual health data for Willits do not support the use of the unrealistically high modeled airborne chrome six concentrations in the Lockheed Report for predicting health risk.

7) CDHS Response*: The cancer incidence review found an additional 12 lung cancers, although this number is within a range that, from a statistical perspective, could have occurred by chance. The predicted cancer risk in the PHA is specific to time period and population contours; also, the highest cancer risks apply to very small populations. It is also plausible that other Remco-related cancers have not yet occurred due to latency, or may have occurred among persons who have moved away. As we state in the document, the cancer risk estimates should not be interpreted as an accurate prediction of the exact number of cancers that would occur, but is a tool in helping quantify and comparing risk in different situations. It is our opinion that the risk estimates are not inconsistent with the findings of the cancer incidence review. During the time period covered in the mortality study, the additional number of lung cancer deaths was nine, although also not statistically significant, similarly, there is no reason to conclude this is inconsistent with either the cancer incidence findings or the cancer risk predicted by the model.

Risk Estimation

The Report compounds the modeling errors and historical operating assumptions by applying conservative and outdated assumptions in computing its hypothetical health risk. Although it is difficult to provide detailed comments because the Report does not refer to the specific quantitative approach used to estimate the theoretical excess cancer risk, it appears that the "cancer slope factor" adopted by the State of California's Office of Environmental Health Hazard Assessment ("OEHHA") was used to calculate the theoretical excess cancer risks. The OEHHA approach is based upon some very conservative assumptions adopted to address uncertainties in certain old epidemiological data, *i.e.,* Mancuso, T. F. (1975). By comparison, use of the U.S. Environmental Protection Agency ("EPA") quantitative risk assessment (as described in the Integrated Risk Information System) would result in theoretical cancer risks at least ten times lower than the results obtained in the Report. The quantitative risk assessment developed by the U.S. EPA is consistent with more recent epidemiological data and independent evaluations developed by the Occupational Safety and Health Administration ("OSHA") (1995).

Consequently, estimating theoretical excess cancer risks using unit risks devised by the U.S. EPA and OSHA would result in risk estimates at least ten times lower than those presented in the Report. This tenfold conservatism is not even mentioned in the Report.

8) <u>CDHS Response</u>: The USEPA and OEHHA cancer slope factors are developed from the same study, Mancuso, T.F (1975) (52). The Mancuso study was based on exposure levels measured as soluble, insoluble, and total chromium (the chromium was not speciated between trivalent and hexavalent). Limitations with the 1975 study make identification of the specific form of chromium responsible for the lung cancer uncertain. In 1997, the study was updated showing lung cancer rates clearly increased by gradient level of exposure to total chromium (53).

USEPA developed their cancer slope factor/unit risk for hexavalent chromium in 1998, using dose-response data for total chromium, potentially leading to a sevenfold underestimation of the risk for hexavalent chromium (53). OEHHA calculated their cancer slope factor/unit risk value assuming the cancer mortality in the Mancuso study was due to hexavalent chromium exposure, which was further assumed to be 1/7 of the total chromium exposure (25). This approach helps reduce some of the uncertainty in the toxicological information, while providing a more health protective value.

CDHS and ATSDR do not use standards developed by OSHA (as suggested by the comment) in evaluating exposure to non-worker populations, as they are not protective of sensitive populations such as children, the elderly, and immune compromised individuals.

Scientific Literature Concerning Chromium

The Report attempts to describe a possible connection between environmental exposure to chromium six and a range of potential health effects based upon occupational studies and literature reviews. Although the Report mentions several literature reviews, it omits reference to findings of other scientific agencies that have reviewed the literature on chromium and concluded that there is insufficient evidence that chrome six exposure is causally associated with non-respiratory cancers. For example, the World Health Organization has concluded that "there is insufficient evidence to implicate chromium as a causative agent of cancer in any organ other than the lung." World Health Organization (1988) Chromium, Environmental Health Criteria, Vol. 61, WHO, Geneva Switzerland. Similarly, the International Agency for Research on Cancer has concluded that "[f]or cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds." International Agency for Research on Cancer, "Chromium and Chromium Compounds," IARC Monographs on the Evaluation of Carcinogenic Risks to Humans:

Chromium, Nickel and Welding, Vol. 49, Lyon, France (1990), p. 211,

Recent studies of environmental chrome six exposure have not found a causal association with adverse health effects. For example, a recent review article examined the effects of environmental chromium exposure in the United Kingdom; it found "no clear evidence to relate exposure to environmental levels of chromium with adverse health effects in either the general UK population or subgroups exposed to chromium around industrialized or contaminated sites." Rowbotham, Anna L., et al., "Chromium in the Environment: An Evaluation of Exposure of the

UK General Population and Possible Adverse Health Effects," *J. Toxic. Environ. Health,* 3:101-136 (2000). Another study, funded by PG&E, examined the cancer and death rates in the zip codes immediately surrounding gas compressor stations in California that used hexavalent chromium. Fryzek, Jon, et al, "Cancer Mortality in Relation to Environmental Chromium Exposure," *Journal of Occupational and Environmental Medicine,* Vol. 43, pp. 635-46 (2001). This study found no significant increase in overall cancer deaths or lung cancer deaths in the area surrounding the gas compressor stations as compared to the rest of the counties.

In reviewing some of the literature on occupational exposures to chromium six, the Report also fails to discuss certain more recent occupational studies. For example, the Report does not refer to certain recent studies, including: Gibb, H., et al., "Lung Cancer Among Workers in Chromium Chemical Production," *American Journal of Industrial Medicine,* 38:115-126 (2000); Gibb, H., et al., "Clinical Findings of Irritation Among Chromium Chemical Production Workers," *American Journal of Industrial Medicine,* 38:127-131 (2000); Luippold, R. S., et al., "Lung cancer mortality among chromate production workers," *Occup. Environ. Med.,* 60:451-457 (2003); and Proctor, D. M., et al., "Workplace Airborne Hexavalent Chromium Concentrations for Painesville, Ohio, Chromate Production Plant (1943-1971)," *Applied Occup. Environ. Hygiene,* 18(6):430-449 (2003), which provide analysis of thresholds for occupational exposures to chrome six below which no significant health effects were observed.

9) <u>CDHS Response</u>*: *These quotations are taken somewhat out of context, as the primary thrust of the evaluation of IARC is its assessment that there is sufficient evidence of chromium[VI] as a carcinogenic compound in humans. The IARC statement about cancers other than lung and sinonasal cavity refers to an evaluation of existing evidence specifically from epidemiological studies, but this does not mean that IARC rules out that there could be other cancers caused by chromium[VI].

Both the Gibb and Luippold studies found highly significant dose-response relationship between cumulative exposure to hexavalent chromium and death from lung cancer. The statement that the three articles "provide analysis of thresholds for occupational exposures to chrome six below which no significant health effects were observed" is somewhat confusing. The Gibb and Luippold studies address death lung cancer deaths only, not any other significant health effects; whether or not other significant health effects can occur at any threshold was not studied and therefore cannot be commented on. Also, the studies should not be interpreted to mean there are thresholds below which no significant health effects exist. The risk at higher levels of exposure was higher, and the risk at lower exposure levels was lower, varied, and was not statistically significant. This does not rule out that there could still be some elevated risk at lower exposure levels. More specifically, Gibb found a strong and statistically significant dose-response relationship between hexavalent chromium exposure and lung cancer (151). Among lowest exposure category, Gibb found the number of observed deaths due to lung cancer to be lower than expected for whites; higher than expected for non-whites; higher than expected for persons of unknown race; averaging to slightly lower than expected overall, although the 95% confidence interval spanned from 0.63 – 1.39). Luippold similarly found a highly significant relationship between risk for death from lung cancer and cumulative hexavalent chromium exposure (test for trend: p=0.00002) (152). Luippold states that there could be a threshold effect, although acknowledging that the data could also be

consistent with a linear dose-response. However, similar to the Gibb data, the SMRs of the three lowest exposure categories are 67 (14-196); 184 (79-362); and 91 (25-234); because the confidence interval of each of these extends well above unity, this means the "true" SMR could be elevated, even at the lower levels (meaning a "threshold" has not yet been demonstrated to exist). The third reference (Proctor), is a report of 23 historic exposure measurement surveys from 1943 – 1971 that could be useful in cancer risk assessment efforts, but does not actually "provide an analysis of thresholds for occupational exposures to chrome six below which no significant health effects were observed." (153)

The PHA did not attempt to provide a comprehensive review of the epidemiological literature on chromium exposure, and did not cite specific lung cancer studies, as that association is considered well proven. The PHA does refer to over 30 scientific studies showing this association. However, the two recent studies mentioned in the comments confirm and strengthen the previous studies' findings of an association between lung cancer and hexavalent chromium exposure. Gibb found a significant and strong dose-response relationship between hexavalent chromium exposure and lung (151). For each additional tenfold increase in cumulative hexavalent chromium exposure, there was a 66% increase in risk of death from lung cancer among this cohort of chromium chemical production workers. Luippold found a strong relationship between lung cancer mortality and cumulative hexavalent chromium exposure (152).

Additional information has been added to the PHA to further clarify the carcinogenicity of hexavalent chromium.

Conclusion

The CDHS Draft Report's seriously flawed operational assumptions cause a gross overestimate of historic emissions input to the model. The questionable meteorology and modeling errors have produced patterns of estimated airborne chromium concentrations that defy reality. The CDHS Draft Report calculates risk based upon a hypothetical model of events that never took place. The Report should be withdrawn because its use of incorrect emission rates, unreliable meteorology, erroneous modeling and flawed contour mapping completely mischaracterizes the concentration and location of historic emissions from the former Remco Facility. A new report should be prepared that accurately describes the historical operations (including the information provided with these comments) and reliably estimates the dispersion of emissions from those operations (correcting for the modeling errors and poor meteorological data described in these comments). Until a new, accurate report is issued, it is premature to discuss the feasibility of medical monitoring based upon the existing, flawed Report. Whatever the modeled emissions and risk calculations, the fact is that excess cancer cases have not been observed in Willits.

Specific Comments Concerning CDHS Draft Report

Whitman Corporation provides the following specific comments regarding the statements and the assumptions in the CDHS Draft Report. Historical records and deposition transcripts referenced in these comments are provided as Tabs 4 to 83.

Summary

(CDHS Draft Report pages 1-4)

1. Page 1, paragraph 2, line 1 reads: *"Ownership of the facility changed several times in its 55-year history, with Whitman Corporation (formerly 1C Industries) becoming the last owner in 1988."*

• This statement is incorrect. Pursuant to a November 29, 1988 "Acquisition Agreement," MC Industries, Inc. acquired the Remco Hydraulics Division from Abex Corporation (a subsidiary of 1C Products company), which had owned the Remco Facility since October 1, 1977. *See* Tab 30. Thus, MC Industries, Inc. became the last owner as of November 29, 1988, and neither Whitman nor any of its predecessors or successors had any interest in the Remco Facility after that date.

10) <u>CDHS Response</u>*: *The comment is vague and does not provide any clarifying language as to Whitman and its predecessors' (Pepsi America) involvement with the site. It is clear Whitman/Pepsi America have responsibility (interest) in the site, as they are responsible under court order and have been funding clean-up costs at the site. Since the comment does not provide a clear definition of Whitman/Pepsi Americas' acquisition of the site, we used information provided by the RWQCB for the facility ownership history.

2. Page 2, paragraph 1, line 5 reads: *"Both of the horizontal tanks and three of the vertical tanks operated without pollution control devices until 1976. "*

• This assumption is incorrect. Records and testimony confirm the use of emission control equipment and practices to physically restrict chrome tank emissions before 1976. A detailed discussion of chrome plating tank installation and emission control equipment installation is provided below.

11) CDHS Response*: *CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

The comments suggest during the earliest time period (1964 –1975) emission controls, consisting of Udylite model 30 and model 60 fan fume scrubbers, polyurethane (poly) balls and foam mist suppressants (Foam-Lok) were used, resulting in 72-98% control of emissions. The only supporting information (provided with the comments) for the use of poly balls was from testimony given by John Figg-Hoblyn, in which he states, "at one time we even had balls floating on the tank"; he does not specify a time period, frequency of use, or which tanks they were used on. In testimony given by Mr. Figg-Hoblyn, it is clear that he has trouble remembering the timing of events at Remco. For example, when asked in what decade (1960s or 1970s) the first outdoor plating tank went in, Mr. Figg-Hoblyn could not remember. Yet in other testimony he states that an outdoor tank existed in 1963. CDHS spoke with a former Remco employee who worked in the plating department from 1972 – 1991 (19 years) about the use of poly ball and Foam-Lok. We were informed that during his 19 years in the plating department, they never used poly balls; Foam-Lok was used very infrequently (about a dozen times) from 1972 – 1976, and only on the indoor horizontal tanks (R. Wake, Remco employee (1972–1991), personal communication November 19, 2003). CDHS interviewed another former employee who worked in the plating department at Remco beginning in 1967–1995.

This employee stated that there were three above ground plating tanks in 1967, two were rectangular (about 12 to 15 feet long by 7 to 8 feet wide) and the other was cylindrical in shape and stood about 12 feet high with an approximate diameter of 48 inches. He said the tanks were not attached to any type of emission control equipment until about 1968, at which time a collection system was installed that pulled the fumes from the tanks and discharged them out the roof. Prior to the collection system the chromic acid vapors inside the building were controlled with a foam mist suppressant (Foam-Lok) and "styrofoam Ts". Once the collection system was installed, the practice of using styrofoam Ts and Foam-Lok ceased (F. Vincent, Remco employee (1967 – 1995), personal communication January 6, 2004). It appears that up until 1968, emissions from the plating activities were controlled to a certain degree and contained within the plating area. The only corporate documentation CDHS has reviewed regarding poly balls or any surface tension reducer was in the 1986 Charles Borcherding correspondence, in which he suggests that using poly balls may help reduce the "quantity of contaminants reaching the roof" (17).

Latham and Watkins consultant Frank Altmayer asserts a scrubber "with serpentine baffles", commonly known as a chevron blade mist eliminator was in place in 1963, based on Mr. Figg-Hoblyn's testimony. Again, there was no time period specified in Mr. Figg-Hoblyn's testimony. Corporate records indicate this type of control equipment (mist eliminator) was purchased in the mid-1970s and according to former workers installed in the late 1970s (R. Wake, Remco employee (1972 – 1991), personal communication November 19, 2003). With regard to the Udylite fan fume scrubbers, Mr. Altmayer, who states in his comments that he is an expert in "chrome plating operations and technologies (equipment)" is apparently unfamiliar and looking for information about this type of equipment. CDHS found an inquiry from Mr. Altmayer on the Internet at www.finishing.com ("The home page of the finishing industry"), in which he states, "I am looking for anyone that has information on some plating equipment from the 190s. Specifically, does anyone have information on a model 30 or model 60 Udylite scrubber?" Thus, the Latham and Watkins assertion that emissions from 1964 – 1975, were controlled by 72-98% is based solely on the use of poly balls and Foam-Lok. It appears that that for a portion of that time period 1963 – 1967, emissions were controlled at some level. For the remainder of the time period (1968–1975), CDHS' original assumption that emissions were uncontrolled is appropriate and supported by the historical record as well as other experts in the field. We have modified the air model and exposure assessment to reflect the 4 years (1963 – 1967) when the two indoor tanks had controls through the use of styrofoam Ts and foam mist suppressant.

Since the release of the public comment draft of the PHA, CDHS learned that in 1972 the outdoor tanks had some type of exhaust collection system that pulled the vapors off the tanks and exhausted it up into the air at a height of about 10-12 feet. The system was reportedly attached to the outside of the building and consisted of a large fan with a pipe (about 3 feet in diameter by 10-12 feet tall) that contained a single spray bar (R. Wake, Remco employee (1972 – 1991) personal communication November 19, 2003). CDHS spoke with Dean Wolbach of the MCAQMD about the efficiency of this type of system, based on his 30+ years of experience. He informed CDHS that this type of system would not be efficient at removing hexavalent chromium from the tank vapors and he is not aware of any testing of such systems (D. Wolbach, MCAQMD, personal communications November 25, 2003). Thus from 1968 – 1975,

emissions from the outdoor vertical tanks have been characterized as uncontrolled. MCAQMD staff concurs with this characterization (D. Wolbach, MCAQMD, personal communications November 25, 2003).

3. Page 6, paragraph 5, line 1 reads: *"Ownership of the facility changed several times in its 55-year history, with Whitman Corporation (formerly 1C Industries) becoming the last owner in 1988)."*

• As noted above, this statement is incorrect. MC Industries, Inc. became the last owner as of November 29, 1988.

12) CDHS Response*: *Please refer to CDHS response #10.

History of Chrome Plating Operations and Pollution Control at Remco___

(CDHS Draft Report pages 8-9)

1. Page 8, paragraph 4, line 1 reads: *"Hard chrome plating operations began in 1963 in the two above-ground horizontal tanks. These tanks were about 12-14 feet long by 5 feet wide by 7 feet deep, and located indoors (Appendix B, Figure 2). "*

• The assumption is incorrect. An August 27, 1965 aerial photograph of the Remco Facility shows that the "1964" building did not exist as of August 27, 1965 and the area of the presumed "1964" building is bare ground. *See Tab* 31; Tab 8. Thus, the assumed horizontal tanks did not exist in 1964 as Lockheed assumed and the Lockheed modeling adopted by the CDHS Draft Report is based on a false assumption.

• The conclusion that the " 1964" building was not completed until after August 1966 is supported by the August 9,1966 "Minutes of Annual Shareholders' Meeting and Special Meeting of Board of Directors of Remco Hydraulics, Inc." Tab 32; Tab 9. These minutes discuss the construction of a new building at the Remco Facility: "The president described the progress that had been made with regard to expansion of the building, chrome tank facilities; the Hydra-flo press; employment status; acquisition of new machinery." Tab 32 (at WHIT 025 1049). Thus, it was only at some point after August 1966 that installation of the two horizontal tanks inside this building was complete.

• A January 12, 1966 construction map appears to detail the building foundation expansion that became the "1964" building described in the Remco board minutes above, further supporting the conclusion that the horizontal tanks were installed after 1966. Tab 33.

13) <u>CDHS Response</u>*: *Latham and Watkins seems to be asserting that there were no horizontal tanks thus no chrome plating in existence in 1964, which is clearly not supported by historical records (some of which were provided with Latham and Watkins comments). As Latham and Watkins is aware, the building designations (i.e., 1964) are representative of the year that the facility expanded. The original plating department was reportedly located in building 1945, immediately east of building 1964. Former workers refer to the initial construction of building 1964 as a "lean-to", which consisted merely of posts, a tin roof and tarps for walls (Figg-

Hoblyn 1997, Budish 1996). The actual year the tanks were moved from building 1945 to building 1964 may be unclear, however the historical record shows that chrome plating was occurring in 1964, in the general area of building 1964/1945.

• In addition, the Lockheed modeling report adopted by the CDHS Draft Report incorrectly models two horizontal tanks assumed to be approximately of the same size (3,200 gallons) from 1964 to 1995. However, correspondence and documentation indicates that the "Tank No. 2" used in the Lockheed modeling and adopted by the CDHS Draft Report was not purchased and installed until 1972. A January 20, 1971 letter from Remco to the RWQCB indicates that, as of that date, only three chrome tanks were in existence (only one vertical tank), and that Tank No. 2 only had an 800 gallon capacity. *See* Tab 15. It was not until 1972 that Remco purchased a horizontal Udylite Chrome tank (Tank No. 2) with the dimensions of 144" x 66" x 82" for $2,450.00. See Tab 34. The conclusion that the full sized Tank No. 2 described in later permits and source testing was not installed until 1972 is corroborated by a written record of tanks dated September 28, 1994, which states with regard to the 144" x 66" Tank No. 2: "Tank new 1972 with Koroseal Liner." Tab 35. According to this record, this tank had a 3,200 gallon capacity.

• The 1972 installation date for the larger Tank No. 2 (as opposed to 1964 modeled by Lockheed) is supported by the history of the electricity sources used for the tanks. In order to operate, a plating tank needs a source of DC electricity—*i.e.,* either a generator or rectifier. If the 800 gallon "Tank No. 2" was used along side Tank No. 1 prior to 1972, the only source of electricity it could have feasibly used was a 2,000 amp generator on hand as of July 30, 1966 (or a 3,000 amp rectifier available in 1969—assuming the 10,000 amp generator was used for an ostensibly larger Tank No. 1 and the 1,000 rectifier was used for cadmium plating). *See* Tab 36 (at MCI 017 0118); Tab 2 at 2, 9-10 and Appendix A.

14) <u>CDHS Response</u>**: **In following the logic presented in the comment, documentation (Tab 2) provided with Latham and Watkins comments indicate a purchase of additional power sources in 1968, suggesting the installation of a larger tank (possibly replacing the smaller tank- 800 gallon) may have occurred in 1968. Another possibility is the 3200 gallon tank purchased in 1972, replaced an already existing 3200 gallon tank. CDHS was informed by one former worker that in 1967, there were three indoor tanks used for chrome plating, two large horizontal tanks, 12-15 long by 5-7 feet across and one cylindrical tank, approximately 12 feet tall (F. Vincent, Remco employee (1967 – 1995), personal communication January 6, 2004). This information supports the operation and use of a larger tank (No. 2) as early as 1967. Further, the dimensions of the larger tank and timeline are consistent with information presented in the Final RI (1). Another worker testified that a vertical tank existed in 1963 (Figg-Hoblyn, 1997). Clearly, inconsistencies still remain with regard to the plating tank installation timeline. CDHS has modified the tank installation timeline to reflect the best available information (refer to CDHS response #1 for detailed information).

2. Page 8, paragraph 4, line 3 reads: *"[Tank Nos. 1 and 2] were reported to have a scrubber that vented through the roof.. . . According to information from Mendocino County Air Quality Management District staff, this scrubber probably consisted of a fan that pulled the hexavalent chromium mist from the chrome tanks and vented it through the roof (D. Wolbach, Mendocino County Air Quality Management District, personal communication, April 4, 2002)... .. CDHS concludes that there is no indication that the system reduced the amount of hexavalent chromium in the air before venting it outside. "*

• The conclusion that Remco did not utilize any emission control equipment from 1964 to 1976, based on Dr. C. Dean Wolbach's statement that Remco's "scrubber probably consisted of a fan that pulled the hexavalent chromium mist from the chrome tanks and vented it through the roof," is a generalization about the chrome plating industry in the 1960s and 1970s that is contrary to the attached documents and testimony concerning techniques used to restrict chromium at the former Remco Facility in these decades.

• Dr. Wolbach testified that he never visited the Remco Facility while it was operating, and neither spoke with anyone at Remco about the history of the scrubbers at the facility nor reviewed any deposition testimony about the history of the scrubbers at the facility before his April 2002 conversation with CDHS. *See* Tab 29 at 17:19 -19:4. Dr. Wolbach stated that the only documents he reviewed prior to his April 2002 conversation with CDHS were scrubber permits issued after 1983 and an EPA testing report. Tab 29 at 19:5 - 21:17. Dr. Wolbach testified that his statement to CDHS regarding Remco's scrubber history was based only on equipment that was used at certain other facilities with which he was involved and the lack of permitting at Remco prior to 1983. Tab 29 at 30:12 - 36:14. Accordingly, Dr. Wolbach has "no knowledge of what actually took place at the Remco facility," and if Remco had emission control equipment on the ground at the facility in the 1970s, "[he] would not have known about it." Tab at 40:21 - 41:12. Thus, rather than investigate historical records and testimony, the CDHS Draft Report relies only on Dr. Wolbach's uncorroborated assumptions.

15) <u>CDHS Response</u>: CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco. In the absence of site-specific technical information, CDHS reviewed documentation published by the USEPA, spoke with former workers and contacted experts in the field. This has resulted in better understanding of past operations at Remco, which has allowed the opportunity to provide a more accurate depiction of past releases. This resulted in revisions to both the early and mid time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated to reflect revised MET data (A detailed discussion of the emission controls used at Remco is provided in CDHS response #2)

Early Years

• Testimony of former Remco employees indicates that in the early years of chrome plating that are part of the Report's 1964-1976 modeling period, Remco utilized a combination of exhaust controls and foam blanket additives. One former chrome plating shop employee testified that Remco utilized scrubbers as early as 1963, and that Remco also "had balls floating on the tank that would keep all the liquid from going up into the air." Tab 22 at 26:22-27:11.

• The early "scrubbers" were most likely chevron blade type exhaust controls, as reflected in the testimony describing scrubbers with "serpentine baffles." Tab 2 at 3-4 and Appendix B; Tab 22 at 201:18-202:2.

• One Remco employee testified that Remco covered the "outside" tanks with plastic sheeting during plating. Tab 23 at 270:2-5. With or without emission control equipment, the vertical tanks were constructed in such a manner that, while Remco plated parts, a large amount of the tank surface was covered by "hardware." Tab 2 at 3-4 and Appendix E.

16) <u>CDHS Response</u>: CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco. This has resulted in better understanding of past operations at Remco, which has allowed the opportunity to provide an even more accurate depiction of past releases. This resulted in revisions to both the early and mid time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated to reflect revised MET data.

The comments suggest during the earliest time period (1964 – 1975) emission controls, consisting of Udylite model 30 and model 60 fan fume scrubbers, polyurethane (poly) balls and foam mist suppressants (Foam-Lok) were used, resulting in 72-98% control of emissions. The only supporting information for the use of poly balls was from testimony given by John Figg-Hoblyn, in which he states, "at one time we even had balls floating on the tank"; he does not specify a time period, frequency of use, or which tanks they were used on. In testimony given by Mr. Figg-Hoblyn, it is clear that he has trouble remembering the timing of events at Remco. For example, when asked in what decade (1960s or 1970s) the first outdoor plating tank went in, Mr. Figg-Hoblyn could not remember. Yet in other testimony he states that an outdoor tank existed in 1963. CDHS spoke with a former Remco employee who worked in the plating department from 1972 – 1991 (19 years) about the use of poly ball and Foam-Lok. We were informed that during his 19 years in the plating department, they never used poly balls; Foam-Lok was used very infrequently (about a dozen times) from 1972 – 1976, and only on the indoor horizontal tanks (R. Wake, Remco employee [1972 – 1991], personal communication November 19, 2003). CDHS interviewed another former employee who worked in the plating department at Remco beginning in 1967–1995. This employee stated that there were three above ground plating tanks in 1967, two were rectangular (about 12 to 15 feet long by 7 to 8 feet wide) and the other was cylindrical in shape and stood about 12 feet high with an approximate diameter of 48 inches. He said the tanks were not attached to any type of emission control equipment until about 1968, at which time a collection system was installed that pulled the fumes from the tanks and discharged them out the roof. Prior to the collection system the chromic acid vapors inside the building were controlled with a foam mist suppressant (Foam-Lok) and "styrofoam Ts". Once the collection system was installed, the practice of using styrofoam Ts and Foam-Lok ceased (F. Vincent, Remco employee [1967 –

1995], personal communication January 6, 2004). It appears that up until 1968, emissions from the plating activities were controlled to a certain degree and contained within the plating area. The only corporate documentation CDHS has reviewed regarding poly balls or any surface tension reducer was in the 1986 Charles Borcherding correspondence, in which he suggests that using poly balls may help reduce the "quantity of contaminants reaching the roof" (17).

Latham and Watkins consultant Frank Altmayer asserts a scrubber "with serpentine baffles", commonly known as a chevron blade mist eliminator was in place in 1963, based on Mr. Figg-Hoblyn's testimony. Again, there was no time period specified in Mr. Figg-Hoblyn's testimony. Corporate records indicate this type of control equipment (mist eliminator) was purchased in the mid-1970s and according to former workers installed in the late 1970s (R. Wake, Remco employee [1971 – 1992], personal communication November 19, 2003). With regard to the Udylite fan fume scrubbers, Mr. Altmayer, who states in his comments that he is an expert in "chrome plating operations and technologies (equipment)" is apparently unfamiliar and looking for information about this type of equipment. CDHS found an inquiry from Mr. Altmayer on the Internet at www.finishing.com ("The home page of the finishing industry"), in which he states, "I am looking for anyone that has information on some plating equipment from the 1970s. Specifically, does anyone have information on a model 30 or model 60 Udylite scrubber?" Thus, the Latham and Watkins assertion that from 1964 – 1975, emissions were controlled by 72-98% is based solely on the use of poly balls and Foam-Lok. It appears that that for a portion of that time period 1963 – 1967, emissions were controlled at some level. For the remainder of the time period (1968 – 1975), CDHS' original assumption that emissions were uncontrolled is appropriate and supported by the historical record as well as other experts in the field. We have modified the air model and exposure assessment to reflect the 4 years (1963 – 1967) when the two indoor tanks had controls through the use of styrofoam Ts and foam mist suppressant.

Since the release of the public comment draft of the PHA, CDHS learned that in 1972 the outdoor tanks had some type of exhaust collection system that pulled the vapors off the tanks and exhausted them up into the air at a height of about 10-12 feet. The system was reportedly attached to the outside of the building and consisted of a large fan with a pipe (about 3 feet in diameter by 10-12 feet tall) that contained a single spray bar (R. Wake, Remco employee [197 – 1992] personal communication November 19, 2003). CDHS spoke with Dean Wolbach of the MCAQMD about the efficiency of this type of system, based on his 30+ years of experience. He informed CDHS that this type of system would not be efficient at removing hexavalent chromium from the tank vapors and he is not aware of any testing of such systems (D. Wolbach, MCAQMD, personal communications November 25, 2003). Thus from 1968 – 1975, emissions from the outdoor vertical tanks have been characterized as uncontrolled. MCAQMD staff concurs with this characterization (D. Wolbach, MCAQMD, personal communications November 25, 2003).

Latham and Watkins' consultant suggests the hardware on the vertical tanks would act as a partial lid, reducing the amount of "raw chromic acid" leaving the tank. However, no site-specific specifications relative to the hardware or technical resources/references were provided to support or quantify this assertion.

The employee testified the tanks were covered only when it rained, not during all plating activities as implied by the comment.

<u>1970-1973—Prior to Chrome Plating Shop Revamp and Installation of tank Nos. 4 and 5</u>

• Historical Remco business records indicate that the CDHS Draft Report's assumption that the tanks operated "without pollution control equipment until 1976" is erroneous. For instance, a January 20, 1971 letter from Remco to the RWQCB contains a discussion of various suppliers of waste water destruction units for, among other things, 4 to 15 gallons per minute of fume scrubber wastewater. *See* Tab 15.

17) <u>CDHS Response</u>: The January 20, 1971 correspondence (Tab 15) referred to by the comment states, "The waste water scrubber will be contingent on the type and size of the scrubber. This waste 4 to 15 gallon /minute will be handled by the above mentioned clarifice or destruction unit", which clearly indicates a scrubber had not yet been purchased. A detailed discussion regarding the pollution control equipment used at Remco is provided in CDHS response #2.

• Numerous Remco inventory and depreciation records show that emission control equipment existed in the early 1970s. For instance, a written asset depreciation record indicates that 2 Udylite Fan Fume Scrubbers were purchased in 1970 and depreciated beginning in 1971. *See* Tab 34 (at MCI 0171270); Tab 16.

• An Abex inventory of the "Plating Building 9," the 1966 building containing the horizontal tanks *(see* Tab 37 (at MCI 020 1582)), also shows that Remco had two "Udylite Fan Fume Scrubber[s]" in 1970—property control tags 1253-01. Tab 37 (at MCI 020 1645). These scrubbers would have been used in 1970 to control emissions on Tank No. 1 and the smaller Tank No. 2 that were installed after 1966 when the building identified as 1964 (Building No. 9) was constructed. This installation date is supported by a Remco Capital Asset schedule, which indicates that as of 1970, Remco had two Udylite Fan Fume Scrubbers. *See* Tab 38 (at MCI 020 1713).

• Another Remco employee stated that in the early to mid-1970s, Remco would place tablets with the trade name "Foam-Lok" into the plating tanks to eliminate the mist coming out of the tanks. *See* Tab 23 at 269:10-24. Foam-Lok is a proprietary foaming agent commonly used in conjunction with floating polypropylene spheres to trap mist produced by the chromium plating solution. *See* Tab 2 at 3-4 and Appendix B.

• Property, Plant & Equipment inventories from 1977 also show that Remco acquired a Chrome Shop Fume Separator in 1970 (Tab 39 (at MCI 017 1287)), a "Fume Scrubber" in 1971 (Tab 39 (at MCI 017 1292); Tab 17), and two Udylite Fan Fume Scrubbers in 1971 (Tab 39 (at MCI 017 1291); Tab 17). These handwritten inventories are corroborated by electronic inventory records reflecting the same acquisition dates. See Tab 39 (at MCI 017 1305) (Chrome Fume Shop Separator); Tab 39 (at MCI 017 1309) (Fume Scrubber); Tab 39 (at MCI 017 1313) (Udylite Fan

Fume Scrubbers); Tab 17. A June 1987 Machinery & Equipment Database also indicates that Remco acquired "Udylite Fan Fume Scrubber (2EA)" in 1971. Tab 40 (at MCI 020 1559); Tab 16. Remco Property Control Tags are even more specific — indicating that in 1972 Remco had a Udylite Master Fume Scrubber Model 30 and Udylite Master Fume Scrubber Model 60. *See* Tab 34 (at MCI 017 1184); Tab 18.

18) <u>CDHS Response</u>: CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco. This has resulted in better understanding of past operations at Remco, which has allowed the opportunity to provide an even more accurate depiction of past releases. This resulted in revisions to both the early and mid time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated to reflect revised MET data.

The modeling conducted for 1976–1990 time period utilized the assumption that emissions were controlled by 98%. This assumption was based on limited site-related information, communications with MCAQMD staff, and information provided in USEPA guidance (16). It now appears this was an overestimation of control, as the documentation in 1986, from the Abex Corporation, Environmental Control Manager Charles H. Borcherding indicates the equipment used (demisters) did not qualify as scrubbers and were not adequate at removing material (chromium) from the "vapor state" (demister exhaust) (17, 18). In other Abex Corporation documentation titled, **"Priority 1 Critical – An environmental problem that would be severe enough to cause a real embarrassment to the company – has the potential to endanger the environment or life",** ***Abex states, the "chrome vapor exhaust equipment is ineffective" (18). Other documentation (written and photo) show/discuss roof staining from deposition of chromic acid on the roof adjacent to the demister exhaust, along with documentation of chromium in run-off water, further indicate the demisters were not efficient (1, 148-150). As stated earlier, Latham and Watkins has not provided any technical information on the control efficiency for the demisters that were used at Remco, starting in the late 1970s. The historical record (and comments submitted by Latham and Watkins) suggests the demisters used at Remco in the late 1970s were consistent with the Chevron-blade mist eliminator. In the absence of site-specific technical information, CDHS reviewed documentation published by the USEPA and contacted experts in the field. The efficiency of Chevron-blade mist eliminator, as cited by the USEPA, ranges from 83-91%. Testimony given by MCAQMD staff, indicate an efficiency range between 40-80%; the higher level of efficiency (80%) would require adequate maintenance of the system {, September 2003 #190}. As discussed above, it does not appear the systems at Remco were effective at controlling emissions at these higher levels (80%).***

Previous comments submitted by Latham and Watkins (related to the comment above) suggest during the earliest time period (1964–1975) emission controls, consisting of Udylite model 30

and model 60 fan fume scrubbers, polyurethane (poly) balls and foam mist suppressants (Foam-Lok) were used, resulting in 72-98% control of emissions. The only supporting information for the use of poly balls was from testimony given by John Figg-Hoblyn, in which he states, "at one time we even had balls floating on the tank"; he does not specify a time period, frequency of use, or which tanks they were used on. In testimony given by Mr. Figg-Hoblyn, it is clear that he has trouble remembering the timing of events at Remco. For example, when asked in what decade (1960s or 1970s) the first outdoor plating tank went in, Mr. Figg-Hoblyn could not remember. Yet in other testimony he states that an outdoor tank existed in 1963. CDHS spoke with a former Remco employee who worked in the plating department from 1972 – 1991 (19 years) about the use of poly ball and Foam-Lok. We were informed that during his 19 years in the plating department, they never used poly balls; Foam-Lok was used very infrequently (about a dozen times) from 1972 – 1976, and only on the indoor horizontal tanks (R. Wake, Remco employee [1972 –1991], personal communication November 19, 2003). CDHS interviewed another former employee who worked in the plating department at Remco beginning in 1967 – 1995. This employee stated that there were three above ground plating tanks in 1967, two were rectangular (about 12 to 15 feet long by 7 to 8 feet wide) and the other was cylindrical in shape and stood about 12 feet high with an approximate diameter of 48 inches. He said the tanks were not attached to any type of emission control equipment until about 1968 maybe 1969, at which time a collection system was installed that pulled the fumes from the tanks and discharged them out the roof. Prior to the collection system the chromic acid vapors inside the building were controlled with a foam mist suppressant (Foam-Lok) and "styrofoam Ts". Once the collection system was installed, the practice of using styrofoam Ts and Foam-Lok ceased (F. Vincent, Remco employee (1967–1995), personal communication January 6, 2004). It appears that up until 1968, emissions from the plating activities were controlled to a certain degree and contained within the plating area. The only corporate documentation CDHS has reviewed regarding poly balls or any surface tension reducer was in the 1986 Charles Borcherding correspondence, in which he suggests that using poly balls may help reduce the "quantity of contaminants reaching the roof".

In the absence of site-specific technical information, Latham and Watkins relies on the comments submitted by their consultant Frank Altmayer, as a basis of information about control technologies, such as the Udylite fan fume scrubber, used at Remco. With regard to the Udylite fan fume scrubbers, Mr. Altmayer, who states in his comments that he is an expert in "chrome plating operations and technologies (equipment)" is apparently unfamiliar and looking for information about this type of equipment. CDHS found an inquiry from Mr. Altmayer on the Internet at www.finishing.com ("The home page of the finishing industry"), in which he states, "I am looking for anyone that has information on some plating equipment from the 1970s. Specifically, does anyone have information on a model 30 or model 60 Udylite scrubber?" Thus, the Latham and Watkins assertion that from 1964 – 1975, emissions were controlled by 72-98% is based solely on the use of poly balls and Foam-Lok. It appears that that for a portion of that time period 1963 – 1967, emissions were controlled at some level. For the remainder of the time period (1968 – 1976), CDHS' original assumption that emissions were uncontrolled is appropriate and supported by the historical record as well as other experts in the field. We have modified the air model and exposure assessment to reflect the 4 years (1963 – 1967) when the two indoor tanks had controls through the use of styrofoam and foam mist suppressant.

Since the release of the public comment draft of the PHA, CDHS learned that in 1972 the outdoor tanks had some type of exhaust collection system that pulled the vapors off the tanks and exhausted it up into the air at a height of about 10-12 feet. The system was reportedly attached to the outside of the building and consisted of a large fan with a pipe (about 3 feet in diameter by 10-12 feet tall) that contained a single spray bar (R. Wake, Remco employee (1971 – 1992), personal communication November 19, 2003). CDHS spoke with Dean Wolbach of the MCAQMD about the efficiency of this type of system, based on his 30+ years of experience. He informed CDHS that this type of system would not be efficient at removing hexavalent chromium from the tank vapors and he is not aware of any testing of such systems (D. Wolbach, MCAQMD, personal communications November 25, 2003). Thus from 1968 – 1975, emissions from the outdoor vertical tanks have been characterized as uncontrolled. MCAQMD staff concurs with this characterization (D. Wolbach, MCAQMD, personal communications November 25, 2003).

1973—Chrome Plating Shop Revamp and Installation of Tank Nos. 4 and 5

• Tank Nos. 4 and 5 were installed at some time in 1973. *See* discussion of Tank Nos. 4 and 5 installation below. A July 30, 1973 Remco map and an August 17, 1973 Remco Map identify a mist eliminator in place three years prior to the assumption made by the CDHS Draft Report and around the same time vertical Tank Nos. 4 and 5 were installed. *See* Tab 41; Tab 34; Tab 19.

19) CDHS Response*: *Information provided by Latham and Watkins (Tabs 49-51) and employee testimony indicate Tank No. 5 was installed in 1970, not 1973 as suggested by Latham and Watkins in this comment.

The building plans referred to in the comment are just that, "plans", a layout for the location of machinery/equipment once the building expansion had been completed (Tab 42).

An August 1973 plan titled, Duct Layout for the Mist Eliminator Chrome Building (Tab 41), shows a construction detail for the mist eliminator, which states, "2-inch flange to be drilled at time of installation" (187). This clearly shows the mist eliminator was not in place in August 1973, as asserted by the comment (187). A number of employees testify that the chrome shop expansion (enclosure of the vertical tanks) was not completed until ~1976 {, July 1996 #5; , March 1997 #6; , December 1996 #7}.

• Remco's utilization of a mist eliminator by 1973 is supported by Remco inventory and depreciation records. Remco estimated first year depreciation records for 1973 indicate that Remco purchased a $16,995.00 mist eliminator. *See* Tab 34 (at MCI 017 1223). A Stanray Corporation capital expenditures process report for 1973 also indicates that Remco had a $16,995.00 mist eliminator. See Tab 34 (at MCI 017 1227); Tab 20. Handwritten and electronic 1977 Remco equipment inventories indicate that Remco acquired a "Chrome Mist Eliminator" in 1974. *See* Tab 39 (at MCI 017 1296, 1310). Electronic Remco equipment inventories from 1987 state that the mist eliminator acquired in 1974 was purchased from Pneumafil Corporation. *See* Tab 40 (at MCI 020 1558). This mist eliminator utilization date is supported by a Remco Capital Asset schedule, which indicates that as of 1974, Remco had a mist eliminator manufactured by Pneumafil. *See* Tab 38 (at MCI 020 1713).

• These Remco records are corroborated by correspondence from regulatory agencies, which indicate that Remco utilized control equipment at least by 1974. A Chronology created by the RWQCB states: " 4/15/74—RWQCB (TBD) inspection. Fume scrubber constructed to clean fumes of all chromic acid vapors. Scrub solution filtered and resulting clean chromic acid returned to tanks for reuse. Cooling tower has been ordered. City will accept boiler blowdown in sewer system." Tab 43; Tab 21. A June 26, 1974 RWQCB "Executive Officers Summary Report" states: "Remco now has a fume scrubber and recycling method for 007, the chromic acid." Tab 44; Tab 21. An August 27, 1974 written notation to an August 6, 1974 letter from Thomas B. Dunbar, assistant water quality control engineer, to Norris W. dark of Stanray Corporation, indicates that "chromic acid that comes out of fume scrubber **is** filtered and recycled." Tab 45; Tab 21.

20) <u>CDHS Response</u>*: *CDHS discussed the existence of vapor collection equipment at Remco as early as the 1960s in the public comment draft PHA. However, Latham and Watkins has not provided any technical information regarding emission control equipment used at Remco. Purchase records for equipment do not provide any information as to the utilization (installation dates, technical specifications, tanks the equipment was used on, etc.) of that equipment. An August 1973 plan titled, Duct Layout for the Mist Eliminator Chrome Building (Tab 41), shows a construction detail for the mist eliminator which states, "2 inch flange to be drilled at time of installation" (154). This clearly shows the mist eliminator was not in place as of August 1973 (154). A number of employees testify that the chrome shop expansion (enclosure of the vertical tanks) was not completed until ~1976 {Wisdom, July 1996 #5; Almida, March 1997 #6; Wake, December 1996 #7}.

The "fume scrubber" mentioned in the RWQCB "Executive Officers Summary Report" does not provide any specific details about the equipment, the tanks it was attached to, or the efficiency. As stated earlier, no technical information has been provided on the efficiency of the equipment and it is not reasonable to assume that the water control engineer had technical expertise in the removal efficiency of air quality equipment. Vapor collection equipment was reportedly used on the vertical tanks, at least by 1972, which may have been what the water quality control engineer referring to (see CDHS response to comment #2). More importantly, Abex documentation and expert testimony show that emission control equipment used during the late 1970s through 1989 was not effective at removing hexavalent chromium from the exhaust stream {, C.H. Borcherding #169; , John Bassano, Jr. #170; , C.H. Borcherding #172; ,Borcherding 1986-1989} (D. Wolbach, MCAQMD, personal communications November 25, 2003).

• Internal correspondence by Remco parent companies also shows that Remco utilized emission control equipment in the early 1970s. An attachment to an August 31, 1988 Letter from D.L. Summers and D.L. Ziegler of PA Holdings Corp. to F.G. Tish and R.H. Fuller of Abex Corp. indicates that a new fume scrubber "will replace the current Chrome Department fume scrubber installed in 1972." Tab 46.

21) <u>CDHS Response</u>*: *There was no technical information provided regarding removal efficiency, description of the equipment, or the tank(s) it was used on. Although, there is documentation that the equipment used at the site was not efficient at controlling emissions (removal of hexavalent chromium prior to discharging to the air). Abex Corporation documentation in 1983 – 1989 indicate the emission control equipment used at the site was not

effective at removing chromium from the vapor state (17, 18, 149). According to documentation provided with these comments and former workers, the emission control equipment purchased in the 1970s was the same equipment in use in 1983 – 1989, referred to in the Abex documentation (discussed above). In the absence of site-specific data, CDSH utilized technical information compiled by the USEPA and information from expert testimony in estimating removal efficiency for this time period {, #179; , September 2003 #190}.

1977-1982—Installation of Tank Nos. 6 and 7

• As discussed in detail below, historical Remco business records and testimony from former Remco employees shows that Tank No. 6 was installed in 1977 and Tank No. 7 was installed in 1982. *See* discussion of Tank Nos. 6 and 7 installation below. The installation date for Tank No. 6 is consistent with Abex Corporation's Fixed Asset Schedule for 1983, which indicates that a Pneumafil mist eliminator was purchased in 1977 for $18,056. *See* Tab 47 (atMCI 017 0714).

22) CDHS Response**: **CDHS presented the same installation dates referred to in the comment for Tank No 6 and Tank No. 7, in both the draft and final PHA.

Purchase records do not provide technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased. There is documentation that the equipment used at the site was not efficient at controlling emissions (removal of hexavalent chromium prior to discharging to the air). Abex Corporation documentation in 1983 – 1989 indicate the emission control equipment used at the site was not effective at removing chromium from the vapor state (Borcherding). According to documentation provided with these comments and former workers, the emission control equipment purchased in the 1970s was the same equipment in use in 1983-1989, referred to in the Abex documentation (discussed above). In the absence of site-specific data, CDSH utilized technical information compiled by the USEPA and information from expert testimony in estimating removal efficiency for this time period {, #179; , September 2003 #190}.

• When Remco installed Tank No. 7 in 1982, it connected it to the mist eliminator purchased in 1977 for Tank No. 6. This is evidenced by a 1986 document, which indicates that one mist eliminator ("demister") is connected to Tank Nos. 1-5, while a second mist eliminator ("demister") is connected to Tank Nos. 6 and 7. *See* Tab 48. This document also corroborates the fact that Remco utilized not one, but two mist eliminators—one purchased in 1973-74 when Tank Nos. 4 and 5 came on-line, and another purchased in 1977 when Tank No. 6 came on-line.

23) CDHS Response**: **Information provided by Latham and Watkins (Tabs 49-51) and employee testimony indicate Tank No. 5 was installed in 1970, not 1973 as suggested by Latham and Watkins in this comment.

Purchase records do not provide technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased. There is documentation that the equipment used at the site (demisters) was not efficient at controlling emissions (removal of hexavalent chromium prior to discharging to the air). Abex Corporation documentation in 1986 indicate the emission control equipment ("two demisters") used at the site was not effective at removing chromium from the vapor state (17).

According to documentation provided with these comments and former workers, the emission control equipment purchased in the 1970s was the same equipment in use through the 1980s, and referred to in the Abex Corporation documentation (discussed above).

In the absence of site-specific technical information, CDSH utilized technical information compiled by the USEPA and information from expert testimony in estimating removal efficiency for this time period {, #179; , September 2003 #190}.

3. Page 8, paragraph 5, line 1 reads: *"Between 1964 and 1966, three vertical chrome tanks (Nos. 3-5) were installed outdoors at the north side of the facility and added to production (Appendix B, Figure 2). "*

• The assumption that vertical Tank Nos. 3 through 5 were installed by 1966 is not supported by historical records or former Remco employee testimony.

<u>Installation of Tank No. 3</u>

• Written Remco historical records each indicate that Tank No. 3 was installed in 1968. *See* Tab 35 ("Original installation 1968"); Tab 49 ("Installed new 1968"); Tab 50 ("Installed new 1968"); Tab 51 ("Original installation about 1968. Original tank was not encased. This tank was replaced and encased in later 1972 early 1973."). Notes on documentation concerning the revamp of the Remco chrome facility in approximately 1973 indicate that activity in December 1972 was taken to "Remove Tank # 3 Originally From 1968" Tab 52.

• Ronald Budish began supervising the chrome plating department in the "early seventies." Tab 53 at 14:1-7. He testified that when he began supervising the chrome plating department in the early 1970s, there were only two, possibly three chrome tanks in the department, only one of which was a thirty-two foot "deep tank that was put in, I believe, again, late sixties, early seventies." The other two tanks were approximately six by twelve by seven or eight feet deep and were enclosed in a pit. Tab 53 at 19:20-20:23.

24) <u>CDHS Response</u>: CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the public comment draft was issued, which has been incorporated. CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees, who combined, worked in Remco's plating department from 1967 – 1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon (Final RI)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity (ref. 9, 184, 185) - replaced in ~1968: 12 x 5.5x7, 3200 gallon (Tab 2 p. 15)

Tank 3: 1968: 3' diameter x 32' deep (Final RI, Tabs 35,49-51)

Tank 4: 1973: 4' diameter x 38' deep (Final RI, Tabs 35, 49-51)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, Tabs 49-51)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI, Tabs 35, 49-51)

Tank 7: 1982: 4' diameter x 60' deep (Final RI prior to 11/25/02 revision, Tabs 35, 49-51)

(Note: Tabs refer to documentation provided with Latham and Watkins comments.)

Installation of Tank Nos. 4 and 5

• As noted above, a January 20, 1971 letter from Remco to the RWQCB refers to only 3 chrome plating tanks. It states that the "plating tanks with exception of Tank No. 3 are recessed in a 5,204 gallon sump." This indicates that Tank No. 3 is the only vertical tank in existence at Remco in January 1971. Tab 15.

• Also as noted above, Ronald Budish, the supervisor of the chrome department in the early 1970s, testified that when he began supervising the chrome plating department, there were only two, possibly three chrome tanks in the department, only one of which was a thirty-two foot "deep tank that was put in, I believe, again, late sixties, early seventies." Tab 53 at 19:20-20:23. He also testified that four additional deep (vertical) tanks were installed when he was working at the Remco Facility. Tab 53 at 31:4-20.

The conclusion that vertical Tank Nos. 4 and 5 were installed in 1973 is further supported by contemporaneous communications with Mendocino County governmental agencies. An investigation report attached to a July 30, 1973 letter from the County of Mendocino Department of Public Health to John Hannon of RWQCB, contains various dated entries indicating that "Weeks Drilling had drilled 2 new chromic acid tanks on the property" (5-23-73 entry), and that "2 holes were dug April 18th" (5-24-73 entry). Tab 54; Tab 12. Further, a Chronology created by the RWQCB states: "5/24/73 — Mr. Miller spoke with Weeks Drilling and learned that two 40' holes had been drilled for the addition of two more chrome plating tanks." Tab 43; Tab 12.

***25) CDHS Response*: The 1970 installation of Tank No. 5 is supported by documentation provided by Latham and Watkins and depositions of former workers. Since Tank No. 5 was 20 feet deep, it is not likely (due to cost) that Remco would have drilled a 40-foot hole for installation of a 20-foot tank. It is more likely the two holes drilled in 1973 were for Tank No. 4 and an anode tank, which was ~35 feet deep (J. Goebel, NCRWQCB, personal communication January 21, 2004). Refer to CDHS response #1 for additional details on the tank installation timeline.**

While certain written tank histories indicate that Tank No. 5 was installed in 1970 *(see* Tabs 49, 50 and 51), other contemporaneous records indicate that this vertical tank did not exist in 1970. As noted above, one document from RWQCB files indicates that as of January 20, 1971 only one vertical tank existed—Tank No. 3 (see Tab 15)—and two contemporaneous third-party records indicate that in 1973, Remco was drilling pits for two other new tanks—Tank Nos. 4 and 5 *(see* Tab 54 and Tab 43). Moreover, the Remco employee in charge of the plating shop starting in the early 1970s testified that only one vertical tank existed at that time and that Remco installed four others. *See* Tab 53 at 19:20-20:23, 31:4-20. In any event, *there is no evidence whatsoever* to support the Interim RI assumption, adopted by the CDHS Draft Report, that Tank No. 5 was installed at any time between 1964 and 1966.

The conclusion that Tank Nos. 4 and 5 were installed in 1973 in connection with Remco's revamp of the chrome plating department in 1972-73 is further supported by Remco's purchase in 1972-73 of the rectifiers that support these tanks. Remco purchased a Clinton 16,000 amp. rectifier in 1973 for Tank No. 4 and an 8,000 amp Udylite Converter/Rectifier each for Tank Nos. 3 and 5 on December 6, 1972. *See* Tab 34 (at MCI 017 1211,1235); Tab 37 (at MCI 020 1644, 1648).

26) <u>CDHS Response</u>: The 1970 installation of Tank No. 5 is supported by documentation provided by Latham and Watkins and depositions of former workers. Since Tank No. 5 was 20 feet deep, it is not likely (due to cost) that Remco would have drilled a 40-foot hole for installation of a 20-foot tank. It is more likely the two holes drilled in 1973 were for Tank No. 4 and an anode tank (~35 feet deep). Refer to CDHS response #1 for additional details on the tank installation timeline.

CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees, who combined, worked in Remco's plating department from 1967–1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon (Final RI)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity (ref. 9, 184, 185) - replaced in ~1968: 12 x 5.5x7, 3200 gallon (Tab 2 p. 15)

Tank 3: 1968: 3' diameter x 32' deep (Final RI, Tabs 35,49-51)

Tank 4: 1973: 4' diameter x 38' deep (Final RI, Tabs 35, 49-51)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, Tabs 49-51)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI, Tabs 35, 49-51)

Tank 7: 1982: 4' diameter x 60' deep (Final RI prior to 11/25/02 revision, Tabs 35, 49-51)

(Note: Tabs refer to documentation provided with Latham and Watkins comments.)

Purchase records do not provide specific information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

4. Page 8, paragraph 6, line 1 reads: *"There is conflicting information as to the actual years Tank Nos. 3-5 were installed. Information presented in the ERM-West Inc. Monitoring Well Installation Report (written for Remco Hydraulics in 1991, and referenced in the Montgomery Watson Interim Remedial Investigation (RI) Report) suggests that these tanks •were installed between 1964 and 1966. In contrast, information presented in the Montgomery Watson Final Remedial Investigation Report suggests that the tanks were installed between 1968 and 1973. "*

• As noted above (and discussed further below), a reasonable review of the evidence indicates that Tank No. 3 was installed in 1968 and Tank Nos. 4 and 5 were installed in 1973 when Remco revamped its chrome plating department.

27) <u>CDHS Response</u>*: *Please refer to CDHS response #1, and #26 above.

• The CDHS Draft Report relies upon an interim report created by Montgomery Watson ("Interim R.I. Report") rather than the vastly more comprehensive final report for its conclusions regarding tank installation dates. An examination of the Interim R.I. Report indicates, however, that the only source it cited for concluding that vertical Tank Nos. 3-5 were constructed in 1964-66 appears to be the 1997 deposition of Jim Wisdom, who first worked at Remco in August 1973. *See* Interim R.I. Report at pp. 2-4.

28) <u>CDHS Response</u>*: *The comment is incorrect. The source cited in the Interim R.I. Report, the Draft R.I Report and the "vastly more comprehensive final report" (e.g., Final R.I. Report, Table 2-2) is the same source for the vertical tank construction dimensions and installation dates (viz. ERM-West Monitoring Well Installation Report, written for Remco in 1991). However, the installation dates in the Draft and Final R.I. were changed and do not reflect the dates presented in the ERM-West report. As stated in the PHA, CDHS contacted Montgomery Watson Harza (MWH) and the WERT about this discrepancy, and never received any clarification or rationale for the changes.

• The deposition of Jim Wisdom does not support the conclusions regarding tank installation dates reached by the Interim R.I. Report and adopted by the CDHS Draft Report. Wisdom testified that he started at the Remco Facility on August 6, 1973. *See* Tab 55 at 10:15-17. Wisdom testified only that when he started at Remco in 1973, three vertical tanks—Tank Nos. 3-5—were there. Tab 55 at 61:14-18. This testimony is consistent with evidence showing that Tank Nos. 3, 4 and 5 were installed in 1968, 1973 and 1973, respectively. Indeed, Wisdom never testified that these tanks were installed between 1964-66 (when he was not at Remco), let alone any precise date on which they were installed. Therefore, the Interim R.I. Report is not supported by the only source that it cites.

29) <u>CDHS Response</u>*: *CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the public comment draft was issued, which has been incorporated.

CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees who combined, worked in Remco's plating department from 1967 – 1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon (Final RI)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity (ref. 9, 184, 185) - replaced in ~1968: 12 x 5.5x7, 3200 gallon (Tab 2 p. 15)

Tank 3: 1968: 3' diameter x 32' deep (Final RI, Tabs 35,49-51)

Tank 4: 1973: 4' diameter x 38' deep (Final RI, Tabs 35, 49-51)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, Tabs 49-51)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI, Tabs 35, 49-51)

Tank 7: 1982: 4' diameter x 60' deep (Final RI prior to 11/25/02 revision, Tabs 35, 49-51)

(Note: Tabs refer to documentation provided with Latham and Watkins comments.)

The WERT and Latham and Watkins (Whitman/Pepsi America's lawyers) have commented on CDHS' use of using data presented in earlier reports and employee testimony rather than using information presented in the Final Remedial Investigation Report (RI), which according to Latham and Watkins contains the most comprehensive information available. However, it appears the actual installation dates for the vertical underground plating tanks is still a source of deliberation, as information presented in the Final RI report has changed once again. The most recent change was a revision to the April 2002 RI report, written by Montgomery Watson Harza, Inc. (MWH). On November 25, 2002, MWH sent a revised table titled, "Table 2-2 Chrome Plating Tank Construction Specifications" in which the construction date for Tank No. 7 was changed from 1981 to 1986. CDHS staff has a copy of a 1983 inspection report from the Mendocino County Air Quality Management District (MCQAMD) that indicates there were seven plating tanks were in operation (147). This information clearly contradicts the most recent change to the tank construction timeline as asserted by the responsible party's consultant.

CDHS identified other inconsistencies with the construction dates of the first three vertical tanks, based on former employee testimony. For example, a former employee who began working at Remco in 1969, testified that there were three outdoor vertical tanks operating when he first began working at Remco, not one, which would have been the case using the later timeline proposed by the RP's consultants and lawyers (Straight 1997). Testimony given by another employee, who began working at Remco in 1972, stated that there were 3 outdoor tanks (Tanks 3-5) operating during the onset of his employ (Wake 1996), which would not have been the case with the later timeline, that suggests there were two outdoor tanks in 1972 (Tank 3 and Tank 5); and the most recent timeline proposed by the RP's lawyers suggesting Tanks 4 and 5 were installed in 1973. Testimony given by another employee suggests that a deep tank (15-20 feet) was in operation in 1963 {, April 1997 #191}. Thus, it is clear there are inconsistencies between former workers regarding the installation dates of the plating tanks. CDHS evaluated all the available information in developing the timeline used in the PHA.

5. Page 9, paragraph 1, line 1 reads; *"CDHS investigated the timing of the installation of the vertical tanks because this information is an important factor in characterizing exposures to the community.. . . CDHS conducted a limited review of employee depositions, and found information that supports the ERM-West construction timeline (3, 6). Therefore, CDHS is assuming that tanks Nos. 3-5 were installed between 1964 and 1966. "*

The CDHS Draft Report's conclusion that Tank Nos. 3-5 were installed between 1964 and 1966 is not supported by the materials that it cites. First, The ERM-West Inc. Monitoring Well Installation Report ("ERM-West Report") includes the following table:

TABLE 1-1	**Tank**	**Construction Information**
Tank Number	**Depth**	**Year Constructed**
3	32’	1965
4	38’	1966
5	21’	1964
6	49’	1975
7	60’	1986

However, the ERM-West Report does not cite any authority for the construction dates set forth on Table 1-1. Moreover, while the CDHS Draft Report states that it "found information that supports the ERM-West construction timeline" and adopts the ERM-West Report's timeline for Tank Nos. 3-6, it does not do so for Tank No. 7 (using a seven tank model from 1976 to 1995). *See* discussion of Tank No. 7 installation date below. There is no support for the installation dates on the ERM-West Report tank construction timeline.

30) <u>CDHS Response</u>*: *The ERM-West report is a credible source and was cited by CDHS in the PHA; this same source is also cited in numerous documents written by the WERT’s consultants. In 1991, ERM-West was hired by Remco to conduct environmental work at the site. It is not an unreasonable assumption that Remco provided ERM-West with site-specific information and would have reviewed the report produced by ERM-West for accuracy. It appears this assumption was also made by the WERT’s consultants as the ERM-West report has been referenced in Preliminary Endangerment Assessment, the Interim R.I, Draft R.I. and the Final R.I.

In response to a September 2, 2003 Public Records Act Request seeking "[a]ny and all records relating to, referencing or reflecting the 'limited review of employee depositions' conducted by the CDHS, as referenced on page 9 of the Public Comment Draft CDHS Report," CDHS made available for copying the May 1, 1997 deposition of Richard G. Strait and the December 20, 1996 deposition of Ronnie Wake in the *Jensen Kelly Corp. v. Allianz Ins. Co.* action. These depositions, cited in support of the Report's statement that it "conducted a limited review of employee depositions, and found information that supports the ERM-West construction timeline," also do not support the conclusion that "tanks Nos. 3-5 were installed between 1964 and 1966."

Richard Strait testified that he started at Remco in 1969, and that he was a machinist in the gun shop, until much later, when he became involved in sales and then was plant manager for two years. He never worked in the chrome plating department. Tab 56 at 15:19 - 16:16; 17:18 - 18:9.

Strait testified that he did not know if there was an inside plating shop at that time he started in 1969. When asked to describe the chrome plating shop in 1969 when he started, he admitted: "I honestly don't know, because I was not involved in that at all." Tab 56 at 18:12 - 20:5.

Ronnie Wake stated that when he started in "clean-up" at the Remco Facility in 1972, there were three vertical tanks. Tab 23 at 29:12-18; 305:15 - 306:9. He at no time stated that Tank Nos. 3-5 were installed in 1964-1966. Indeed, Wake admitted that he does not know when Tanks 3-5 were installed. Tab 23 at 229:23-25.

31) CDHS Response*: CDHS reviewed depositions of former workers in an effort to identify consistency/inconsistency relating to the construction dates of the chrome tanks, as these dates had changed, without clarification, in a number of the remedial documents for the site. CDHS identified inconsistencies with the construction dates of the first three vertical tanks, based on testimony given by former workers. For example, a former worker who began working at Remco in 1969, testified that there were three outdoor vertical tanks operating when he first began working at Remco, not one, which would have been the case using the later timeline proposed by the RP's consultants and lawyers {, May 1997 #18}. Testimony given by another employee, who began working at Remco in 1972, stated that there were 3 outdoor tanks (Tanks 3-5) operating during the onset of his employment {, December 1996 #7}. This further contradicts the later timeline, which suggests there were two outdoor tanks in 1972 (Tank 3 and Tank 5); and the most recent timeline proposed by the RP's lawyers suggesting Tanks 4 and 5 were installed in 1973. Testimony given by another employee suggests that a deep tank (15 feet) was in operation in 1963 {, April 1997 #191}. As stated in the PHA, on a number of occasions CDHS attempted to obtain additional clarification from MWH and the WERT regarding inconsistencies between the tank installation timelines, and received none. It is for these reasons CDHS appropriately chose to use a more conservative timeline (published in Remco reports) in evaluating potential exposures.

6. Page 9, paragraph 2, line 1 reads: *"By 1976, vertical tank Nos. 6-was installed and the outdoor plating area \vas enclosed as part of a building expansion. "*

• The assumption that Tank No. 6 was installed by 1976 (which, according to the modeling scenarios, means that it is assumed by the CDHS to have been installed and operating on January 1, 1976) is contradicted by historical Remco business records and testimony from former Remco employees.

• An internal Remco memorandum written in 1985 by Ron Budish regarding the failure of the liner of Tank No. 6 indicates that Tank No. 6 "was installed new in 1977." Tab 57; Tab 13. Budish's memo is supported by three written analyses of the installation of the chrome tanks, which also indicate that Tank No. 6 was installed in 1977. *See* Tab 35 ("Original installation 1977"); Tab 50 ("Installed new 1977"); Tab 51 ("Installed new in 1977 and replaced in 1985").

• The conclusion that Tank No. 6 was installed in 1977 is further corroborated by written and electronic Remco inventory records, which indicate that Remco purchased a $116,342 vertical chrome tank in 1977. *See* Tab 39 (at MCI 017 1294, 1309); Tab 13. A Remco Capital Asset schedule indicates that this tank was purchased in 1977 for $120,509. Tab 38 (at MCI 020 1713).

This document indicates that this tank was scrapped by 1987, which is consistent with Ron Budish's memorandum indicating that, in late 1985, Tank No. 6 failed and required replacement. Tab 57; Tab 13.

The rectifier history for Tank No. 6 also supports the conclusion that Tank No. 6 was only in use after January 1, 1977. A 1986 submission to the MCAQMD from Remco indicates that Tank No. 6 utilized a total amperage of 24,000. *See* Tab 48. This amperage was supplied to Tank No. 6 after its installation in 1977 by two 12,000 amp Clinton Power Rectifiers purchased by Remco in 1976. *See* Tab 37 (at MCI 020 1639, 1641). This rectifier history is supported by the August 19, 1981 map drawn by Richard Chiantelli (former Remco employee), showing two rectifiers in the immediate vicinity of Tank No. 6. *See* Tab 58.

32) <u>CDHS Response</u>*: *CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the public comment draft was issued, which has been incorporated. As expected the changes to model altered the output somewhat, but did not substantially change the overall exposure picture for Willits residents. Further, ATSDR determined that releases of hexavalent chromium were likely orders of magnitude higher than those estimated by the model, due to operational issues identified at the site (Appendix D).

CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees who combined, worked in Remco's plating department from 1967 – 1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon (Final RI)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity (ref. 9, 184, 185) - replaced in ~1968: 12 x 5.5x7, 3200 gallon (Tab 2 p. 15)

Tank 3: 1968: 3' diameter x 32' deep (Final RI, Tabs 35,49-51)

Tank 4: 1973: 4' diameter x 38' deep (Final RI, Tabs 35, 49-51)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, Tabs 49-51)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI, Tabs 35, 49-51)

Tank 7: 1982: 4' diameter x 60' deep (Final RI prior to 11/25/02 revision, Tabs 35, 49-51)

(Note: Tabs refer to documentation provided with Latham and Watkins comments.)

7. Page 9, paragraph 2, line 2 reads: *"Tank Nos. 7 was reportedly installed by 1982" while* paragraph 4, line 4 reads**:** *"Between 1976 and 1990, seven indoor tanks were used."*

• The statement on page 9, paragraph 2 of the CDHS Draft Report suggesting that Tank No. 7 was installed in 1982 does not comport with the modeling scenario, which assumes that Tank No. 7 was installed by 1976. Historical records and testimony from former Remco employees indicates that Tank No. 7 was installed in 1982, and was rarely, if ever, used for chrome plating. A November 1981 memorandum from C.H. Borcherding indicates that, at that time, Remco utilized only "four well-type chrome tanks" and that Tank No. 7 "is not yet in service." Tab 59; Tab 14. This observation that Tank No. 7 was not in use yet in 1981 is supported by an April 3, 1981 invoice and contract between Weeks Drilling Co. and Remco, which states that Weeks was hired to drill and ream a 70-foot deep hole at the Remco Facility. *See* Tab 60.

• Written Remco memoranda regarding installation dates of the chrome plating tanks serve as further evidence that Tank No. 7 was installed in 1982. *See Tab 35* ("Original installation 1982"); Tab 49 ("Installed new 1982"); Tab 50 ("Installed new 1982"); Tab 51 ("Installed new in 1982"). This date is corroborated by a written map and inventory, as well as electronic backup, which show that Tank No. 7 was purchased in 1982 and refurbished in 1987. *See* Tab 37 (at MCI 020 1638, 1639, 1641). Other Remco Machinery & Equipment records from June 1987 also indicate that Remco acquired "Chrome Tank #7" in 1982 for $88,690. Tab 40 (at MCI 020 1561); Tab 14.

• Rectifier history for Tank No. 7 also supports an installation date of 1982. A 1986 submission to the MCAQMD from Remco indicates that Tank No. 7 utilized a total amperage of 16,000. *See* Tab 48. This amperage was supplied to Tank No. 7 after its purchase and installation in 1982 by a 16,000 amp Clinton Power Rectifier. *See* Tab 37 (at MCI 020 1639, 1641). The written map corresponding with this inventory indicates that this 16,000 rectifier sat directly to the northwest of Tank No. 7. *See* Tab 37 (at MCI 020 1638). This rectifier history is supported by the August 19,1981 map drawn by Richard Chiantelli (former Remco employee), showing no rectifier for Tank No. 7 and indicating that Tank No. 7 was, as of that date, "not in use." *See* Tab 58.

• A former Remco chrome plating department employee, John Almida, testified that Tank No. 7 (the largest of all of the vertical tanks at approximately 70 feet deep) was installed in approximately 1981 or 1982 to do an electroless nickel plating job for Martin Marietta (for which he was responsible for driving the parts back from Houston, Texas). *See* Tab 61 at 63:1-22.

• The assumption in the modeling for the CDHS Draft Report that Tank No. 7 was used for chrome plating continuously from 1976 to 1995 is further drawn into question by records and testimony indicating that Tank No. 7 was generally used for testing cylinders—not chrome plating—and that it was only used sporadically for chrome plating in 1990 and 1991. A former Remco employee. Guy Madden, testified that Tank No. 7 was not used for chrome plating from 1991 to 1996:

Tank number seven was used as a test tank at 1991, and was drained. And we left it down because we didn't need it anymore. And we left it out of service for that period of time. [^] Traditionally, it was not being used. It wasn't abandoned. It wasn't anything other than it a, was temporarily out of service. And remained out of service from 1991 until 1996.

Tab 62 at 424:18-425:15.

John Figg-Hoblyn, another former Remco employee, confirmed that Tank No. 7 was installed only to test the part for the Martin Marietta job, stating: That - well, the one that we've always talked about was the Martin Marietta job .... And this one rod that we did build, it was built in sections. And I think when it was finished, it was like 70 foot long. . . . And Tank 7 was put in the ground, just to test-just to test that, that cylinder. And they assembled that cylinder and put it all together, this full acme threaded sections.

Tab 22 at 303:2-22.

• The fact that Tank No. 7 was not used after 1991 is corroborated by several documents as well as testimony from former Remco employees. The USEPA "June 1991 Chromium Electoplaters Emission Test Report, Remco Hydraulics, Inc., Willits, California" (produced by Lockheed Martin/REAC pursuant to a Latham & Watkins subpoena), which states: "During this source test, six of the seven plating tanks were in operation." Table 2-1 of the USEPA Test Report indicates that Tank No. 7 was not in service. *See* Tab 63 (at LM 01 0463-4). A written record of Remco chrome tanks on September 28, 1994 indicates that as of 1991, Tank No. 7 was down: "Tank # 7 1991 Tank down needs liner Est. cost $7,000.00." Tab 35. A written record of electrical use by each tank in 1992 indicates: "tank 7 out of service" (Tab 64 (at MCI 021 1213)), while another written record of chromic acid added to tanks during 1991 states that Tank No. 7 was "down after 10/18/91" (Tab 65).

• A written diagram of a chrome plating tank with a note that it is the "Current Configuration 3/29/91" indicates: "TANK # 7 - 48" DIA x. 50 FT. DEEP (NOT IN SERVICE)." Tab 66. In his deposition, Richard Strait testified, with regard to this document, that Tank No. 7 was rarely used:

Q. Down on the bottom it says tank 7 not in service. You have any understanding about why that was the case?

A. Tank seven was normally used for ID, plating of internal diameters, inside diameters. It was quite often not used other than long parts that required inside— plating of the inside diameter. If that's what this implies to, that may be the case.

Tab 56 at 134:23-135:4.

• Further testimony of a former Remco employee indicates that Tank No. 7 was not used for chrome plating as of 1987 or 1988. Ronnie Wake testified, when referred to a picture of the chrome plating shop, that the deep plating area at Remco appeared as shown in the picture in 1987 or 1988 because Tank No. 7 was "not a chrome plating tank yet." Wake testified that as of that time, Remco "evidently used .. . tank 7, to preload the anode for plating the I.D. of this tank" and not chrome plating. He stated: "And the reason I know this is because the power rectifier that was feeding it, all the electrical current, the plumbing for the chromic acid, is not hooked to the tank yet." Tab 23 at 111:2 - 112:7. These statements are corroborated by a written memo by Ron Budish, which indicates that, as of May 5, 1986, Tank No. 7 did not have the anodes that are required for chrome plating. *See* Tab 49 (at MCI 035 2139).

• Finally, two former Remco employees testified that Tank No. 7 was never used for chrome plating. Frederick Vincent testified that Remco never put chromium solution in Tank No. 7 and it was never used for chrome plating, stating that, for Tank No. 7 "it was just too expensive to put anodes and to fill it up. They never did fill it up." He stated: "Seven is a testing - where they - once they assembled big cylinders, they'd come down, and they'd cycle them. They'd lower them inside there, and then they'd have to cycle it through there to make sure the packing and stuff didn't leak. They used it for testing." Tab 24 at 106:19 - 107:17. Jim Wisdom testified: "I don't ever remember tank 7 ever being up and running" and when asked whether Tank No. 7 was ever "used for chrome plating, he stated, "Not that I remember." Tab 55 at 572:16-573:10.

33) <u>CDHS Response</u>*: *Conflicting information regarding the early time periods of Remco operations posed a challenge in establishing modeling assumptions. While we make every effort to be as accurate as possible, given the choice of potential exposure scenarios (tank installation timeline) we chose to use a scenario (published in Remco reports) that would not underestimate exposures and potential adverse health effects. ATSDR determined that releases of hexavalent chromium were likely orders of magnitude higher during the later two time periods (1975 – 1989, 1990 – 1995), than those estimated by the model, due to operational issues identified at the site (Appendix D).

Latham and Watkins provide conflicting information on the usage of Tank No. 7; in one case suggesting that this tank was never used for chrome plating. It is clear this tank was used for chrome plating, though the frequency is unclear. The overall increased cancer risk from chrome plating operations at Remco is not changed by inclusion or exclusion of Tank No. 7.

<u>Overview of Computer Air Modeling</u>

(CDHS Draft Report pages 11-13)

8. Page 12, paragraph 4, line 7 reads: *"Area sources (like a camp fire) generally occur at ground level. Contaminants released from area sources tend to have higher concentrations in the near field (the area closest to the source or tank) and do not disperse as far into the air. Point source releases occur above ground level. Contaminants released from point sources tend to disperse farther in the air than those released from area sources and concentrations tend to be lower in the near field (close to the stack). In both cases (areas and point sources), concentrations decrease with distance from the source. "*

• By mistakenly classifying the emissions from Tank Nos. 3-7 as area sources, rather than point sources from the scrubber stack as they were operated, the model decreases the dispersion of these emissions. Tab 3 at 8-11.

• The CDHS Draft Report recognizes that concentrations decrease with distance from the source. However, because of a mapping or coordinate error, the contours in the report depict the highest concentrations approximately 250 meters south of the former Remco Facility, in direct contradiction of this principle of dispersion. Tab 3 at 4-7 and Fig. 2-1.

34) <u>ATSDR/CDHS Response</u>*: *The air model has been revised to reflect revisions to the MET data and the mapping coordinates have been adjusted and the contours re-plotted.

9. Page 12, paragraph 5, line 1 reads: *"The way in which contaminants disperse in the air is known as aerial dispersion. Aerial dispersion is a complex process governed by many factors such as wind direction, wind speed, turbulence, mixing height, diffusion, terrain, biota presence, particle size and chemistry. Generally, the transport of air pollutants are more dependent on wind direction than any other factor (16). "*

• The meteorological data used to model dispersion, including the wind speed and wind direction data, are not reliable. The meteorological station is not subject to independent audits or proper calibration procedures. It has not been sited, operated nor maintained in compliance with EPA Guidance for meteorological monitoring in regulatory modeling applications or other similar documents. Tab 3 at 13-26.

• The data set produced from the meteorological monitoring station raises issues about the quality of the station. Months of data from 1996 were deleted from the period of record because an audit of the co-located pollutant monitoring system found that it was not operated to meet applicable specifications. Tab 25 at 47:23 - 48:17; 50:24 -50:7. Wind speed data is adjusted downward by approximately two miles per hour beginning in July 1999, but not for prior years. Wind speed data, identified as miles per hour in the electronic files, is reported as miles per hour until July 1998, but appears to be reported in meters per second thereafter. Tab 3 at 29-31 and Fig. 3-5; Tab 25 at 54:1 - 55:7. Wind direction data shifts by approximately thirty degrees beginning in June 2001, which raises the question of whether the data before or after the shift are correct. Tab 3 at 27-29 and Fig. 3-4; Tab 25 at 52:24 - 53:13.

• Most importantly, a mapping coordinate error caused the dispersion contours to be mistakenly centered approximately 250 meters south of the former Remco Facility, rather than on the former Remco property, as they should be shown. Tab 3 at 4-7 and Fig. 2-1. This error substantially overstates the highest off-site concentrations of modeled airborne chromium.

• The result of these errors is a series of emission contours that are incorrectly shaped, and located in a manner that is completely inexplicable.

35) <u>ATSDR/CDHS Response</u>*: *CDHS and ATSDR received correspondence from the MCAQMD regarding an audit conducted on the MET (meteorological) station on the roof of the Safeway, near the Remco site (155). We were informed that MCAQMD staff and David Sutter of Precise Environmental Consultants (Latham and Watkins consultant) evaluated the air districts MET station and discovered that there were notable inconsistencies with the data after 2002. The data used for modeling predated these inconsistencies, but ATSDR found some less significant artifacts. One artifact is the steady decline in the wind speed measurements after May of 1998, which may be the result of slow wearing. The MCAQMD estimates that the wind speed measurements are 30-40% lower. The specific impact will be addressed in the uncertainty section. However, mathematically a 40% decrease in wind speed will create a 40% increase in the predicted maximum concentrations, but will also prevent the plume from spreading downwind, thus decreasing the concentrations at other locations. From a Public health perspective, long-term average cancer risk is not changed when the maximum levels are increased and the minimum levels are decreased by the same amount or vice versa.

ATSDR also discovered that the wind directions reported during 1997 contained two continuous unusual events (out of 8,760 hours). The events, which may be recalibration events, would not inhibit the ability to predict long-term average exposures. However, our scientists chose to leave this data out because of the existence of those events. Therefore, the revised modeling used only the best available data.

The models were re-run by ATSDR with "cross hairs" placed at the center of all the sources (for reference).

10. Page 13, paragraph 4, line 1 reads: *"There are a number of factors that add uncertainty to the model. Therefore, the estimated concentrations should be viewed as the best central estimate with error bounds on either side (14). "*

• A detailed review of the available data concerning the Remco Facility's tank history, rectifier history and emission control techniques, demonstrates that the model is not, in fact, a central estimate. The ISCST modeling and exposure estimates are only as accurate as the assumed data input into the model. Given the series of mistaken operating assumptions discussed above that cause this modeling and risk assessment to estimate emissions from approximately 40 years of plating tank operations that never took place, the incorrect assumption that no emission controls were used at the Remco Facility until 1976, the inflated electrical usage assumptions, the errors in the meteorological data, and the mistaken location of the Remco Facility, this modeling cannot be considered a central estimate of the historical airborne concentrations resulting from emissions from the Remco Facility operations. Tab 2 at 1-13; Tab 3 at 1-39.

36) <u>CDHS Response</u>*: *As a result of recently obtained information regarding the tank installation history, and most importantly, better information about the air pollution equipment used at the site, the air model has been revised to reflect these changes and a discussion of uncertainty with the MET data added. CDHS has incorporated the revised tank installation history and exposure evaluation into the final PHA.

<u>Air Modeling of Hexavalent Chromium Concentrations, 1964-1995</u>

(CDHS Draft Report pages 13-14)

11. Page 14, paragraph 2, line 1 reads: *"In addition to the 1966-1975 time period, REAC modeled the estimated concentrations of hexavalent chromium from 1964-1966, when only two horizontal plating tanks were in operation (17). "*

• As noted above, the assumption that Tank Nos. 1 and 2 were installed prior to 1964 is incorrect. The purported "1964" building was not constructed until 1966, so any earlier chrome plating would not have the characteristics of Tank No. 1 and Tank No. 2 as later constructed. *See* Tab 8.

37) <u>CDHS Response</u>*: *Latham and Watkins seems to be asserting that there were no horizontal tanks thus no chrome plating in existence in 1964, which is clearly not supported by historical records (some of which were provided with Latham and Watkins comments). As Latham and Watkins is aware, the building designations (i.e., 1964) are representative of the year that the facility expanded. The original plating department was reportedly located in building 1945, immediately east of building 1964. Former workers refer to the initial construction of building 1964 as a "lean-to", which consisted merely of posts, a tin roof and tarps for walls {, April 1997 #191; , May 1997 #16}. The actual year the tanks were moved from building 1945 to building 1964 may be unclear, however the historical record shows that chrome plating was occurring in 1964, in the general area of building 1964/1945. The air model has been revised to reflect the time period (1963 – 1967) when the two horizontal tanks were located in the "lean-to" structure and emissions were controlled using surface tension reducers.

12. Page 14, paragraph 3, line 1 reads: *"In 1976, the plating tanks were enclosed in a building and emissions/fumes from the plating tanks were captured, pulled through a scrubber system, and vented through the roof."*

• As noted above, the assumption that Remco did not utilize emission control equipment until 1976 is incorrect. The company records and testimony indicate that Remco used various emission control techniques, including "chevron" mist eliminators, fume scrubbers, polyurethane balls, foam emission suppressants and tarps to control emissions. *See* Tab 7.

38) <u>CDHS Response</u>*: *CDHS has reviewed the vast amount of information provided with the comments that, for the most part, shows the purchase of certain types of emission control equipment, but provides no technical information related to the removal efficiency of the equipment, installation dates of the equipment, or the tanks for which the equipment was purchased.

Since the release of the public comment draft, CDHS conducted additional inquiry regarding the historical use and efficiency of emission control technologies used at Remco. This has resulted in better understanding of past operations at Remco, which has allowed the opportunity to provide a more accurate depiction of past releases. This resulted in revisions to both the early and mid time periods. The scenario for the early time period has been updated to reflect limited emission controls on some of the tanks, and the middle time period updated to reflect a lower level of control than had been previously assumed. All three time periods have been updated to reflect revised MET data.

The modeling conducted for 1976 – 1990 time period utilized the assumption that emissions were controlled by 98%. This assumption was based on limited site-related information, communications with MCAQMD staff, and information provided in USEPA guidance (16). It now appears this was an overestimation of control, as the documentation in 1986, from the Abex Corporation, Environmental Control Manager Charles H. Borcherding indicates the equipment used (demisters) did not qualify as scrubbers and were not adequate at removing material (chromium) from the "vapor state" (demister exhaust) (17, 18). In other Abex Corporation documentation titled, **"Priority 1 Critical – An environmental problem that would be severe enough to cause a real embarrassment to the company – has the potential to endanger the environment or life"**, ***Abex states, the "chrome vapor exhaust equipment is ineffective" (18). Other documentation (written and photo) show/discuss roof staining from deposition of chromic acid on the roof adjacent to the demister exhaust, along with documentation of chromium in run-off water, further indicate the demisters were not efficient (1, 148-150). As stated earlier, Latham and Watkins has not provided any technical information on the control efficiency for the demisters that were used at Remco, starting in the late 1970s. The historical record (and comments submitted by Latham and Watkins) suggests the demisters used at Remco in the late 1970s were consistent with the Chevron-blade mist eliminator. In the absence of site-specific technical information, CDHS reviewed documentation published by the USEPA and contacted experts in the field. The efficiency of Chevron-blade mist eliminator, as cited by the USEPA, ranges from 83-91%. Testimony given by MCAQMD staff, indicate an efficiency range between 40-80%; the higher level of efficiency (80%) would require adequate maintenance of the system {, September 2003 #190}. As discussed above, it does not appear the systems at Remco were effective at controlling emissions at these higher levels (80%).***

The comments suggest during the earliest time period (1964 – 1975) emission controls, consisting of Udylite model 30 and model 60 fan fume scrubbers, polyurethane (poly) balls and foam mist suppressants (Foam-Lok) were used, resulting in 72-98% control of emissions.

The only supporting information provided with the comments for the use of poly balls was from testimony given by John Figg-Hoblyn, in which he states, "at one time we even had balls floating on the tank"; he does not specify a time period, frequency of use, or which tanks they were used on. In testimony given by Mr. Figg-Hoblyn, it is clear that he has trouble remembering the timing of events at Remco. For example, when asked in what decade (1960s or 1970s) the first outdoor plating tank went in, Mr. Figg-Hoblyn could not remember. Yet in other testimony he states that an outdoor tank existed in 1963. CDHS spoke with a former Remco employee who worked in the plating department from 1972 – 1991 (19 years) about the use of poly ball and Foam-Lok. We were informed that during his 19 years in the plating department, they never used poly balls; Foam-Lok was used very infrequently (about a dozen times) from 1972 – 1976, and only on the indoor horizontal tanks (R. Wake, Remco employee (1972 – 1991), personal communication November 19, 2003). CDHS interviewed another former employee who worked in the plating department at Remco beginning in 1967 – 1995. This employee stated that there were three above ground plating tanks in 1967, two were rectangular (about 12 to 15 feet long by 7 to 8 feet wide) and the other was cylindrical in shape and stood about 12 feet high with an approximate diameter of 48 inches. He said the tanks were not attached to any type of emission control equipment until about 1968, at which time a collection system was installed that pulled the fumes from the tanks and discharged them out the roof. Prior to the collection system the chromic acid vapors inside the building were controlled with a foam mist suppressant (Foam-Lok) and "styrofoam Ts". Once the collection system was installed, the practice of using styrofoam Ts and Foam-Lok ceased (F. Vincent, Remco employee (1967 – 1995), personal communication January 6, 2004). It appears that up until 1968, emissions from the plating activities were controlled to a certain degree and contained within the plating area. The only corporate documentation CDHS has reviewed regarding poly balls or any surface tension reducer was in the 1986 Charles Borcherding correspondence, in which he suggests that using poly balls may help reduce the "quantity of contaminants reaching the roof" (17).

Latham and Watkins consultant Frank Altmayer asserts a scrubber "with serpentine baffles", commonly known as a chevron blade mist eliminator was in place in 1963, based on Mr. Figg-Hoblyn's testimony. Again, there was no time period specified in Mr. Figg-Hoblyn's testimony. Corporate records indicate this type of control equipment (mist eliminator) was purchased in the mid-1970s and according to former workers installed in the late 1970s (R. Wake, Remco employee (1971 – 1992), personal communication November 19, 2003). With regard to the Udylite fan fume scrubbers, Mr. Altmayer, who states in his comments that he is an expert in "chrome plating operations and technologies (equipment)" is apparently unfamiliar and looking for information about this type of equipment. CDHS found an inquiry from Mr. Altmayer on the internet at www.finishing.com ("The home page of the finishing industry"), in which he states, "I am looking for anyone that has information on some plating equipment from the 1970s. Specifically, does anyone have information on a model 30 or model 60 Udylite scrubber?" Thus, the Latham and Watkins assertion that from 1964 – 1975, emissions were controlled by 72-98% is based solely on the use of poly balls and Foam-Lok. It appears that that for a portion of that time period 1963 – 1967, emissions were controlled at some level. For the remainder of the time period (1968 – 1975), CDHS' original assumption that emissions were uncontrolled is appropriate and supported by the historical record as well

as other experts in the field. We have modified the air model and exposure assessment to reflect the 4 years (1963 – 1967) when the two indoor tanks had controls through the use of styrofoam Ts and foam mist suppressant.

Since the release of the public comment draft of the PHA, CDHS learned that in 1972 the outdoor tanks had some type of exhaust collection system that pulled the vapors off the tanks and exhausted it up into the air at a height of about 10-12 feet. The system was reportedly attached to the outside of the building and consisted of a large fan with a pipe (about 3 feet in diameter by 10-12 feet tall) that contained a single spray bar (R. Wake, Remco employee (1971 – 1992), personal communication November 19, 2003). CDHS spoke with Dean Wolbach of the MCAQMD about the efficiency of this type of system, based on his 30+ years of experience. He informed CDHS that this type of system would not be efficient at removing hexavalent chromium from the tank vapors and he is not aware of any testing of such systems (D. Wolbach, MCAQMD, personal communications November 25, 2003). Thus from 1968 – 1975, emissions from the outdoor vertical tanks have been characterized as uncontrolled. MCAQMD staff concurs with this characterization (D. Wolbach, MCAQMD, personal communications November 25, 2003).

<u>Estimation of the Size of the Population within Different Exposure Contours</u>

(CDHS Draft Report pages 14-15)

13. Page 14, paragraph 6, line 1 reads: *"For example, within the dark blue contour line, we estimated about 3,500 residents would have been present during the 1964-1975 time period. This means that approximately this many persons may have had inhalation exposure to estimated annual levels of airborne hexavalent chromium of 0.1 ug/m^3 during those years (Appendix B, Figure 3). A smaller number of persons (378) are estimated to have had exposure to estimated levels of 1.0 ug/m^3 during that time. Yet closer to the facility, within the yellow contour line, there would have been about 58 residents in the earliest time period (1964-1975). This means that about 58 people may have been exposed to levels of hexavalent chromium estimated at 5.0 µg/m during the earlier period. Also during that time period, approximately 27 people may have been exposed to levels estimated at 10 µg/m , and possibly 12 persons to estimated levels of 20 µg/m . "*

• Given the erroneous operating assumptions and modeling errors discussed above, these contours cannot be used to estimate theoretical public health risk. The emissions are grossly overstated for the reasons set forth above—they assumed more than 40 years of tank operations that never took place, assumed that no emission controls were present when they were in use, and assumed unrealistically high electrical and tank usage.

• The emission contours are located in the wrong place because of a mapping coordinate error and the emission contours are incorrectly shaped because the meteorological data is in error. The contours which are mistakenly located approximately 250 meters south of the former Remco Facility cannot possibly be used to estimate exposure and calculate theoretical health risk. Tab 3 at 4-7 and Fig. 2-1.

39) <u>CDHS Response</u>: CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the

public comment draft was issued, which has been incorporated. As expected the changes to model altered the output somewhat, but did not substantially change the overall exposure picture for Willits residents (please refer to CDHS response #1 and #2 for detailed information relating to the installation of the plating tanks and emission control equipment used at Remco).

The mapping coordinates have been adjusted and the contours re-plotted (please refer to ATSDR response #4 for more detailed information).

Health Effects of Hexavalent Chromium

(CDHS Draft Report pages 16-17)

14. Page 16, Paragraph 3, line 1 reads: *"Inhalation of hexavalent chromium has also been associated with nasal and stomach cancer; however, these cancer effects have not been well studied. "*

Scientific and health agencies reviewing the scientific literature on chromium have not found a causal association between chromium exposure and non-respiratory cancers in humans. For example, the World Health Organization has concluded that "there is insufficient evidence to implicate chromium as a causative agent of cancer in any organ other than the lung." World Health Organization (1988) Chromium, Environmental Health Criteria, Vol. 61, WHO, Geneva, Switzerland. Similarly, the International Agency for Research on Cancer has concluded that "[f]or cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds." International Agency for Research on Cancer, "Chromium and Chromium Compounds," IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Chromium, Nickel and Welding, Vol. 49, Lyon, France (1990), p. 211. In fact, Dr. Max Costa, frequently an expert witness for plaintiffs in chromium cases, published an article in 1993 in which he wrote: "Data on ... cancer risk in other [non-lung] sites are insufficient." Cohen, M.D., Kargacin, B., Klein, C.B. and Costa, M. (1993), "Mechanisms of chromium carcinogenicity," *Crit. Rev. Toxicol.,* 23, 255-281.

40) CDHS Response*: In many of the occupational studies that found elevated lung cancer to be associated with chromium exposure, other cancers were also evaluated, but lung cancer was the only cancer that was found to be elevated. The International Agency for Research on Cancer (IARC) has evaluated chromium and concluded that "there is sufficient evidence in humans for the carcinogenicity of chromium[VI] compounds as encountered in the chromate production, chromate pigment production and chromium plating industries." {, 1990 #175}. Within its evaluation of epidemiological studies at the time of publication (1989) it stated that "[f]or cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds. In 1988, the World Health Organization found similarly did not find enough evidence to classify chromium as a causative agent of cancers other than lung {, #176}.

However, although inconsistent, some studies have found elevations of cancers other than lung, nasal and sinus cavity. Besides respiratory cancer, ATSDR identifies oral cavity cancer and stomach cancer to be potentially related to chromium inhalation exposure (36). A high number of precancerous oral cavity lesions were found among a group of Czech chromium

platers (36). Stomach cancer has been found to be significantly elevated in some studies of platers (Sorahan, Franchini) and other chromium-exposed workers (44, 82-85). An early study of chromate production workers at five plants in the US found rates of cancer of the digestive tract to vary from 0 to 3.04/1000 compared to 0.59/1000 for controls (Machle & Gregorius 1948, reported in WHO document 1988) {, #176}. Also, several studies have found a significant association between chromium and bladder cancer (Rosenman, Becker), including a case-control study of bladder cancer and occupation that identified this relationship (Kunze), which adds strength to the validity of this potential association (84, 86, 87). Two studies found liver cancer mortality to be significantly elevated among chromium exposed workers (82, 88).

<u>Noncancer Health Effects Evaluation</u>

(CDHS Draft Report pages 17-21)

15. Page 19, Paragraph 5, line 1 reads: *"Respiratory problems, such as bronchitis and asthma—Several chromium worker studies have shown decreases in pulmonary function tests . .. that are used to diagnose obstructive pulmonary disease. "*

• The text refers to "bronchitis and asthma." The studies cited relate solely to asthma.

• The study cited by Kuo, H-W, et al., "Concentration and size distribution of airborne hexavalent chromium in electroplating factories," *American Industrial Hygiene Association Journal,* 58:29-32 (1997) (reference no. 31) is not a chromium worker study designed to evaluate pulmonary function as the text suggests. Instead, Kuo and colleagues examined concentration and size distribution of airborne hexavalent chromium in Taiwanese electroplating factories. This study thus is an exposure study, not a study relating to pulmonary function tests.

41) <u>CDHS Response</u>: CDHS mistakenly cited the incorrect reference (#31) in the discussion of respiratory problems. The proper study (same author) has been cited.

16. Page 19, Paragraph 8, line 1 reads: *"Reproductive effects—In studies of welders, chromium exposure has been associated with effects on sperm quality and increased risk of spontaneous abortions among spouses of these welders (19, 37). Welders are exposed to other metals in addition to hexavalent chromium. The level of exposure associated with these effects was not reported. "*

• As with many of the Appendices, Appendix E of the CDHS Draft Report contains a more detailed discussion of the scientific literature regarding possible health effects associated with exposure to chrome six than is contained in the body of the Report. The Report would present a more balanced discussion of the literature if some of this information were moved into the body of the Report, or specific references to contrary studies listed in Appendix E were included.

• This particular section of the Report (Report at p. 19) fails to provide a balanced discussion of male reproductive effects. It makes no reference at all to studies showing a negative association between chromium exposure and male reproductive effects, although Appendix E does describe some negative studies. *See* CDHS Draft Report at pp. 100-101.

• However, even Appendix E does not discuss relevant studies. The Report refers to two studies by Niels Henrick I. Hjollund and colleagues regarding male mediated spontaneous abortion with reference to stainless steel welding (Report at pp. 100-101), but fails to discuss an additional study by Hjollund and colleagues regarding sperm quality with reference to metal welding (Hjollund, N. H. I., et al., "Semen Quality and Sex Hormones with Reference to Metal Welding," *Reproductive Toxicology,* 12:91-95 (1998)). This recent study found no statistically significant differences in any semen quality measures or hormones between the exposed group and reference groups. Another relevant study the CDHS Draft Report does not mention is Jelnes, J. E., Knudsen, L. E., "Stainless Steel Welding and Semen Quality," *Reproductive Toxicology,* 2:213-215 (1988). This study also did not show any significant decrease in semen quality for stainless steel welders as compared to non-welders.

42) <u>CDHS Response</u>*: *We present information for health effects that have been linked to hexavalent chromium. We have also presented information about studies showing no effect. For instance, there has been a study showing an effect on male fertility and this was presented in the PHA and there have been studies not showing an effect and these were described as well (summarized on pages 36 and 37 and described more fully on pages 100 and 101 of the public comment draft). In Appendix E, we summarize studies that did not show an effect on the lung, the kidney, reproductive system and have a section entitled, "Effects that have been studied and do not seem to be associated with chromium exposure." We added additional study information to the reproductive toxicity section in Appendix E.

<u>Increased Cancer Risk Estimates for the Willits Community— Willits residents</u>

(CDHS Draft Report pages 23-24)

17. Page 23, Paragraph 5, line 1 reads: *"The following [section] lists the rate of estimated lifetime increased cancer risk (primarily lung) for adult and child residents (cancer risk estimates for each contour color are provided in Appendix C, Table 8). "*

• The Report fails to describe in detail the methodology used to determine the theoretical excess cancer risk. For example, the Report does not provide important exposure parameters, including inhalation rates for children and assumptions regarding body weights. This approach makes it difficult to provide scientific or quantitative comments upon the risk analysis portion of the Report.

43) <u>CDHS Response</u>*: *A discussion of the exposure assumptions is provided in the Increased Cancer Risk Estimates for the Willits Community section of the PHA. Exposure assumptions and methodology can also be found in Appendix C, Table 8.

• The Report does not explicitly refer to the specific quantitative approach used to estimate the theoretical excess cancer risk. However, it appears that the cancer slope factor adopted by the State of California's Office of Environmental Health Hazard Assessment ("OEHHA") was used to calculate the theoretical excess cancer risks. The OEHHA approach is based on old epidemiological data, *i.e.,* Mancuso, T. F. (1975), and as a result, OEHHA adopted a very conservative approach to unit risk for chrome six exposure to address uncertainties in this older data. By comparison, use of the U.S. Environmental Protection Agency ("EPA") unit risk, as described in the Integrated Risk Information System ("IRIS"), would result in theoretical cancer risks at least ten times lower than the results obtained in the Report. Moreover, the quantitative risk assessment developed by the U.S. EPA is consistent with more recent epidemiological data and independent evaluations developed by the Occupational Safety and Health Administration ("OSHA") (1995) and the European Union's Scientific Committee on Occupational Exposure Limits ("SCOEL") (2003).

44) <u>CDHS Response</u>: The USEPA and OEHHA cancer slope factors are developed from the same study, Mancuso, T.F (1975) (52). The Mancuso study was based on exposure levels measured as soluble, insoluble and total chromium (the chromium was not speciated between trivalent and hexavalent). Limitations with the 1975 study make identification of the specific form of chromium responsible for the lung cancer uncertain. In 1997, the study was updated showing lung cancer rates clearly increased by gradient level of exposure to total chromium (53).

USEPA developed their cancer slope factor/unit risk for hexavalent chromium in 1998, using dose-response data for total chromium, potentially leading to a sevenfold underestimation of the risk for hexavalent chromium (53). OEHHA calculated their cancer slope factor/unit risk value assuming the cancer mortality in the Mancuso study was due to hexavalent chromium exposure, which was further assumed to be 1/7 of the total chromium exposure based on an industrial hygiene survey {Bourne, 1950 #154, 54). This approach helps reduce some of the uncertainty in the toxicological information, while providing a more health protective value.

CDHS and ATSDR do not use standards developed by OSHA (as suggested by the comment) in evaluating exposure to non-worker populations, as they are not protective of sensitive populations such as children, the elderly and immune compromised individuals.

<u>Comparison of Occupational Chromium Levels with Air Modeling Levels Estimated Near Remco</u>

(CDHS Draft Report pages 25-26)

18. Page 25, Paragraph 3, line 1 reads: *"This information is found in a few occupational studies, which may have been conducted in other parts of the country or world, and which have information about workers' exposure levels to hexavalent chromium. Although this exposure information is limited, the air concentrations found in occupational health studies to be associated with an increased risk in lung cancer were typically higher than the air modeling estimates of the highest annual average chromium levels in Willits. "*

• Although the CDHS Draft Report discusses some older occupational studies with high occupational chromium exposure measurements, it does not refer to certain recent studies, including: Gibb, H., et al., "Lung Cancer Among Workers in Chromium Chemical Production," *American Journal of Industrial Medicine,* 38:115-126 (2000); Gibb, H., et al., "Clinical Findings of Irritation Among Chromium Chemical Production Workers," *American Journal of Industrial Medicine,* 38:127-131 (2000); Luippold, R. S., et al., "Lung cancer mortality among chromate production workers," *Occup. Environ. Med.,* 60:451-457 (2003); and Proctor, D. M., et al., "Workplace Airborne Hexavalent Chromium Concentrations for Painesville, Ohio, Chromate

Production Plant (1943-1971)," *Applied Occup. Environ. Hygiene,* 18(6):430-449 (2003). These studies provide a discussion of occupational exposures at a variety of chromium six workplace concentrations. The Report's failure to consider recent, relevant literature regarding the effects of occupational chromium exposure renders the findings in this section of the Report suspect. The Report also fails to address certain studies that have examined health effects in relation to residence near industrial sites that produced or used chromium products. For example, a recent review article examined the effects of environmental chromium exposure in the United Kingdom; it found "no clear evidence to relate exposure to environmental levels of chromium with adverse health effects in either the general UK population or subgroups exposed to chromium around industrialized or contaminated sites." Rowbotham, Anna L., et al., "Chromium in the Environment: An Evaluation of Exposure of the UK General Population and Possible Adverse Health Effects," *J. Toxic. Environ. Health,* 3:101-136 (2000). Another study examined the cancer and death rates in the zip codes immediately surrounding gas compressor stations in California that used hexavalent chromium. Fryzek, Jon, et al, "Cancer Mortality in Relation to Environmental Chromium Exposure," *Journal of Occupational and Environmental Medicine,* 43(7):635-640 (2001). This study, funded by PG&E, found no significant increase in overall cancer deaths or lung cancer deaths specifically, in the area surrounding the gas compressor stations, as compared to the rest of the counties.

45) <u>CDHS Response</u>*: *To date, the few analyses of environmentally exposed populations of which we are aware have generally not found an association between chromium exposure and cancer, and this is already stated in the PHA.

Both the Gibb and Luippold studies found highly significant dose-response relationship between cumulative exposure to hexavalent chromium and death from lung cancer. The statement that the three articles "provide analysis of thresholds for occupational exposures to chromium[VI} below which no significant health effects were observed" is somewhat confusing. The Gibb and Luippold studies address death lung cancer deaths only, not any other significant health effects; whether or not other significant health effects can occur at any threshold was not studied and therefore cannot be commented on. Also, the studies should not be interpreted to mean there are thresholds below which no significant health effects exist. The risk at higher levels of exposure was higher, and the risk at lower exposure levels was lower, varied, and was not statistically significant. This does not rule out that there could still be some elevated risk at lower exposure levels. More specifically, Gibb found a strong and statistically significant dose-response relationship between hexavalent chromium exposure and lung cancer (151). Among lowest exposure category, Gibb found the number of observed deaths due to lung cancer to be lower than expected for whites; higher than expected for non-whites; higher than expected for persons of unknown race; averaging to slightly lower than expected overall, although the 95% confidence interval spanned from 0.63-1.39. Luippold similarly found a highly significant relationship between risk for death from lung cancer and cumulative hexavalent chromium exposure (test for trend: p=0.00002) (152). Luippold states that there could be a threshold effect, although acknowledging that the data could also be consistent with a linear dose-response. However, similar to the Gibb data, the SMRs of the three lowest exposure categories are 67 (14-196); 184 (79-362); and 91 (25-234); because the confidence interval of each of these extends well above unity, this means the "true" SMR could be elevated, even at the lower levels (meaning a "threshold" has not yet been

demonstrated to exist). The third reference (Proctor), is a report of 23 historic exposure measurement surveys from 1943 – 1971 that could be useful in cancer risk assessment efforts, but does not address any health effects itself (153).

The PHA did not attempt to provide a comprehensive review of the epidemiological literature on chromium exposure, and did not cite specific lung cancer studies, as that association is considered well proven. The PHA does refer to over 30 scientific studies showing this association. However, the two recent studies mentioned in the comments confirm and strengthen the previous studies' findings of an association between lung cancer and hexavalent chromium exposure. Gibb found a significant and strong dose-response relationship between hexavalent chromium exposure and lung cancer (151). For each additional tenfold increase in cumulative hexavalent chromium exposure, there was a 66% increase in risk of death from lung cancer among this cohort of chromium chemical production workers. Luippold found a strong relationship between lung cancer mortality and cumulative hexavalent chromium exposure (152).

<u>Cancer Review Data for Willits—Rationale for Cancer Review and Choice of Cancers</u>

(CDHS Draft Report pages 27-28)

19. Page 27, Paragraph 8, line 1 reads: *"The review [by CDHS] also included: prostate, lymphoma, Hodgkin 's disease, leukemia, bone, stomach, urinary tract, renal, bladder, testicular, and liver cancer (some of these are specific cancers that fall within broader categories). The evidence for an association between chromium and these cancers varies considerably. However, a number of them were included—even in the absence of meaningful evidence—because they have been identified as cancers that possibly might be related to chromium by a frequently cited researcher. Dr. Max Costa, who reviewed and reported on other people 's studies. Because a cancer appeared on the list does not mean that the cancer is necessarily related to chromium exposure. "*

• As acknowledged in Appendix E to the CDHS Draft Report, there are many criticisms of the Costa review article. In fact. Dr. Costa himself published an article in 1993 in which he wrote: "Data on ... cancer risk in other [non-lung] sites are insufficient." Cohen, M.D., Kargacin, B., Klein, C.B. and Costa, M., "Mechanisms of chromium carcinogenicity," *Crit. Rev. Toxicol.,* 23:255-281 (1993). This Costa review article has also been criticized by other articles that are not described in the Report. One such published, peer-reviewed article is Rowbotham, Anna L., et al., "Chromium in the Environment: An Evaluation of Exposure of the UK General Population and Possible Adverse Health Effects," *J. Toxic. Environ. Health,* 3:101-136 (2000). This article states that the Costa review article presents epidemiological data "out of context" and that the article does not "provide reasonable evidence of causality." It concludes that "[the link between Cr(VI) and the occurrence of these cancers in this speculative review has therefore been proposed on the basis of suggestive rather than actual evidence and is largely unsubstantiated by the epidemiological data."

• The statements in this review article about the association of chromium with types of cancers other than respiratory cancer are contrary to the findings of the government agencies and scientific groups that have carefully evaluated the scientific literature on chromium. For example, the World Health Organization has concluded that "there is insufficient evidence to implicate chromium as a causative agent of cancer in any organ other than the lung." World Health Organization (1988) Chromium, Environmental Health Criteria, Vol. 61, WHO, Geneva Switzerland. Similarly, the International Agency for Research on Cancer has concluded that "[f]or cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds." International Agency for Research on Cancer, "Chromium and Chromium Compounds," IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Chromium, Nickel and Welding, Vol. 49, Lyon, France (1990), p. 211.

46) <u>CDHS Response</u>: These quotations are taken somewhat out of context, as the primary thrust of the evaluation of IARC is its assessment that there is sufficient evidence of chromium[VI] as a carcinogenic compound in humans. The statement about cancers other than lung and sinonasal cavity falls within the section on evaluation of epidemiological studies, but this does not mean that IARC rules out that there could be other cancers caused by chromium[VI]. (See also CDHS response #9)

• Another published, peer-reviewed article also contains detailed criticisms of the Costa review article: De Flora, Silvio, "Threshold mechanisms and site specificity in chromium (VI) carcinogenesis," *Carcinogenesis,* 21:533-541 (2000). This article states that the Costa review article "suffers from a number of inaccuracies and gross mistakes, regarding references, working categories, identity or definition of cancer sites and report of data. Moreover, Costa arbitrarily selected those data which could be of some use to support his theories. In contrast he disregarded other data reported in the same papers, many of which showed negative or even opposite trends."

47) <u>CDHS Response</u>: To expand on what we stated in the report, we examined other cancers, after qualifying that specific evidence for their association with chromium was lacking, because without looking for other associations it is impossible to detect them if they do exist. Because the community has a legitimate and broad concern about a number of cancers, and is aware of Dr. Costa's work, we thought it appropriate to examine those cancers he cited as possibly related. Also, as most existing studies have focused on lung cancer, and additional data on the question of other cancers is limited.

<u>Limitations of Evaluation</u>

(CDHS Draft Report pages 31-32)

20. Page 32, Paragraph 2, line 1 reads: *"There are a number of reasons why it is difficult to tell from this type of review whether specific exposures caused cancer in a community. Cancer takes a long time to develop (usually many years), so people may have cancer for a long time before they learn about it. "*

• The CDHS Draft Report concludes that the period of highest emissions began in 1966 and ended in 1976. The latency period since these highest levels of estimated emissions is more than 25 to 35 years, which is a reasonable time to detect cancer health effects in the community if any were actually present. The absence of excess cancers in Willits after this extended period raises serious questions about the accuracy of the hypothetical risk described in the Report. *See* Tab 28 at 9.

48) <u>CDHS Response</u>*: *The time elapsed since persons were exposed from 1976 through 1995 would be 8 to 26 years, so not all cancers would be expected to have occurred by the time of the report; also, the latency period for lung cancer risk may extend beyond 35 years.

<u>Recommendations</u>

(CDHS Draft Report pages 43-45)

21. Page 43, paragraph 7, line 1 reads: *"CDHS/ATSDR recommend the feasibility of medical monitoring/clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to air releases of hexavalent chromium from Remco, between 1964-1995, be considered. "*

• The proposal to evaluate the feasibility of medical monitoring is based upon computed, theoretical risks that are flawed for the reasons stated above. The mistaken historical assumptions, meteorological data deficiencies and modeling errors are so numerous, that these computations cannot reasonably be used as a basis to consider the feasibility of medical monitoring. The absence of excess cancers in the Willits population after a substantial latency period suggests that medical monitoring may not be appropriate or necessary.

49) <u>CDHS Response</u>*: *The air model, operational history and exposure assessment have been revised to reflect information previously not available to CDHS. While the inputs may have altered the model slightly, it does not change the overall exposure picture for Willits residents. Further, ATSDR determined that releases of hexavalent chromium were likely orders of magnitude higher than those estimated by the model, due to operational issues identified at the site (Appendix D). The conclusions and recommendations (including the appropriateness of medical monitoring for the impacted community) listed in the public comment draft have not been changed based on the revisions to the PHA. (Please refer to CDHS response #9 for limitations in drawing definitive conclusions based on Cancer Registry data and CDHS response #47 regarding cancer latency.)

<u>References</u>

(CDHS Draft Report pages 46-54)

22. Page 46, Reference No. 14 (and Appendix D): *"Atmospheric Dispersion Modeling Remco Hydraulics, Inc. Site, Willits, CA. Lockheed Martin, Inc. Prepared for: Agency for Toxic Substances and Disease Registry; 2002 Sep. Report No.: U.S. EPA Contract No.: 68-C99-223. "*

• The CDHS Draft Report cites as a reference and appends the unsigned September 2002 draft of the Lockheed Martin, Inc. Atmospheric Dispersion Modeling Report rather than the revised final, signed November 2002 modeling report.

50) <u>CDHS Response</u>*: *Comment noted and the oversight has been resolved.

<u>Appendix B—Figures</u>

(CDHS Draft Report pages 63-68)

23. *Appendix B, Figure 2:* "History of Building Expansion, Remco Hydraulics, Inc. Site. "

• As noted above this map is erroneous in several respects. *See* discussion above. For example, the building labeled "1964" was not constructed until after August 9, 1966. *See* Tab 31; Tab 8; Tab 32; Tab 9. Moreover, it claims that all five vertical chrome plating tanks were installed from 1963-1973. The evidence shows that these tanks were installed from approximately 1968 to 1982. Nevertheless, the purported 1963-1973 installation dates of vertical Tank Nos. 3-7 contradict even the assumptions made by the CDHS Draft Report. Moreover, while the evidence indicates that Remco revamped the chrome department in 1973, the indication that "~1973" was the date that Remco constructed the building over the deep plating tanks contradicts the statement made in the CDHS Draft Report at page 2, paragraph 2, line 1 that this building was constructed "by 1976".

51) <u>CDHS Response</u>*: *Please refer to CDHS responses #1, #13, #14 #19, #26, #29 and #31 regarding tank installation dates, as this same comment has been repeated and addressed multiple times.

The documentation provided by Latham and Watkins consist of "plans" to revamp the chrome department, not documentation that it was completed by 1973. Reportedly, Building 1973 was constructed in portions, with the area that enclosed the vertical tanks occurring last, in about 1976 (Wake 1996, Almida 1997, Wisdom 1996). The actual completion date of this expansion is unclear; thus CDHS used the phrase "by 1976" based on the above referenced employee depositions.

24. Appendix B, Figures 3-5: *"Annual Average Concentrations of' Airborne Hexavalent Chromium."*

• As described above, the model emission contours are not scientifically defensible.

• The emission rates are incorrectly specified to the model as grams per second, rather than grams per second per meter squared. This error overstates the emissions from the vertical chrome plating tanks in each era of operations. Tab 3 at 7-8.

52) ATSDR Response: The emission rates are correctly specified in the air model (Appendix D).

• The emission contours are based upon ground level receptors, rather than receptors at breathing zone heights. Placing the model receptors at ground level can contribute to overestimated modeled concentrations. Tab 3 at 11.

53) ATSDR Response: The air modeling was conducted to reflect the operating conditions at the time, based on the best available information.

• The modeling uses a non-standard approach to terrain, and incorrectly specifies certain tanks that were vented through a stack from the scrubber or mist eliminator as ground level area sources. Some of these errors can increase modeled chromium concentrations, particularly in areas close to the former Remco Facility. Tab 3 at 11.

54) ATSDR Response: The air modeling has been revised to reflect the operating conditions at the time, based on the best available information.

• The meteorological data used to model dispersion, including the wind speed and wind direction data, are not reliable because the meteorological station has not been sited, operated nor maintained in compliance with a quality assurance program appropriate for this application. Tab 3 at 13-33.

• These limitations are apparent in the data set produced from the meteorological monitoring station, including a change in the predominant wind direction by approximately thirty degrees beginning in June 2001. Tab 3 at 27-29 and Fig. 3-4.

55) ATSDR Response: The data used for modeling (1996-2000) predated inconsistencies with wind direction beginning in 2001.

• Most importantly, a mapping or coordinate error caused the highest concentrations of modeled emissions to be centered approximately 250 meters south of the Remco Facility, rather than on the property as they should be depicted. Tab 3 at 4-7 and Fig. 2-1.

56) ATSDR Response: The models were re-run by ATSDR with "cross hairs" placed at the center of all the sources (for reference).

<u>Appendix D—Atmospheric Dispersion Modeling Report</u>

(CDHS Draft Report pages 75-93)

25. Section 4.0 (page 85), paragraph 6, line 1 reads: *"In this study, the surface meteorological data can be considered to be reasonably reliable and representative. They were obtained from the MCAQMD from a weather station located in the town of Willits, CA directly across the street from the Remco facility. This weather station provided typical surface meteorological parameters: wind speed, wind direction, temperature and pressure."*

• As described above, the meteorological station was not sited, operated nor maintained in a manner to produce reliable data. Tab 3 at 13-26.

• The meteorological station is located too close to a line of tall trees that can affect wind speed and wind direction. Tab 3 at 17-19 and Fig. 3-1.

• The meteorological station was not subject to appropriate calibration or independent audits. Tab 3 at 19-26; Tab 25 at 43:7-24, 45:16 - 46:19.

57) <u>CDHS Response</u>: The local meteorological (MET) data used to model past air releases from Remco is better than most modeling situations used to predict future impacts to communities as part of a risk assessment. For instance, risk assessments generally use default regulatory MET data to evaluate potential impacts to communities, resulting in very conservative values that can be up to 20 times higher than what would be predicted using local data (D. Wolbach, MCAQMD, personal communication November 12, 2003).

• The data produced by the meteorological station was internally inconsistent and unreliable. The predominant wind direction changes by thirty degrees after June 2001, indicating that a physical adjustment or accidental reorientation of the wind direction sensor occurred. The wind speed data is edited (downward by approximately 2 miles per hour) after July 1997. The wind speed data is scaled differently after June 1998, most likely reflecting a change to reporting wind speed in meters per second, rather than miles per hour. Tab 3 at 26-31 and Figs. 3-3 to 3-5.

58) ATSDR/*__*CDHS Response*__: *CDHS received correspondence from the MCAQMD regarding an audit conducted on the MET (meteorological) station on the roof of the Safeway, near the Remco site (181). We were informed that MCAQMD staff and David Sutter of Precise Environmental Consultants (Latham and Watkins consultant) evaluated the air districts MET station and discovered that there were notable inconsistencies with the data after 2002. The data used for modeling predated these inconsistencies, but ATSDR found some less significant artifacts. One artifact is the steady decline in the wind speed measurements after May of 1998, which may be the result of slow wearing. The MCAQMD estimates that the wind speed measurements are 30-40% lower. The specific impact will be addressed in the uncertainty section of the air model report (Appendix D). However, mathematically a 40% decrease in wind speed will create a 40% increase in the predicted maximum concentrations, but will also prevent the plume from spreading downwind, thus decreasing the concentrations at other locations. From a Public health perspective, long-term average cancer risk is not changed when the maximum levels are increased and the minimum levels are decreased by the same amount or vice versa.

ATSDR also discovered that the wind directions reported during 1997 contained two continuous unusual events (out of 8,760 hours). The events, which may be recalibration events would not inhibit the ability to predict long-term average exposures. However, our scientists chose to leave this data out because of the existence of those events. Therefore, the revised modeling used only the best available data.

26.Appendix B—Calculations For ISCST3 Source Emission Rates, contains the following table:

CALCULATIONS FOR ISCST3 SOURCE EMISSION RATES (refer to Appendix B, Lockheed report)

• It is unrealistic to assume that chrome plating tanks were operated at or near their maximum capacity 16 hours per day. The electrical rate used for plating depends upon the plating being performed. Plating is often performed at far less than the maximum electrical capacity. *See* Tab 2 at 6-10.

59) ATSDR Response: There is evidence that REMCO willingly operated outside of their permitted times while they knew that their air pollution control devices were not functioning properly. Any scenario based on the data collected during planned testing events and using permitted values is likely to underestimate the actual exposures.

• Remco records confirm that plating jobs were regularly performed at less than the rectifier electrical capacity. For example, Remco records reflect that electrical use for the plating tanks in 1991 and 1992 were only 7.28% and 5.15% of the electrical use assumed in the model. Tab 2 at 7-8, 9-10.

60) CDHS/ATSDR Response: The electrical usage data used by Lockheed and ATSDR is based on testing conducted at the Remco facility—testing which is done at optimized conditions, not worst case. Modeling was limited to the permitted hours, which are known to have been exceeded. Any scenario based on the data collected during planned testing events and using permitted values is likely to underestimate the actual exposures.

Appendix E—Toxicological Summary for Chromium

(CDHS Draft Report pages 94-110)

27. Page 102, paragraph 6, line 1 reads: *"The author of one review article identified studies of cancer in which chromium exposure was present. These types of cancer included prostate, lymphoma, leukemia, bone, stomach, genital, urinary tract, renal, bladder, and testicular, and Hodgkin 's disease. Without additional evidence, many of these findings would typically not be considered meaningful for a number of reasons. "*

• As described above, this review article by Dr. Costa has been criticized in other published papers because, among other things, "[the link between Cr(VI) and the occurrence of these cancers in this speculative review has therefore been proposed on the basis of suggestive rather than actual evidence and is largely unsubstantiated by the epidemiological data." Rowbotham, Anna L., et al., "Chromium in the Environment: An Evaluation of Exposure of the UK General Population and Possible Adverse Health Effects," *J. Toxic. Environ. Health,* 3:101-136 (2000).

***61) CDHS Response**: As we discuss in our report, the review article by Dr. Costa does not prove the cancers he addresses are linked to chromium exposure. To expand on what we stated in the report, we examined other cancers, after qualifying that specific evidence for their association with chromium was lacking, because without looking for other associations it is impossible to detect them if they do exist. Because the community has a legitimate and broad concern about a number of cancers, and is aware of Dr. Costa's work, we thought it appropriate to examine those cancers he cited as possibly related. Also, as most existing studies have focused on lung cancer, and additional data on the question of other cancers is limited.*

28. Page 103, paragraph 4, line 1 reads: *A few studies reported estimates of the chromium levels to which workers had been exposed. One study estimated worker hexavalent chromium exposure levels to be 413 ug/m^3 during the years 1945-49 (18). "*

• As noted above, the Report fails to discuss certain more recent studies that provide a discussion of occupational exposures at a variety of chromium six workplace concentrations, including: Gibb, H. et al., "Lung Cancer Among Workers in Chromium Chemical Production," *American Journal of Industrial Medicine,* 38:115-126 (2000). The Report also fails to include a discussion of studies that have examined health effects in relation to residence near industrial sites, including one that found "no clear evidence to relate exposure to environmental levels of chromium with adverse health effects in either the general UK population or subgroups exposed to chromium around industrialized or contaminated sites." Rowbotham, Anna L., et al., "Chromium in the Environment: An Evaluation of Exposure of the UK General Population and Possible Adverse Health Effects," *J. Toxic. Environ. Health,* 3:101-136 (2000).

62) <u>CDHS Response</u>: Both the Gibb and Luippold studies found highly significant dose-response relationship between cumulative exposure to hexavalent chromium and death from lung cancer. The statement that the three articles "provide analysis of thresholds for occupational exposures to chrome six below which no significant health effects were observed" is somewhat confusing. The Gibb and Luippold studies address death lung cancer deaths only, not any other significant health effects; whether or not other significant health effects can occur at any threshold was not studied and therefore cannot be commented on. Also, the studies should not be interpreted to mean there are thresholds below which no significant health effects exist. The risk at higher levels of exposure was higher, and the risk at lower exposure levels was lower, varied, and was not statistically significant. This does not rule out that there could still be some elevated risk at lower exposure levels. More specifically, Gibb found a strong and statistically significant dose-response relationship between hexavalent chromium exposure and lung cancer (151). Among lowest exposure category, Gibb found the number of observed deaths due to lung cancer to be lower than expected for whites; higher than expected for non-whites; higher than expected for persons of unknown race; averaging to slightly lower than expected overall, although the 95% confidence interval spanned from 0.63-1.39). Luippold similarly found a highly significant relationship between risk for death from lung cancer and cumulative hexavalent chromium exposure (test for trend: p=0.00002) (152). Luippold states that there could be a threshold effect, although acknowledging that the data could also be consistent with a linear dose-response. However, similar to the Gibb data, the SMRs of the three lowest exposure categories are 67 (14-196); 184 (79-362); and 91 (25-234); because the confidence interval of each of these extends well above unity, this means the "true" SMR could be elevated, even at the lower levels (meaning a "threshold" has not yet been demonstrated to exist). The third reference (Proctor), is a report of 23 historic exposure measurement surveys from 1943 – 1971 that could be useful in cancer risk assessment efforts, but does not actually "provide an analysis of thresholds for occupational exposures to chrome six below which no significant health effects were observed."

The PHA did not attempt to provide a comprehensive review of the epidemiological literature on chromium exposure, and did not cite specific lung cancer studies, as that association is considered well proven. The PHA does refer to over 30 scientific studies showing this association. However, the two recent studies mentioned in the comments confirm and strengthen the previous studies' findings of an association between lung cancer and hexavalent chromium exposure. Gibb found a significant and strong dose-response relationship between hexavalent chromium exposure and lung (151). For each additional tenfold increase in cumulative hexavalent chromium exposure, there was a 66% increase in risk of death from lung cancer among this cohort of chromium chemical production workers. Luippold found a strong relationship between lung cancer mortality and cumulative hexavalent chromium exposure (152).

Additional information has been added to the PHA to further clarify the carcinogenicity of hexavalent chromium.

Comments submitted by the Willits Environmental Remediation Trust

The Willits Environmental Remediation Trust ("Willits Trust") has reviewed the *Draft Public Health Assessment/or Abex/Remco Hydraulics Facility* ("Draft PHA") prepared by ATSDR for the California Department of Health Services ("CDHS"), as submitted for public comment on July 21, 2003. The Willits Trust is aware that the CDHS conducted the Draft PHA as part of CDHS's upcoming Health Risk Assessment ("HRA") for the former Remco Hydraulics Facility. It is our understanding that the HRA, when completed, will evaluate potential past exposure during operation of the Remco Facility, as well as potential current and future health risks associated with contamination at the Remco Site.

As you are aware, the Willits Trust has been charged by the Federal District Court for the Northern District of California, as its instrumentality, with responsibility for the investigation and remediation (the "Work") of the former Remco Hydraulics, me. Facility in Willits, California ("Site")[††††]' and is required to conduct such Work in a manner consistent with the federal National Contingency Plan.

To date, the Willits Trust has completed a comprehensive Site characterization, a pilot study and certain interim remedial actions ("IRAs"). The Willits Trust is currently conducting additional IRAs, a pilot study, a baseline risk assessment, and a feasibility study for the Site. The baseline risk assessment will evaluate current and future risks, and will not evaluate potential past risks associated with the Remco Site. The baseline risk assessment's focus on current and future risk is consistent with the Willits Trust's charge, which is limited to addressing only current and future threats to human health and the environment that may be posed by hazardous substances at the Site.

Given the prospective nature of the Willits Trust, the focus of its Draft PHA comments are limited primarily to the portions of the Draft PHA regarding current and/or future potential health risks. Nevertheless, the Willits Trust also offers comments on portions of the report that evaluate past hypothetical exposures to the extent that the Willits Trust has information in its possession that conflicts with the assumptions, assertions or conclusions made in the Draft PHA.

Site Ownership

The CDHS states in paragraph 2 of the *Summary* (p. 1) and in para. 2 of the *Information about Remco* (p. 6) that *"In 2000, the Consent Decree was amended and the site was acquired by the Willits Trust."* In fact, the Willits Trust acquired responsibility for the Remco Property in August 1997, upon entry of the Consent Decree, not in 2000.

1) CDHS Response*: *We have revised the PHA to reflect the comment.

[††††] The term *"Remco Site"* or *"Site"* as used in this letter refers to the Remco Facility and areas contiguous to the Remco Facility where Hazardous Substances associated with Facility operations have come to be located.

Remco Operations

In preparing key reports, including the Remedial Investigation/Feasibility Study Work Plan, as well as the Interim Remedial Investigation Report, Draft Remedial Investigation Report, and Final Remedial Investigation Report ("Final RI Report"), the Willits Trust reviewed and summarized readily available information regarding the past operations at the Remco Facility. However, consistent with the Willits Trust charge of assessing current and future contamination and risks, the primary purpose of any historical review was *not* to precisely determine the dates of past Facility operations with certainty. Rather, historical information was provided to place any proposed activities and current findings into context, as well as to assist in the collection of sufficient information for the purposes of fully characterizing the current Site conditions (e.g., identifying the location of reported historical releases to optimize sampling locations).

As such, the dates in Reports prepared by the Willits Trust, while reflecting information available to the Willits Trust at the time, are not the result of extensive verification efforts and should be considered approximate unless otherwise stated that the dates are known with certainty.

It should be further noted that, as the Willits Trust collects additional information regarding past operations, subsequent reports and report addenda incorporate any updated and revised information regarding past operations. With this in mind, the dates and information contained in the Final RI Report supercede, and should be considered more accurate than, any description of Site operations set forth earlier document. The Willits Trust has been further informed that Whitman Corporation has undertaken a considerable effort, through a thorough review of historical documentation such as interviews, deposition transcripts and correspondence, to create a time line that will provide a more accurate account of historical activities at the Site. Historical activities listed on the time line reportedly include tank installations, scrubber installations and operational details. Upon receipt of this time line and the related background materials, the Willits Trust will conduct its own independent assessment as to its accuracy and will likely incorporate substantial portions of this revised time line into future reports and addenda.

2) CDHS Response*: *CDHS assumed that the WERT was acting on behalf of the responsible parties in submitting documents to the oversight agency that are accurate and complete. If submitted reports are in fact, deficient, this should be noted in those documents.

Period of Operation

CDHS incorrectly states *(Summary,* p. 2, para. 1 and *Information about Remco,* p. 6, para. 1) that Remco operated as an industrial machine shop from 1940 to 1995. Industrial operations at the property began in 1945, not 1940.

3) CDHS Response*: *We have revised the PHA to reflect the comment.

Chrome Plating Tank Installations

The Willits Trust did provide estimated dates for installation of the chrome plating tanks in the Interim Remedial Investigation Report (Montgomery Watson, July 2000). However, the information contained in this document was based solely on information contained in an ERM-West Monitoring Well Installation Report (ERM West, March 1991). Subsequent to the issuance of the Interim Remedial Investigation Report, the Willits Trust conducted a more thorough review of the ERM report and determined that there was no documentation to support the ERM-reported dates for chrome plating tank installation and operation at the Remco Facility. Therefore, the Willits Trust reviewed additional information, also subsequent to the release of the Interim Remedial Investigation Report, regarding operations at the former Remco Facility. This information included deposition testimony of former Remco employees and supporting operations documentation. This data indicated that the dates referenced in the ERM-West report were in error. As such, in issuing the Final RI Report, the Willits Trust provided a revised tank installation time line, setting forth information regarding the dates of tank installations, as well as other operational information.

When CDHS contacted a consultant working for the Willits Trust, in May of 2002, regarding tank installation dates and the discrepancy between the *Interim* and *Final* RI Reports, the CDHS representative was informed of the Willits Trust's recommendation to utilize the time line in the Final RI Report, at least as between the two reports. However, in the Draft PHA (p. 8), the CDHS states that:

> We were informed that the timeline presented in the Final RI was based on employee depositions rather than the ERM-West report, because the Willits Trust legal counsel "identified some discrepancies" in the 1991 ERM-West report (Terry James, Montgomery Watson, personal communication. May 22, 2002). To date, the Willits Trust has not provided CDHS with information about these discrepancies. CDHS conducted a limited review of employee depositions, and found information that supports the ERM-West construction timeline. Therefore, CDHS is assuming that tanks Nos. 3-5 were installed between 1964 and 1966.

Further inquiry conducted by the Willits Trust with respect to this statement indicates that neither the Willits Trust, nor its consultant, Montgomery Watson, stated that the reason for updating the tank construction information was due to "discrepancies" in the ERM-West Report. Similarly, consultation with the Willits Trust's legal counsel indicates no discrepancies within the ERM-West Report itself. Rather, as indicated above, it was the total lack of relevant citations and backup information in the ERM-West Report that caused the Willits Trust to seek additional information, including former employee deposition testimony and supporting documents. Once this review was conducted, it was determined by the Willits Trust that the dates set forth in the ERM-West Report were not only stated without support or citation, but that many of them were incorrect.

4) CDHS Response*: *The conversations between CDHS, Montgomery Watson Harza (MWH) and the Willits Environmental Remediation Trust (WERT) were accurately summarized/cited in the PHA.

In 1991, ERM-West was hired by Remco to conduct environmental work at the site. It is not an unreasonable assumption that Remco provided ERM-West with site-specific information and would have reviewed the report produced by ERM-West for accuracy. It appears this assumption was also made by the WERT's consultants, as the ERM-West Monitoring Well Installation Report, written for Remco in 1991, was cited in the Interim R.I. Report, the Draft R.I Report and the Final R.I. Report (Table 2-2) as the source for the vertical tank construction dimensions and installation dates. However, the installation dates in the Draft

and Final R.I. were changed and do not reflect the dates presented in the ERM-West report (though this was the report cited to contain the information). This inconsistency prompted CDHS to contact MWH and the WERT.

It appears the actual installation dates for the vertical underground plating tanks is still a source of deliberation, as information presented in the Final RI report has changed once again. The most recent change was a revision to the April 2002 RI report, written by Montgomery Watson Harza, Inc. (MWH). On November 25, 2002, MWH sent a revised table titled, "Table 2-2 Chrome Plating Tank Construction Specifications" in which the construction date for Tank No. 7 was changed from 1981 to 1986. CDHS staff has a copy of a 1983 inspection report from the Mendocino County Air Quality Management District that states seven plating tanks were in operation. This information clearly contradicts the most recent change to the tank construction timeline as asserted by the responsible party's consultant.

Since the release of the public comment draft of the PHA additional information has been made available to CDHS; as a result we have modified the tank installation timeline and exposure evaluation in the Final PHA.

Thus, the actual reason that the tank information was updated in the Final RI Report was that additional, credible information was obtained and reviewed after submittal of the Interim Remedial Investigation Report. A review of our consultant's conversation further indicates that CDHS was specifically directed to the Final RI Report for the Willits Trust's then best estimate of Site operational dates. In addition, our records indicate that CDHS has never requested any additional information regarding operational dates from the Willits Trust.

5) <u>CDHS Response</u>: Please refer to CDHS response #2 above regarding most recent/unresolved inconsistency related to the installation date for Tank No.7. The comment indicates operational dates in the Final RI Report were based on the "Willits Trust's then best estimate", and not operational records. As stated in the Final RI Report (pages 2-16), " Most operational documents were last in the possession of the Remco Facility's last owner, which is now bankrupt. The Willits Trust has recently been made aware of some additional records and is currently making efforts to obtain and review these records". CDHS staff contacted the WERT on a number of occasions seeking information related to operational dates and received none. The only technical report available discussing the plating tank timeline was the 1991 ERM-West report. In the absence of operational records we accurately concluded the differing timelines (based on communications with the WERT, MWH and the reference from the Final RI Report) were based on interpretation. Further, the WERT's Trustee serves on the CDHS Site Team, which was formed to provide ongoing information on the PHA process and provide a mechanism for feedback and the sharing of information. The data needs for the development of the Air PHA were discussed at a Site Team meeting in 2001 and in subsequent data requests from CDHS to the WERT. If the WERT obtained additional records subsequent the Final RI and CDHS requests, these records could have been forwarded to CDHS.

Since the release of the public comment draft PHA, Whitman/Pepsi America has made some operational records available to CDHS.

In support of CDHS's use of dates between 1964 and 1996 for installation of Tank Nos. 3-5, the CDHS has stated that they conducted a limited review of two former employee depositions, R. Straight (May 1997) and R. Wake (December 1996). However, neither of these two individuals were employees of Remco during the 1964-1966 time period[‡‡‡‡]. The Willits Trust's more comprehensive review of all available deposition testimony, as well as documents attached as exhibits to the depositions, resulted in the Willits Trust's estimates of tank construction dates submitted in the Final RI Report. However, as indicated above, the Willits Trust has been informed that Whitman Corporation has conducted a much more comprehensive review of operational dates which, after the conduct of an independent investigation by the Willits Trust, might result in further modifications to the Willits Trust's previously published historical operations summaries.

6) <u>CDHS Response</u>*: *CDHS has consistently used all available and credible information sources to evaluate past exposures. Additional information has become available since the public comment draft was issued, which has been incorporated. As expected the changes to model altered the output somewhat, but did not substantially change the overall exposure picture for Willits residents.

Conflicting information regarding the early time periods of Remco operations posed a challenge in establishing modeling assumptions regarding the tank installation and emission control history. While we make every effort to be as accurate as possible, given the choice of potential exposure scenarios (tanks installation timeline), we chose to use a scenario (published in Remco reports) that would not underestimate exposures and potential adverse health effects.

CDHS has reviewed the information provided with the comments (not previously available), and conducted additional interviews with former employees who combined, worked in Remco's plating department from 1967 – 1995. We have modified the tank installation timeline in the PHA to reflect the following:

Tank 1: ~1963(4): 14 x 5 x 7, 3500 gallon capacity (1)

Tank 2: ~1963(4): ~ 4' x 6' x 4.5', 800 gallon capacity - replaced in ~1968: 12 x 5.5x7, 3200 gallon (1, #184, #185)

Tank 3: 1968: 3' diameter x 32' deep (1, #183)

Tank 4: 1973: 4' diameter x 38' deep (1, #183)

Tank 5: 1970: 3' diameter x 20'6" deep (Wake 1996, Straight 1996, #183)

Tank 6: 1977: 4' diameter x 48'8" deep (Final RI)

Tank 7: 1982: 4' diameter x 60' deep (Final RI prior to 11/25/02 revision, #183)

---

‡‡‡‡ Mr. Wake was an employee from 1972- 1991 and Mr. Straight was an employee from 1969-1993.

CDHS has received comments from the WERT and Latham and Watkins (Whitman/Pepsi America's lawyers) for using data presented in earlier reports and employee testimony rather than using information presented in the Final Remedial Investigation Report (RI), which according to Latham and Watkins contains the most comprehensive information available. However, it appears the actual installation dates for the vertical underground plating tanks is still a source of deliberation, as information presented in the Final RI report has changed once again. The most recent change was a revision to the April 2002 RI report, written by Montgomery Watson Harza, Inc. (MWH). On November 25, 2002, MWH sent a revised table titled, "Table 2-2 Chrome Plating Tank Construction Specifications" in which the construction date for Tank No. 7 was changed from 1981 to 1986. CDHS staff has a copy of a 1983 inspection report from the Mendocino County Air Quality Management District (MCQAMD) that indicates there were seven plating tanks were in operation (147). This information clearly contradicts the most recent change to the tank construction timeline as asserted by the responsible party's consultant.

CDHS identified other inconsistencies with the construction dates of the first three vertical tanks, based on former employee testimony. For example, a former employee who began working at Remco in 1969, testified that there were three outdoor vertical tanks operating when he first began working at Remco, not one, which would have been the case using the later timeline proposed by the RP's consultants and lawyers {, May 1997 #18}. Testimony given by another employee, who began working at Remco in 1972, stated that there were 3 outdoor tanks (Tanks 3-5) operating during the onset of his employ, which would not have been the case with the later timeline, that suggests there were two outdoor tanks in 1972 (Tank 3 and Tank 5); and the most recent timeline proposed by the RP's lawyers suggesting Tanks 4 and 5 were installed in 1973 {, December 1996 #7}. Testimony given by another employee suggests that a deep tank (15-20 feet) was in operation in 1963 {, April 1997 #191}. As stated in the PHA, on a number of occasions CDHS attempted to obtain additional clarification from MWH and the WERT regarding inconsistencies between the tank installation timelines, and received none. It is for these reasons CDHS appropriately chose to use a more health protective timeline in evaluating potential exposures.

The WERT's Trustee serves on the CDHS Site Team, which was formed to provide ongoing information on the PHA process and provide a mechanism for feedback and the sharing of information. The data needs for the development of the Air PHA were discussed at a Site Team meeting in 2001 and in subsequent data requests from CDHS to the WERT. If the WERT obtained additional records subsequent the Final RI and CDHS requests, these records could have been forwarded to CDHS.

Since the release of the public comment draft PHA, Whitman/Pepsi America has made some operational records available to CDHS.

<u>Use of Scrubbers on Chrome Plating Tanks</u>

The CDHS states that there were no pollution control devices used until 1976 (Summary, p. 2, para. 1). As summarized in the Final Remedial Investigation Report, former deposition testimony and records indicate that there were pollution control devices used on the chrome plating tanks *prior* to 1976. Again, it is our understanding that Whitman Corporation will be providing additional data with respect to historical installation and operational dates associated with scrubbers formerly located at the Site.[§§§§3] This information should be considered and included in the air modeling conducted by CDHS.

7) CDHS Response*: *The historical information provided by Whitman Corporation/Pepsi America consisted mostly of records indicating the purchase of certain types of equipment, not operational dates as suggested by the comment. Whitman Corporation/Pepsi America did not provide any technical documentation as to the efficiency of the emission control equipment, the tanks in which the equipment was used nor the dates it was installed. CDHS conducted additional inquiry with former workers and air pollution control experts. Reportedly, Remco used various types of collection equipment to pull the vapors from the plating tanks (discussed in the public comment draft PHA); however this equipment was not effective at removing (scrubbing) the hexavalent chromium from the exhaust stream. CDHS' original assumption that emissions prior to 1976 were uncontrolled is appropriate and supported by the historical record.

Current/Future Inhalation Exposure Pathway

CDHS' Draft PHA recommends that the Willits Trust take measures to "... mitigate resuspension of hexavalent chromium-contaminated dusts or soil that could be generated during remedial activities at the site." (Draft PHA, p. 43) It appears that the Draft PHA's basis for this recommendation appears to be based upon a limited number of samples, some of which may not be indicative of dust related risk at all. Specifically, CDHS states (p. 10) that it has:

> ... identified a potential exposure pathway to hexavalent chromium and lead from resuspension of contaminated soils or dust residue on building surfaces that may become entrained in the air during remedial and other activities at the Site. High levels of chromium ... and lead ... have been detected in dust samples collected inside the Remco facility by the Department of Toxic Substances Control and in wipe samples collected by the Willits Trust.

After receiving the Draft PHA, the Willits Trust requested all information that the CDHS relied on regarding the DTSC data. The CDHS provided the Willits Trust only with a fax transmittal sheet from Jan Goebel of the Regional Water Quality Control Board to Tracy Barreau that transmitted a laboratory analytical report for two solid samples and three liquid samples. The fax transmittal sheet had a hand written comment that states "Dust samples from the floor near the vertical plating tanks". Ms. Barreau indicated that she had no other information regarding the data. The Willits Trust has made repeated requests of Ms. Goebel for additional information regarding the DTSC data, including information on the location of the samples, sampling methodology, and Chain-of-Custody documentation for the samples. To date, Ms. Goebel has not been able to provide the Willits Trust with any additional information regarding the collection of the samples at issue.

The Willits Trust's concerns regarding CDHS' reliance upon these DTSC samples for their conclusion, that there is a "current and future" risk posed by contaminants at the Site, is

---

[§§§§] By the time the Willits Trust assumed responsibility for the Site in 1997, the bulk of the scrubber equipment had been sold at auction and removed from the Site.

compounded by two additional factors. Firstly, the area in which the samples were reportedly collected ("the floor near the vertical plating tanks") has been thoroughly cleaned since 1999 and, therefore, the data collected, even if valid at the time, are likely not representative of current Site conditions and do not pose a current or prospective threat. Any access to remaining contaminants in the vicinity of the sample area around the former chrome shop (including the chrome tanks) is also limited, due to the fact that the area is cordoned off, restricting vehicular and pedestrian traffic in this area. Secondly, the only sample that the Willits Trust observed the DTSC collecting during this 1999 appeared to be a sample of "chrome salts" adjacent to the vertical tanks in which the chrome salts were scraped into a sample jar. These chrome salts are not subject to resuspension unless intentionally disturbed, and are not "dust" as characterized by the fax transmittal from the RWQCB. Based on this information, the data collected by the DTSC is not representative of current Site conditions nor material that could have been resuspended during remedial and other activities at the Site.

The Willits Trust collected wipe samples as part of the PEA. The results from this sampling were reported in the PEA Report, the Interim Remedial Investigation Report and the Final Remedial Investigation Report. As summarized in these documents, the highest levels of chromium and lead were detected in the area of the former chrome plating shop. As indicated above, this area is cordoned off to minimize disturbance of the building materials. In addition, some of these materials have subsequently been cleaned and/or removed and no longer represent current Site conditions. In addition, air samples have been collected during Site activities, which clearly show that neither workers nor members of the public have been exposed to unsafe levels of contaminants during Site activities.

8) <u>CDHS Response</u>**: **There is an ongoing source for dust contamination inside the facility from rising groundwater contaminated with hexavalent chromium. CDHS staff have visited the site on a number of occasions and observed chromium salts/residue on the floor in the former plating department. There are a number of activities ongoing and planned at the site making the resuspension of these contaminants possible. CDHS agrees that as long as measures are taken to reduce access or disturbances to this area, the resuspension of dust from this area is unlikely.

Given these concerns regarding the sampling procedures employed, and given the absence of documentation regarding the location, sampling methodology and chain-of-custody for the DTSC samples, it is inappropriate, and contrary to standard guidance and scientific practices, to rely upon or make any conclusions regarding the data regarding present or prospective risk to human health or the environment. As such, the Willits Trust requests that CDHS strike any references to "current and future health hazard" posed by contaminants at the Site from this and any future Draft PHA. To the extent that CDHS wishes to address present or future health hazards, the Willits Trust recommends that such conclusions and recommendations are more appropriately the subject of the upcoming "comprehensive public health assessment," referenced at page 5 of the Draft PHA. The comprehensive public health assessment will reportedly deal with "all *potential* routes of exposure, including ingestion, inhalation, dermal contact, etc.

9) <u>CDHS Response</u>**: **The recommendations made in the public comment draft PHA are appropriate and remain unchanged. We will consider restating recommendations related to future remedial work at the site in the comprehensive PHA, as suggested by the comment.

Lastly, the Willits Trust has *always* taken adequate measures to mitigate the potential exposure to Site-related contaminants during any investigation or remedial activities at the Site and will continue to do so. Further, the adequacy of these mitigation measures has been consistently confirmed through the use of monitoring, to ensure that the public is adequately protected during Site activities and will continue to do so.

10) <u>CDHS Response</u>*: *As a public health agency, it is appropriate that we recommend these measures. We appreciate the WERTS' past history and intention to follow through on these measures.

<u>Computer Air Modeling</u>

The Willits Trust understands that because there were no air measurements of hexavalent chromium during the period of chrome plating operations at the Remco Facility, the CDHS relied on a computer air model to estimate potential historical hexavalent chromium emissions from the Remco Facility. The Willits Trust further understands that the use of models is a generally accepted practice for estimating exposure concentrations in the absence of analytical data.

Assumptions, in the absence of analytical data, it is also critical to model *the full range of* uncertainty in the underlying assumptions that may impact the model results so as to represent the reasonable range of potential emissions from the Facility. Specifically, the Willits Trust recommends that the CDHS model be revised to include the corrected dates of chrome plating tank construction and operation, and include the corrected dates of scrubber construction and operation, including utilization of a range of potential scrubber efficiency based on all the available data regarding past practices at the facility.

Lack of Documentation Detail. In addition, the documentation of the air model (Appendix D, Atmospheric Dispersion Modeling) lacked sufficient detail to fully evaluate and comment on the modeling results. As stated before in this letter, the evaluation should be based on the most complete information available. Accordingly, the modeler should be provided with a copy of the Final Remedial Investigation Report and the most recent addenda thereto, rather than relaying on the Interim Remedial Investigation Report. Given that the conclusions from the Draft PHA report all are direct outcomes of the modeling results, the Willits Trust requests that the computer modeling be revised and the Draft PHA resubmitted as a Second Draft PHA Report for public comment, so that a complete review of this critical information can be conducted prior to release of any final documentation.

11) <u>CDHS Response</u>*: *Additional information on the uncertainty of the air model is provided in the final PHA. Since the public comment release of the PHA, CDHS obtained additional information (previously not provided to CDHS) and conducted additional inquiry, which has allowed for an even more accurate depiction of past releases and exposure. The air model and exposure assessment have been revised to reflect this information and a discussion provided in the final PHA. While some of the assumptions used in the PHA have changed, the conclusions and recommendations have not been altered from those presented in the public comment draft PHA. ATSDR/CDHS will not reissue another draft for comment.

More Detail Requested. Within the Second Draft PHA Report, the Willits Trust requests that the following information be discussed in more detail:

- A map showing the location of all assumed sources as well as the height of the assumed source emission relative to the ground surface. (From a preliminary review of model input data, it does not appear that the stack emissions and source area emission height locations were properly entered in the model. Further, the Willits Trust is unsure as to whether the modeler has correctly identified the location of the sources based on the fact that the footprint of the Remco building is improperly identified on the Site Location map.)

- A map showing the assumed topography at the Site. The model documentation states that the model included the effects of terrain. Given the potential significant impact of terrain on modeling results, it is appropriate to provide a depiction of the model input conditions assumed.

- A discussion of how the building (and specifically the numerous different roof heights relative to stack and source emission locations) would impact the transport of hexavalent chromium emissions. It does not appear as if the model incorporates any impacts of the buildings on the emissions. Given that the scrubber emission location was, for the majority of the time, located at a height less than the surrounding roof heights (both to the north and the south), the Willits Trust believes that the building would have had a significant impact on the distribution of emissions from the Remco Facility.

Potential Mapping Errors. As the Willits Trust has discussed with CDHS previously, the Willits Trust is concerned that there is an error with the figures depicting predicted estimated concentrations (included as Figures 3 - 5). Based on our review of a portion of the modeling results, it appears that the modeled results are incorrectly plotted on the base map, resulting in predictions of the maximum concentrations significantly to the south-southeast of the Remco Facility. The Willits Trust recommends a detailed review of the modeling input, output, and methodology used in creating the graphics in the revised Draft Modeling documentation.

12) <u>CDHS Response</u>: Additional information/discussion on the air model is provided. The air model has been revised to reflect recently obtained information. The mapping coordinates have been reviewed and the contours plotted accordingly.

Sensitivity Analysis. Lastly, the modeling should include a sensitivity analysis to evaluate the impact of different model assumptions on the resultant estimated potential exposure concentrations. The incorporation of a sensitivity analysis is a normal procedure in any environmental modeling, and is critical to be included in modeling efforts that are unable or do not attempt to calibrate or verify the modeling results with actual data.

13) <u>CDHS Response</u>: Additional information on the uncertainty/sensitivity of the air model is provided in the final PHA (Appendix D).

<u>Medical Monitoring</u>

The Willits Trust is concerned regarding the CDHS Draft PHA assertion that medical monitoring/clinical evaluation for Willits residents and people who worked in Willits, counseling and stress support services might be available under the Amended Final Consent Decree, Final

Order and Final Judgment; And Order Establishing The Willits Environmental Remediation Trust, Case No. C96-0283 SI, (N. D. Cal.), entered by the United States Federal District Court on December 22,2000 ("Consent Decree"). Specifically, CDHS recommends (Summary pp. 3-4, and Recommendations p. 43) that:

> ... the feasibility of medical monitoring/clinical evaluation for Willits residents and people who worked in Willits who may have been exposed to air releases of hexavalent chromium from Remco, between 1964-1995, be considered.... If medical monitoring is undertaken, CDHS recommends an expert work group with community representation be established to develop a protocol for medical/clinical services, including criteria for participation and an overall implementation plan. These activities could fall under the medial monitoring provision of the Consent Decree.

The Willits Trust has spent a considerable amount of time reviewing and interpreting the various provisions of the Consent Decree and the impact of those provisions, including the Medical Monitoring provisions, on the Work. A review of the Consent Decree, and the context within which it was drafted, clearly indicates that the Consent Decree does *not* allow for the use of the Medical Monitoring Reserve for the medical monitoring of individuals who were exposed to historical releases of contaminants from Remco. Rather, the Medical Monitoring Reserve, once funded, was intended to *exclusively* address any *current or prospective* impacts on human health potentially posed by hazardous substances remaining at the Site from the date of entry of the Consent Decree forward.

The reasons specifically preventing application of the Consent Decree's Medical Monitoring Reserves in the present instance are straightforward:

- *Consent Decree Limited to Prospective Impacts.* The litigation which the Consent Decree resolved has its origins in statutory and common law nuisance. The remedy for nuisance *prospective* in nature, *i.e.,* the abatement of the existing nuisance. The City of Willits, in the underlying action, actually could not have sought damages (potentially including medical monitoring) on behalf of individuals allegedly exposed to historical contamination. Such alleged exposures are, properly, the subject of separate personal injury actions brought by the individuals claiming injury. In fact, several personal injury actions have already been filed in connection with the Site, separate and apart from the City's action seeking prospective investigation and cleanup, which the Consent Decree resolved;

- *Medical Monitoring Reserve Limited to Prospective Impacts.* The Medical Monitoring Reserve was formulated at a time prior to the formulation of the PEA and the exhaustive remedial investigation subsequently conducted by the Willits Trust. As such, it was uncertain whether the Site formed a current or prospective threat to human health, potentially exposing the Willits Trust to personal injury claims upon transfer of the Site to the Willits Trust. Had there actually been a present or future threat to human health, and had the funding mechanism set forth in the Consent Decree been triggered, the Trustee would have been authorized to establish the Medical Monitoring Reserve *solely* to monitor *current* and *prospective* impacts posed by any contamination that existed at the Site once it was transferred to the Willits Trust.

- *No Significant Prospective Impacts Posed by Current Contamination.* Fortunately, shortly after the Consent Decree was entered, the Willits Trust conducted a PEA investigation, and determined that the hazardous substances at the Site posed no significant current threat to human health or the environment. The primary basis of this finding was a lack of complete exposure pathways and the presence of various Site access restrictions and other control mechanisms.

- *Limitations on Trustee's Ability to Fund.* The Consent Decree contains two significant limitations on the Trustee's ability to fund any Medical Monitoring Reserve, neither of which have been satisfied to date. Initially, the Trustee may only fund the Medical Monitoring Reserve with funds obtained in a separate insurance recovery action, which recovery has not yet occurred. Second, certain expenditures, such as prior enforcement fees, must be reimbursed to Settling Parties prior to funding of the reserves set forth in the Consent Decree. Such reimbursements have not been made to date.

For the reasons set forth above, CDHS' desire to conduct medial monitoring and clinical services in association with hypothetical historical exposures (1964 - 1995) clearly falls outside of the scope of the Consent Decree and the Trustee's ability to fund the Medical Monitoring Reserve set forth therein. Therefore, the Willits Trust requests that the first recommendation in the Draft PHA be modified so as to strike the statement that medical monitoring and clinical services "could fall under the medical monitoring provision of the Consent Decree." Similarly, the Willits Trust requests that this assertion be removed from the On-going actions portion of the Draft PHA, as set forth on page 44.

14) <u>CDHS Response</u>*: *Comment noted. ATSDR/CDHS anticipates that interpretations of the Consent Decree will be made by Judge Ilston or from the Superior Court.

<u>Conclusions</u>

In conclusion, for the reasons set forth above, the Willits Trust respectfully requests that the Draft PHA be revised to address the comments set forth above, as well as those received from other commentors. Once revised, the Willits Trust respectfully requests that the document once again be issued in *draft* form, this time with underlying modeling and other data available for public review and comment.

15) <u>CDHS Response</u>*: *CDHS obtained additional information (previously not provided to CDHS) and conducted additional inquiry, which has allowed for a more accurate depiction of past releases and potential exposure. The air model and exposure assessment have been revised to reflect this information and a discussion provided in the final PHA. While some of the assumptions used in the PHA have changed, the conclusions and recommendations have not been altered from those presented in the public comment draft PHA. ATSDR/CDHS will not reissue another draft for comment.

The Willits Trust appreciates the opportunity to review the Draft PHA and hopes that the comments provided will assist CDHS in revising this document. We look forward to your response to these comments.

[Letter signed by the Trustee for the Willits Environmental Remediation Trust]